ALABAMA DEPARTMENT OF TRANSPORTATION

MAINTENANCE BUREAU

1409 Coliseum Boulevard, Montgomery, Alabama 36110
P.O. Box 303050, Montgomery, Alabama 36130-3050
PHONE: (334) 242-6272 FAX: (334) 242-6378

Kay Ivey
Governor

John R. Cooper
Transportation Director

June 24, 2019

To: Mark Bartlett
FHWA Division Administrator

Attn: Kristy Harris
Program Analyst / Pavement & Materials

From: John R. Cooper
John R. Cooper, Transportation Director ghc

Reference: ALDOT's Transportation Asset Management Plan

Dear Mr. Bartlett:

In response to the Moving Ahead for Progress in the 21st Century Act (MAP-21), the Alabama Department of Transportation (ALDOT), in cooperation with our local division field FHWA office, has been diligently working to complete our Transportation Asset Management Plan (TAMP). The development process for our TAMP started in 2014 and a first draft was completed in 2016. In 2018, the TAMP was updated using 2017 pavement and bridge condition data. In 2019, the TAMP was updated to meet the guidelines for the annual consistency determination.

Attached is ALDOT's completed Transportation Asset Management Plan. If you have any questions about our TAMP, please contact Ben Yates at 334-242-6277.

BCY

Cc: Mr. Don Arkle, Chief Engineer
Mr. George Conner, Deputy Director, Operations
Ms. Maxine Wheeler, Deputy Director, Administration
Mr. Ed Austin, Assistant Chief Engineer, Policy and Planning
Mr. Stacey Glass, State Maintenance Engineer
Mr. Scott George, State Materials and Tests Engineer
Mr. Tim Colquett, State Bridge Engineer
Mr. Ed Phillips, State Local Transportation Engineer

D Y E   M A N A G E M E N T   G R O U P ,   I N C .
601 108th Avenue NE, Suite 1900, Bellevue, WA 98004
T: (425) 637-8010 • F: (425) 637-8020 • www.dyemanagement.com

Alabama Department of Transportation (ALDOT)

Transportation Asset Management Plan (TAMP)

Final Report

June 2020

Alabama Department of Transportation (ALDOT) Transportation Asset Management Plan (TAMP)

Final Report

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Executive Summary

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The Alabama Department of Transportation (ALDOT) strives to find innovative and cost-effective approaches for improving the state's transportation system. The development of ALDOT's Transportation Asset Management Plan (TAMP) is consistent with ALDOT's desire to make data-driven spending decisions related to its assets. In short, ALDOT puts into practice – both on a regular basis and more specifically through this TAMP effort – the underlying principle of Transportation Asset Management (TAM): better decision making based upon quality information and well-defined objectives. The TAMP will be a central resource for multiple ALDOT Bureaus for asset information, management strategies around those assets, financial sources and forecasting, and business management processes. ALDOT, assisted by Dye Management Group, Inc. (DMG), began the TAMP development process in 2014 and completed its initial TAMP in the spring of 2018.

A. TAMP Goals and Objectives

The TAMP Executive and Steering Committees guided the plan's development. The Executive Committee included the Chief Engineer, Assistant Chief Engineer of Policy and Planning, Chief Financial Officer, Deputy Director of Operations, Chief of the Computer Services Bureau, State Maintenance Engineer, Assistant State Maintenance Engineer for Management and Training, and Deputy Director of Administration.

The Steering Committee comprised sixteen members, including staff from the following Bureaus: Local Transportation, Data Collection & Data Management, Maintenance, Materials & Tests, Bridge, and Finance. Other members included a Region Engineer and two FHWA representatives.

DMG met with the Steering and Executive Committees at key points throughout the TAMP's development to present information gathered from their data collection efforts and request feedback on the interim work products and main ideas presented at the committee meetings. In addition, DMG conducted interviews with leadership in the Maintenance, Construction, and Bridge Bureaus. Based on the information captured from the stakeholder interviews and a review of existing plans, ALDOT developed the eight goals presented in Exhibit 1 to guide TAM within the Department.

Exhibit 1: TAMP Goals

	Goal
1	Instill TAM as an integral part of the ALDOT business model to foster adaptation.
2	Use a risk management framework to identify threats and opportunities for projects and programs.
3	Preserve Alabama's transportation assets, such as pavement and bridges.
4	Make sure the TAMP influences and is influenced by other plans.

Goal	
5	Use the TAMP to identify and streamline processes shared by multiple Bureaus and unify activities to advance ALDOT collaboration.
6	Identify sustainable funding patterns for roads and bridges to address needs.
7	Stabilize the peaks and valleys of project schedules (design and lettings) to improve project delivery.
8	Improve data quality and knowledge/process retention to progress toward structured, data-driven decision-making processes.

B. ALDOT Asset Inventory and Condition

The Moving Ahead for Progress in the 21st Century Act (MAP-21) requires that, at a minimum, all pavement and bridges on National Highway System (NHS) routes be included in a TAMP. In addition to including all NHS pavements, regardless of their ownership, they also included state-owned non-NHS pavements and bridges. This comprises 11,019 centerline miles (28,878 lane-miles) of pavement and 5,814 bridges (83.6 million square feet of deck area). Approximately 98 percent of ALDOT-managed centerline miles (10,701) are paved with asphalt and are given a pavement condition rating (PCR). The remaining 2 percent have not been assigned a PCR for one of three reasons: 1) incomplete condition data, meaning that data have been reported for less than 30 percent of the segment's length, 2) road segments are made of concrete, or 3) road segments are in tunnels or on bridges. Existing asset condition was documented for both pavement and bridges to establish the baseline for future analysis.

C. Periodic Evaluations of Facilities Requiring Repair and Reconstruction Due to Emergency Events

According to the final rule related to asset management plans published on October 24, 2016 (23 CFR 515 and 23 CFR 667), state DOTs must "perform statewide evaluations to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events." An emergency event is defined as a "natural disaster or catastrophic failure resulting in an emergency declared by the Governor of the State or an emergency or disaster declared by the President of the United States." Repair and reconstruction is defined as "work on a road, highway, or bridge that has one or more reconstruction elements" and excludes the following emergency repairs as defined in 23 CFR 668.103: "temporary traffic operations undertaken during or immediately following the disaster occurrence for the purpose of: (1) Minimizing the extent of the damage, (2) Protecting remaining facilities, or (3) Restoring essential traffic."

To address this requirement, ALDOT collected the appropriate data related to emergency events and repair work, analyzed the data, and found that thirty-six locations "repeatedly required repair or reconstruction due to emergency events" between 1997 and 2018. A total of 78 events requiring repair and reconstruction occurred in these locations. Approximately one-third of these events occurred between 1997 and 2008 and two-thirds occurred between 2009 and the present. Most of these events were related to severe weather, including hurricanes, and the greatest concentration of events was in the Southwest Region of Alabama. About fifty-five percent of the repair or reconstruction activities related to slope failures or slides, 9% were related to bridge and culvert repairs, and 9% were related to drainage, sinkholes, or other environmental issues. The remaining 27% did not include descriptions beyond “emergency repairs.”

ALDOT also reviewed available emergency events cost data from its Comprehensive Project Management System (CPMS), which is its Department-wide software system that houses project management and cost data. Costs can vary widely for these different types of repairs.

ALDOT reviewed costs from 32 of these events. The range of costs for these specific emergency repairs related to slope failures and slides during the 1997-2018 time period was approximately $400 - $456,000, with an average cost of $59,000. Bridge repair or replacement costs can vary widely, depending upon the severity of the issue, the size of the bridge, and if the bridge must be replaced. Costs for other types of repairs can vary widely as well. To provide a few examples, the following costs were gathered from CPMS and represent costs for individual events.

- Bridge scour - $117,000
- Cross drain failure - $108,000
- Culvert repair – In one instance, the cost was $36,000; in another instance, the cost was $1.3 million.

D. Pavement Condition

ALDOT uses its Pavement Management System to store pavement condition data and to create the Preliminary Prioritization Report (PPR). The PPR includes a series of reports and maps used to disseminate PCR scores, which are also available on ALDOT’s Intranet site. It also provides the ability to identify overlays most in need of attention in terms of routine and preventive maintenance. Pavement is rated according to several factors. After it is rated, a composite PCR score is assigned to each pavement segment.

Prior to 2015, ALDOT’s PCR process was not optimized for forecasting future conditions. To address this challenge, the Pavement Management Section developed a new PCR based on four factors relevant to pavement condition, with a maximum possible score of 100. The revised PCR methodology was presented to the Pavement Management Steering Committee for review and was approved for use in 2015. The numbers in the TAMP were calculated according to the new PCR methodology. The lane-mile totals are determined for three route types (Interstates, Non-Interstate NHS, and Non-NHS roads) in three condition categories (Good, Fair, and Marginal).

The most recent condition ratings, collected in 2016, are presented in Exhibit 2. In summary, most rated pavements, approximately 64 percent (18,471.64 lane-miles), are in good condition, 18.7 percent are in fair condition, and 17.4 percent are in marginal condition.

Exhibit 2: Pavement Condition Ratings by Route Type

	Good PCR >= 70		Fair 70 > PCR > 55		Marginal PCR <= 55		Total
Route Type	**Lane-Miles**	**Percent of Type**	**Lane-Miles**	**Percent of Type**	**Lane-Miles**	**Percent of Type**	**Lane-Miles**
Interstate	2,906.85	76.98%	554.327	14.68%	314.70	8.33%	**3,775.88**
Non-Interstate NHS	6,859.14	66.23%	2,195.12	21.20%	1,301.70	12.57%	**10,355.96**
Non-Interstate NHS (non-state-owned)	72.39	19.99%	253.25	69.93%	36.52	10.09%	**362.16**
Non-NHS	8,633.26	60.02%	2,391.67	16.63%	3,359.14	23.35%	**14,384.08**
Asphalt Total	**18,471.64**	**63.96%**	**5,394.37**	**18.68%**	**5,012.07**	**17.36%**	**28,878.08**

Source: PCR scores from data collected in 2016. Pavement Management Section, Bureau of Materials & Tests.

E. Bridge Condition

ALDOT currently tracks structurally deficient and posted bridges and uses three ratings from the National Bridge Inventory (NBI) Bridge Condition Thresholds: Good, Fair, and Poor. These conditions are quantified in both count and square feet of deck area for five categories of bridges, as shown in Exhibit 3: Bridge Condition Ratings by NHS Group.

Exhibit 3: Bridge Condition Ratings by NHS Group

	Good		Fair		Poor		Totals
	Deck Area*	Percent	Deck Area*	Percent	Deck Area*	Percent	Deck Area*
Bridges carrying Interstate highways	5,955,000	17.0%	28,081,388	80.3%	931,481	2.7%	34,967,871
Bridges carrying other NHS roads (state-owned)	10,900,910	44.1%	13,997,670	54.4%	260,263	1.5%	25,158,842
Bridges carrying other NHS roads (non-state-owned)	346,494	64.6%	189,052	35.3%	0	0.0%	535,546
Bridges carrying non-NHS roads (state-owned)	10,390,020	45.2%	12,256,746	53.3%	334,110	1.5%	22,980,876
Bridges carrying non-NHS roads (non-state-owned)	15,175,741	52.3%	12,604,045	43.4%	1,252,095	4.3%	29,031,880
Total	**42,768,165**	**38.0%**	**67,128,901**	**59.5%**	**2,777,949**	**2.5%**	**112,675,014**
NHS Bridges	**17,202,404**	**28.4%**	**42,268,111**	**69.7%**	**1,191,743**	**2.0%**	**60,662,258**
State-Owned	**27,245,930**	**32.8%**	**54,335,804**	**65.4%**	**1,525,854**	**1.8%**	**83,107,588**

Note: *Deck area is measured in square feet.

The condition of Alabama's bridges can be summarized as follows: 38.0 percent are in good condition, 59.5 percent are in fair condition, and 2.5 percent are in poor condition. Additionally, NHS and state-owned bridges are totaled for analysis within the TAMP, as the federal requirements focus on the bridges and pavement that comprise the NHS.

F. ALDOT Systems and Data

Throughout the TAM analysis, the project team identified gaps between current department TAM data and systems and those required by the FHWA and exemplified by best practices. An example of a pavement gap for ALDOT is "No quantifiable pavement condition target because condition data is not consistent year to year." This gap illustrates an issue in the process and/or data ALDOT utilizes to make decisions. Strategies, as shown in

Exhibit 4, are included within the TAMP to address these gaps. A more detailed table of the strategies that incorporates timeframe and cost is provided in Appendix D.

Exhibit 4: Strategies for Implementation

No.	Strategy	Purpose
1	Implement an enhanced pavement management system	To enable the Department to conduct pavement condition forecasting based on various funding levels, provide guidance for project selection, and allocate funds based on need.
2	Fully implement AASHTOWare™ Bridge Management software (BrM)	To enable candidate project and program generation and estimate future performance at the corridor and network level.
3	Expand/enhance asset data collection	Consistent asset inventory and condition assessment will improve the ability to develop performance-based budgets.
4	Enhance work accomplishment data	To improve the unit cost and treatment effectiveness metrics.
5	Develop policy and performance measures to prepare for cross-asset/trade-off analysis	Understand and address performance measures across assets as ALDOT establishes specific targets and measures for each asset class. This is a first step to implementing effective cross-asset/trade-off analysis processes and TAM best practices.
6	Improve risk management tools	To assess the impact of negative events to state assets, particularly of bridge failures due to natural and man-made disasters. Provide management models and data to use in risk evaluation modules (e.g., AASHTOWare BrM).
7	Improve preservation practices	Minimize life-cycle costs to maintain assets.
8	Include additional assets in future iterations of the TAMP	To enable a more comprehensive approach to TAM.
9	Ensure organizational adoption	To oversee the full implementation of modern TAM practices and data-driven decision making.

G. Life Cycle Planning

To effectively practice transportation asset management, an agency must conduct life cycle planning, which is defined in 23 CFR 515.5 as, "a process to estimate the cost of managing an asset class, or asset sub-group, over its whole life with consideration for minimizing cost while preserving or improving the condition." ALDOT understands that a worst-first mentality toward maintaining pavements and bridges is expensive. It is much more cost-effective to keep these assets in good condition than to let them fall into fair or poor condition.

Section *IV: Life Cycle Planning* describes the different work types ALDOT applies to its pavement and bridge assets and includes a crosswalk to illustrate how ALDOT's work types align with the federal work types outlined in the TAMP regulations.

Life cycle planning was also an area of focus when conducting the investment analysis portion of the TAMP. ALDOT considered not only the overall cost of each scenario for this ten-year period, but also the condition of the assets at the end of that period and what that means in terms of cost and performance for the years beyond FY2028. For example, when creating investment scenarios, ALDOT included scenarios that support good asset preservation practices.

H. Risk Management and Analysis

During several risk assessment interviews and workshops, ALDOT staff and executives identified potential asset management risks, estimated consequences and likelihoods, and proposed mitigation strategies. The risks were categorized as follows: Business & System Performance, Environmental, Financial, Health & Safety, Legal & Compliance, and Reputation/Stakeholder Management.

One example of a risk is diminished revenues from reduced annual vehicle miles traveled (VMT) due to increased vehicle fuel efficiency and/or fewer vehicle trips per person. The mitigation strategy for this risk could include a new model for revenue estimation that considers this change. Also, ALDOT should educate and inform elected officials, decision makers, and the public on the potential impacts.

I. Financial and Investment Analysis

The financial analysis determined how much funding ALDOT can expect to receive to manage its assets. For the purposes of the financial analysis, this plan assumes that ALDOT allocated $684 million to pavement and bridge activities in FY 2017. The actual FY 2017 budget was higher ($702 million); however, ALDOT preferred to use a slightly lower number that was more typical. This total includes state and federal funding, both of which are not projected to increase in future years, after accounting for inflation.

While the Fixing America's Surface Transportation (FAST) Act and recent state legislative proposals may produce a funding increase for ALDOT, it is still too early to quantify those potential increases. Thus, this TAMP's projections assume consistent funding levels across the ten-year period.

1. Pavement

After reviewing ALDOT's current budget and revenue sources and projections, the project team ran three pavement investment scenarios to determine how ALDOT's performance targets can and will be addressed. Currently, ALDOT lumps the five work types (Maintenance, Preservation, Rehabilitation, Reconstruction, & New Construction) into two programs, Interstate Maintenance and Federal-Aid Maintenance.

- **Achieve the target levels[i] established by the TAMP Steering Committee for use in these scenarios:** This scenario requires a budget of $492.8 million annually to achieve the target levels individually for each road class and improve the current road conditions.

- **Continue current budget levels for the next ten years (FY 2019-2028):** Current pavement spending for ALDOT is approximately $473 million annually, adjusted for inflation. Over the ten-year period, this scenario predicts that ALDOT will achieve the pavement condition target levels for all NHS groups (Interstate, Non-Interstate NHS, and Non-NHS pavements).
- **Increase the existing budget by 10 percent to assess the impact on highways:** This scenario provides sufficient funding to achieve the target goals for all NHS groups. An increased budget (approximately $517 million annually, adjusted for inflation) allows ALDOT to improve the condition of the system after ten years, with the majority of pavement in good condition.

The results are summarized in Exhibit 5. It is important to consider these results through the lens of life-cycle planning and maintenance and preservation. While the current budget levels scenario is the least expensive, it allows the largest percentage of roadways to fall into fair condition, which means that costs to repair or replace these pavements will be high in the years beyond FY2028. Therefore, that scenario doesn't rate well from a life-cycle planning perspective. While the budget increase of 10% scenario results in the greatest percentage of pavements in good condition, it is quite expensive and does not minimize cost, which is also not ideal from a life-cycle planning perspective. The "achieve target levels" scenario fares best when considering life-cycle planning because it does the best to maintain the assets in a state of good repair while minimizing cost.

ALDOT understands that a worst-first mentality toward maintaining pavements is expensive. It is much more cost-effective to keep a road in good condition then to let it fall into fair or poor condition. ALDOT conducted its investment analysis with these perspectives in mind, selecting scenarios such as the target scenario that supports the idea of setting and maintaining condition targets that support good asset preservation practices.

Per CFR 515, ALDOT categorized projected pavement expenditures according to the federal work types and estimates that for each year of the 10-year planning horizon, the breakdown will be as follows:

- Preservation - $221.8 M (45%)
- Rehabilitation - $271 M (55%)

Exhibit 5. Pavement Investment Scenarios Results

Scenarios		FY2028			Budget	
		Interstate	Non-Interstate NHS	Non-NHS	$M/year	
Achieving Target Levels	Good	70.0%	70.0%	60.1%	$ 210.2	Interstate
	Fair	20.2%	20.0%	25.4%	$ 145.7	Non-Interstate NHS
	Marginal	9.8%	10.0%	14.5%	$ 136.9	Non-NHS
					$492.8 Target Total	
Current Budget	Good	61.9%	45.1%	45.5%	$ 190.1	Interstate
	Fair	36.8%	47.2%	45.6%	$ 130.3	Non-Interstate NHS
	Marginal	1.3%	7.7%	8.9%	$ 152.5	Non-NHS
					$472.9 Current Budget Total	
Budget Increase 10%	Good	77.3%	64.0%	54.0%	$ 195.0	Interstate
	Fair	19.6%	30.3%	43.1%	$ 164.1	Non-Interstate NHS
	Marginal	3.1%	5.7%	2.9%	$ 157.7	Non-NHS
					$516.8 Budget Increase Total	

2. Bridge

Similarly, the bridge scenarios vary based on funding availability and the desire to reach a specific target level. As of 2017, 98 percent of the state's bridges were in good or fair condition. The four scenarios have been compared against this metric. Currently, ALDOT lumps the five work types (Maintenance, Preservation, Rehabilitation, Reconstruction, & New Construction) into the bridge replacement program.

- **Continue current bridge budget levels for the next ten years (FY 2019-FY 2028):** If current funding levels continue at $91 million annually and are adjusted for inflation, ALDOT can expect to achieve 95.9 percent good or fair condition.
- **Increase the existing bridge budget by 20 percent:** There are only nominal gains in this scenario, as the percent good or fair would still be 96 percent.
- **Achieve the target level of 97 percent of state-owned bridges in good or fair condition:** To achieve the target level of 97 percent good or fair, ALDOT would need to more than double its current funding.
- **Maintain the current bridge condition levels (as of 2017), without regard for resources:** To maintain 98 percent of the state's bridges in good or fair condition over the next ten years, ALDOT would need to spend $297 million annually, more than triple the current funding level. These results are summarized in Exhibit 6.

Exhibit 6: Bridge Investment Scenarios Results

Scenarios		Current Spending	Increase 20%	97% Good or Fair	98% Good or Fair (Current Condition)
% Deck Area in Good or Fair Condition (in FY2028)	State - NHS	95.2	95.4	97.0	98.1
	State - Off NHS	96.6	96.7	97.0	98.4
	State - All	95.6	95.8	97.0	98.2
$Million/Year Required	State - NHS	$ 66	$ 80	$ 166	$ 223
	State - Off NHS	$ 25	$ 30	$ 38	$ 74
	State - All	**$ 91**	**$ 110**	**$ 204**	**$ 297**

To achieve its goals, ALDOT must select an investment approach that addresses the $171.8 million annual shortfall – $58.8 million for pavements and $113 million for bridges – over the next ten years.[ii] Life-cycle planning and preservation are critical when considering how to address this challenge. This should be done through a mix of preservation optimization and an increase in funding.

The current spending scenario is the least expensive, but it allows the % of deck area that is poor to increase, which is not great from a preservation standpoint. Over time, this will cause more and more bridges to reach a point where they need to be replaced immediately, which is very costly. The 20% increase scenario does not support preservation either. The funding is still insufficient to achieve the desired condition levels. The 97% good or fair scenario does the best in terms of supporting life-cycle planning and preservation. The 98% good or fair scenario is great from an asset condition standpoint, but does not minimize cost. It is the most expensive option, at more than three times ALDOT's current bridge spending.

Per CFR 515, ALDOT categorized projected bridge expenditures according to the federal work types and estimates that for each year of the 10-year planning horizon, the breakdown will be as follows:

- Preservation - $25.5 M (12.5%)
- Rehabilitation - $9.2 M (4.5%)
- Maintenance - $4.1 M (2%)
- Reconstruction - $165.2 M (81%)

I. Introduction and Goals

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A. Introduction

Asset management is defined as "a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair (SOGR) over the lifecycle of the assets at minimum practicable cost."[iii] This initial transportation asset management plan (TAMP) summarizes ALDOT's asset management planning processes for its pavements and bridges and includes the specific data and analysis for each required TAMP component, as defined in the final October 24, 2016 rulemaking. Additionally, it identifies areas of excellence and areas in which ALDOT could more effectively use its resources.

TAMPs, part of the National Highway Performance Program (NHPP), were federally mandated by the Moving Ahead for Progress in the 21st Century Act (MAP-21), enacted in 2012[iv]. The Fixing America's Surface Transportation (FAST) Act, passed in 2015, continued the NHPP. Requiring states to create TAMPs promotes the concept of transportation asset management (TAM) in DOTs. One goal of TAM is to achieve better decision making based upon quality information and well-defined objectives, which overlaps with ALDOT's mission statement:

> "To provide a safe, efficient, environmentally sound intermodal transportation system for all users, especially the taxpayers of Alabama. To also facilitate economic and social development and prosperity through the efficient movement of people and goods and to facilitate intermodal connections within Alabama. ALDOT must also demand excellence in transportation and be involved in promoting adequate funding to promote and maintain Alabama's transportation infrastructure."[v]

Within this report, general goals of the ALDOT TAMP and TAM objectives are aligned with the vision of the TAMP Steering Committee and desired TAMP outcomes. The plan includes reviews of existing plans, stakeholder input, and analysis of the decision-making processes for pavements and bridges. All of these activities support the development of ALDOT's goals by providing insights into the critical issues, customer expectations, and/or existing or emerging plans and strategies.

ALDOT's TAMP development was a two-phase process. The first phase began in 2014 and ended with a draft TAMP in 2016. After the final bridge and pavement performance measures rulemakings were published, ALDOT began the second phase of the TAMP. In this phase, ALDOT updated its draft TAMP with new data, including pavement and bridge inventory and condition, financial data, a revised risk register, and investment scenarios.

B. Plan Review and STIP Coordination

1. Plan Review

The TAMP is designed to supplement other long-range plans within the state and will enable ALDOT to make decisions to better address asset performance gaps. The TAMP will also provide inputs to, and utilize outputs from, other planning reports. It will not replace other planning reports; rather, the TAMP complements the other reports and provides specific information about pavement and bridge business practices, conditions, and performance.

The following documents were reviewed during the TAMP development process:

- BrM User Manual (2014)
- RoadMAP Asset Management Manual (2012)
- 2009-2010 Level of Service Customer Report (2010)
- ALDOT Current Maintenance Processes (2008)
- ALDOT Future Model: Level of Service Measures (2008)
- Alabama Statewide Transportation Plan Update (2008)
- Alabama Statewide Transportation Plan (2017)

During the review process, the TAMP goals were cross-referenced against the vision, mission, goals, or guiding principles included in the previously adopted plans. In the *Alabama Statewide Transportation Plan* (2017), one section that was particularly relevant to this effort was “Section 6: Future Trends and Issues”, that identified topics that will influence Alabama’s transportation system in the future. In that section, a focus on the State of Good Repair was mentioned as one of five key trends. The report mentioned that there is a funding trend in which an increasing percent of funding is being used for resurfacing, bridge, and safety projects and less funding is being allocated for capacity projects.

2. STIP Process Review and Coordination

In addition to reviewing planning documents, ALDOT reviewed internal business processes such as the development of the Statewide Transportation Improvement Program (STIP), which identifies programming and funding for transportation projects and programs. This document has an important connection with the TAMP, as it incorporates the bridge and pavement condition targets established as part of the National Performance-Based Program and Planning requirements. Both the STIP and the TAMP support the national transportation goals. For example, maintaining an infrastructure asset system in a state of good repair is one of the national goals. As detailed within this TAMP, ALDOT has a preservation focus and conducts a pavement prioritization process to identify pavement maintenance and preservation projects, for eventual inclusion in the STIP.

The ALDOT TAMP team met with the following ALDOT employees to coordinate with key stakeholders to discuss alignment of the various TAMP and STIP processes and provide any technical assistance as the metropolitan planning organizations (MPOs) selected their pavement and bridge targets:

- STIP Coordinator
- Key decisionmakers in the Local Transportation Bureau
- Assistant Bureau Chief, Planning Studies, in the Bureau of Office Engineering

C. Stakeholder Input

ALDOT included stakeholder input throughout its TAMP development, which was a two-phase process. Dye Management Group, Inc. (DMG) assisted with both phases. In Phase 1, DMG conducted a kickoff meeting and stakeholder interviews on November 5 and 6, 2014. They also conducted interviews with additional ALDOT personnel on December 3, 2014. These interviews helped define current department business processes, identify process gaps, and understand stakeholder expectations for the TAMP project.

During the second phase, on December 5, 2017, DMG and the ALDOT Project Manager conducted a Steering Committee meeting to discuss updates, with a focus on TAMP goals and objectives, the risk assessment, performance targets, and investment scenarios.

D. Goal Identification

Because the main purpose of asset management is to "achieve and sustain the desired state of good repair [SOGR] over the life cycle of the assets at a minimum practicable cost", it is important to define what SOGR means to ALDOT and to think about the agency's goals in connection with the SOGR outcome.

ALDOT's ideal transportation system is one that achieves the condition targets ALDOT developed for its pavements and bridges and is therefore in a SOGR. More specifically, a SOGR is one in which the majority of the Interstate and non-NHS pavements are in good condition and fewer than five percent are in poor condition. For bridges, a SOGR means that the majority of NHS bridges are in good or fair condition, with three percent or fewer in poor condition. These targets were informed by ALDOT's overall goals, listed below and included in Exhibit 7, which outlines how the TAMP will work to achieve each goal for ALDOT.

- **Instill TAM as an integral part of the ALDOT business model to foster adaptation.** Make the TAMP a living document with continual development and updates, which might include expanding to analyze additional assets in the future.
- **Use a risk management framework to identify threats and opportunities for projects and programs.** A risk management framework helps ensure that TAMP

objectives are achievable by routine ALDOT business practices, even in the face of significant risk factors such as funding uncertainty and natural hazards.

- **Preserve Alabama's transportation assets, such as pavement and bridges.** ALDOT intends to incorporate life-cycle planning to shift the focus from "worst-first" methodology to strategic preservation, to avoid or delay major rehabilitation and replacement costs. This will help ALDOT become more proactive with improvements, rather than reacting to needs.
- **Make sure the TAMP influences and is influenced by other plans.** This will help link planning to programming and maintenance activities to ensure consistency and collaboration in activities, objectives, and policies across ALDOT's Bureaus.
- **Use the TAMP to identify and streamline processes shared by multiple Bureaus and unify activities to advance ALDOT collaboration.** Having a comprehensive voice and focus will help break down silos in the Department, which will perpetuate sharing data and perfecting processes, practices, and software improvements across business units. This is ultimately an improvement in efficiency and cost effective, given limited state resources.
- **Identify sustainable funding patterns for roads and bridges to address needs.** This is a dedicated or short-term planning of fund allocation to roads and bridges to maximize efficiency. This will allow the right improvement at the right time to occur.
- **Stabilize the peaks and valleys of project schedules (design and lettings) to improve project delivery.** This will assist both ALDOT personnel and private contractors to better manage workload and improve efficiency.
- **Improve data quality and knowledge/process retention to progress toward structured, data-driven decision-making processes.** MAP-21 has focused on the transparent process and decisions in DOTs. Allowing data to help influence decisions aids in conveying the message and actions to legislatures and stakeholders.

Exhibit 7: ALDOT Goals and TAMP Accomplishments

Goal	How TAMP will Address
Instill TAM as an integral part of the ALDOT business model to foster adaptation.	The ALDOT TAMP details implementation strategies designed for ALDOT.
Use a risk management framework to identify threats and opportunities for projects and programs.	The risk management chapter of the TAMP defines risk; how ALDOT has incorporated it into TAM; and how the consideration of risk informs maintenance practices, asset replacement or rehabilitation, and emergency response.
Preserve Alabama's transportation assets, such as pavement and bridges.	TAM is a business model that helps establish life-cycle cost analysis (LCCA) approaches for transportation assets and links processes, data, and measures across the Department. By applying LCCA, ALDOT will shift the focus from "worst-first" methodology to strategic preservation.

Goal	How TAMP will Address
Make sure the TAMP influences and is influenced by other plans.	The movement toward performance-based planning and data-driven decision making within the TAMP and implementation strategies will facilitate the linkage between planning, programming, and maintenance activities.
Use the TAMP to identify and streamline processes shared by multiple Bureaus and unify activities to advance ALDOT collaboration.	TAM, as a business model, helps address data gaps and overlapping processes which may improve with increased collaboration and efficiency.
Identify sustainable funding patterns for roads and bridges to address needs.	The financial analysis and investment scenarios chapters of the TAMP work together to determine project workload, service levels, and funding expectations, and plan accordingly.
Stabilize the peaks and valleys of project schedules (design and lettings) to improve project delivery.	The asset inventory and condition chapter of the TAMP describes agency processes for management over the entire life cycle of ALDOT's assets. This helps plan for future needs and improvements.
Improve data quality and knowledge/process retention to progress toward structured, data-driven decision-making processes.	The TAMP will also serve as a policy document detailing Department business and decision-making processes. Documentation of current data and process gaps enables the Department to identify opportunities for improved data collection and thereby, improved decision making.

In addition to the goals ALDOT identified for itself, ALDOT reviewed the national transportation goals and determined that ALDOT's goals align with the national goals.

II. ALDOT Asset Inventory and Condition

■

This chapter summarizes the processes used to collect ALDOT's pavement and bridge inventory and condition data and set pavement and bridge targets. Also included is a discussion of future condition projections, gaps in the current processes, strategies to address those gaps, and a discussion of periodic evaluations of facilities requiring repair and reconstruction due to emergency events.

A. Pavements

This section details the pavement inventory and condition assessment processes; summarizes the condition of ALDOT-managed pavement; considers federal condition targets and the process to forecast future pavement conditions; and concludes with a discussion of gaps in the current pavement condition assessment processes and how to address them.

1. Inventory and Condition Assessment Process

This section describes the pavement inventory and condition assessment processes and tools used to support these processes.

a. Data Collection

Pavement distress data is provided yearly from a data collection vendor for ALDOT and is collected according to the FHWA-approved Data Quality Management Plan as required for Transportation Performance Management (TPM) requirements (Appendix A). Data is collected on the National Highway System (Interstate and Non-Interstate NHS) yearly. Data is also collected on non-NHS routes biennially by Region, with the North, East Central, and Southwest collected in odd years and West Central and Southeast collected in even years.

ALDOT's Pavement Management System (PMS) matches roadway condition data provided by the data collection vendor to overlay data for reporting. Pavement overlays are tracked once they are awarded to construction contractors. The Construction Bureau sends a letter to the contractor at substantial completion to notify that the project has been accepted into state maintenance once the final punch list items have been completed and the opportunity to file lien has been circulated in a local newspaper. The date accepted becomes the initial date with respect to age calculations for the pavement.

If the pavement was surveyed by ALDOT's data collection vendor before the "accepted for maintenance" date, it is reported as "New" in the pavement condition inventory database. Pavements under contract (that have been awarded but not accepted) also fall into this category. Otherwise, the pavement is scored using the condition assessment process described later in this report. Overlays are populated in the Pavement Management System after they have been awarded, but it may take up to two years from the date of acceptance to receive a score if the pavement is not on the NHS. However, little or no distress should be present in this timeframe.

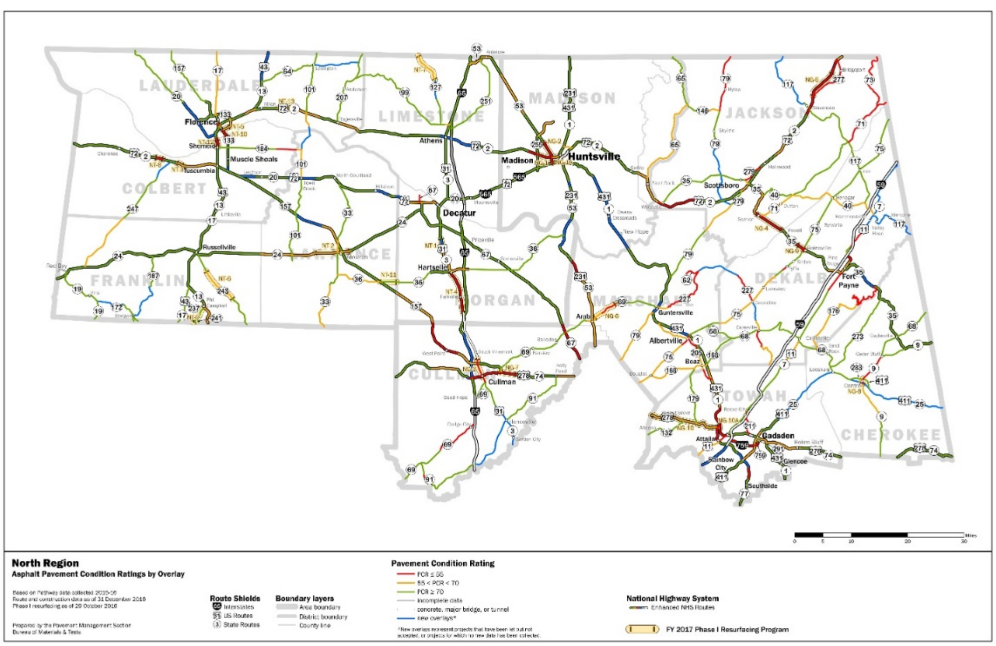
The TAMP requirements state that ALDOT must coordinate and obtain necessary data from other NHS owners. ALDOT collects all NHS data for the state and therefore does not need to obtain data from other agencies.

b. Preliminary Prioritization Report Database

The Preliminary Prioritization Report (PPR) has evolved from a report showing a single 0-100 score per overlay to a series of reports and maps using overall scores and subscores in various combinations. These subscores, based on 0-100 ratings of roughness (from IRI), wheelpath cracking, rutting, and pavement age, provide more information to Regions and Areas that allows for the identification of overlays most in need of attention in terms of routine and preventive maintenance. Due to uncertainty regarding highway speed collection of cracking data, the PPR is used primarily as a screening tool to help Areas focus on specific treatment types rather than prescribing their use. For instance, a certain preventive maintenance treatment that works well on pavements that are cracked but not rutted can be matched with appropriate candidate segments for further inspection. It is up to the Areas to decide on which candidates to apply the treatment.

ALDOT is divided into five Regions, with two Areas per Region. Areas use this data to establish their priority lists for maintenance resurfacing and preventive maintenance. An example of a Region PPR map is provided in Exhibit 8.

Exhibit 8: 2017 North Region PPR Map



Source: (January 2017). ALDOT 2017 PPR.

The ALDOT PPR Database includes the following information:

- Overlay project data, including beginning and ending mile posts, exclusions, date the project was accepted for maintenance, and date the project was awarded for new construction (if not yet accepted)
- Location, including Region, Area, District, and county
- Distress subscores, Pavement Condition Rating, grouping and sorting information
- Other information on pavement type (Concrete/Bridge/Tunnel)
- Annual Average Daily Traffic calculated as a weighted average per overlay
- Truck Average Daily Traffic calculated as a weighted average per overlay
- NHS status

The condition, as reported from the PMS on the report forms the basis for the on-system condition assessment. Off-system, where the age of pavement is generally not known, the condition is determined using the Highway Performance Monitoring System (HPMS) submittal.

2. Current Inventory

ALDOT manages 10,888 centerline miles of pavement, all of which are ALDOT-owned routes. The types of pavement identified by the pavement management system (PMS) are summarized in Exhibit 9.

Exhibit 9: Summary of ALDOT-Managed Pavement by NHS Group*

Type	Centerline Miles		Percent of Total
Asphalt		10,701	98.28%
Concrete		154	1.42%
Non-Pavement	**Bridges**	31	0.29%
	Tunnel	2	0.02%
Total		**10,888**	**100.00%**

*Note: Totals based on overlays at least partially consisting of NHS mileage.
Source: (January 2017). ALDOT Preliminary Prioritization Report (January 2017).

Most centerline miles (98.28 percent) are asphalt. Condition is scored on asphalt only. Thirty-three centerline miles of bridges and tunnels are treated as their own pavement sections and are not rated. (Most bridges, however, are absorbed into their respective overlays.) In the PMS, concrete may refer to jointed plain concrete pavement, jointed reinforced concrete pavement, continuously-reinforced concrete pavement, or composite pavement (hot mix asphalt over Portland cement concrete) that has only a thin asphalt, open grade friction course (OGFC), or NovaChip overlay. When determining condition, these types of pavement are treated as asphalt in the Highway Performance Monitoring System (HPMS).[vi] The National Highway System (NHS) status of ALDOT-managed pavement and non-state owned NHS pavement is displayed in Exhibit 10.

Exhibit 10: Summary of NHS and ALDOT-Managed Pavement by NHS Group

NHS Status	Centerline Miles	Percent of Total
Interstates	1,001.8	9.90%
Other NHS (state-owned)	3,184.8	28.9%
Other NHS (non-state-owned)	130.78	1.19%
Non-NHS (non-state-owned)	6,701.9	60.82%
Total	**11,019.28**	**100.00%**

Source: (January 2017). ALDOT 2017 Preliminary Prioritization Report.

3. Current Condition

a. Condition Assessment Process

The pavement condition assessment process begins with the collection of various types of distresses for all pavement by ALDOT's contractor in the form of 0.01-mile segments. The distress data is then aggregated by overlay, as is traffic data. Next, the data is merged and the indexes and overall PCR are calculated. Segments awarded but not accepted, or accepted but not tested, are identified as "new." The data collection details can be found in Appendix A. All processing occurs within the PMS.

b. 2017 PPR (2016 Pavement Condition Assessment)

The Pavement Management Section uses a weighted approach to ensure that a high or low score on a small portion of the network does not skew the overall results.

Exhibit 11 shows the resulting asphalt conditions based on data collected in 2016.[vii] Lane-miles are added to the condition assessment for use in the scenario investment analysis but are not used in the PPR. Most (but not all) roadway surfaces, 98.28 percent, are included in the condition assessment. The rest are incomplete or are not asphalt pavement.

Exhibit 11: Condition of Lane-Miles by Route Type

	Good PCR >= 70		Fair 70 > PCR > 55		Marginal PCR <= 55		Total
Route Type	**Lane-Miles**	**Percent of Type**	**Lane-Miles**	**Percent of Type**	**Lane-Miles**	**Percent of Type**	**Lane-Miles**
Interstate	2,906.85	76.98%	554.33	14.68%	314.70	8.33%	**3,775.88**
Non-Interstate NHS (state-owned)	6,859.14	66.23%	2,195.12	21.20%	1,301.70	12.57%	**10,355.96**
Non-Interstate NHS (non-state-owned)	72.39	19.99%	253.25	69.93%	36.52	10.09%	**362.16**
Non-NHS	8,633.26	60.02%	2,391.67	16.63%	3,359.14	23.35%	**14,384.08**
Asphalt Total	**18,471.64**	**63.96%**	**5,394.37**	**18.68%**	**5,012.07**	**17.36%**	**28,878.08**

Source: 2017 PPR. Pavement Management Section, Bureau of Materials & Tests.

4. Condition Targets

a. FHWA Pavement Condition Performance Measures and Targets

On January 18, 2017, FHWA passed the final rule (23 CFR 490) that established national performance measures to assess pavement and bridge conditions. The performance measures for pavements are:

- Percentage of Interstate pavements in good condition
- Percentage of Interstate pavements in poor condition
- Percentage of non-Interstate NHS pavements in good condition
- Percentage of non-Interstate NHS pavements in poor condition

The rule was effective May 20, 2017 and stated that by January 1, 2018, state DOTs must collect data for Interstate pavements that conform to the final rule. States must report the following metrics: International Roughness Index (IRI), rutting, cracking %, and faulting. These are required for only one direction. The Baseline Performance Period Report for the 1st Performance Period is due October 1, 2018. State DOTs must report four-year targets for Interstate pavements and two-year and four-year targets for non-Interstate NHS pavements.

In addition to these measures, FHWA requires states and metropolitan planning organizations (MPOs) to establish pavement and bridge targets. These targets will be tracked according to the proposed measures.

Additionally, the final rule established two requirements related to minimum condition. In both the Interstate and non-Interstate NHS classes of pavement, states are allowed up to 5 percent in poor condition. Additionally, missing, invalid, and unresolved data shall not comprise more than 5 percent of data on the Interstate System and the non-Interstate NHS.

ALDOT collects data on IRI, transverse cracking, wheel path cracking, non-wheel path cracking, rutting, and faulting. The Department collects pavement condition information in both directions on four-lane routes, including undivided routes, except for concurrent passing lanes. On divided routes, data is collected in the outside lane in each direction. ALDOT will be able to supply the data needed for the new FHWA reporting requirements.

ALDOT selected the following pavement condition targets to comply with the pavement condition performance measures final rule:

- For Interstate pavements:
  - Greater than 50% in good condition
  - Less than 5% in poor condition
- For Non-Interstate NHS pavements:
  - Greater than 40% in good condition
  - Less than 5% in poor condition

b. ALDOT Internal Pavement Condition Targets

As part of the initial TAMP process, the Steering Committee met on September 15, 2015 to establish target performance levels for pavement and bridges. These targets relate to ALDOT's internal performance measure: the PCR. ALDOT's PCR comprises different metrics than the pavement condition metrics established in FHWA's final rule on pavement and bridge condition performance measures, published on January 18, 2017.

However, in this plan, only the targets expressed in terms of PCR will be discussed. From this point forward, these will be referred to as ALDOT's internal pavement condition targets, displayed in Exhibit 12. The values reflect the percentage of asphalt pavement in each condition range (based on the PCR score) per road category. These targets are also used in the investment scenarios portion of the TAMP.[viii]

Exhibit 12: ALDOT Internal Pavement Condition Targets

Road	Good	Fair	Marginal
Interstate	70%	20%	10%
Non-Interstate NHS	70%	20%	10%
Non-NHS	60%	25%	15%

Source: Alabama Department of Transportation (December 2017).

5. Condition Projections

ALDOT used its PCR method to make pavement condition forecasts, which are included in the financial and investment analysis of this TAMP. The prediction methodology is described in greater detail in Chapter VI, Investment Scenarios.

6. Gap Analysis: Current and Future Condition

ALDOT conducted gap analyses in two areas. The first area relates to asset condition. Per 23 CFR 515.9, ALDOT conducted a performance gap analysis by identifying gaps between the current and target condition of its pavements and bridges and the target based upon the funding projections included in Chapter V, Financial Analysis. The second gap analysis was conducted on ALDOT's processes and data and is described in the following section.

The first step in conducting this analysis was to determine the time period to be used. ALDOT selected FY 2018-2028 and used historical funding data from FY 2012-2017 to create a projection for FY 2018-2028. It is expected that revenue increases over the next ten years will remain consistent with the past five years.

The second step was to summarize the baseline data to be used in the analysis. ALDOT selected the December 2017 dataset generated from ALDOT's PMS.

The third step was to run the three investment scenarios selected during the stakeholder workshops, which are described in greater detail in the Investment Scenarios section. These scenarios used baseline data to estimate the future condition of the Interstate, Non-Interstate NHS, and Non-NHS pavements in Alabama.

The final step was to review the results, which were expressed in terms of ALDOT's internal performance metric, the PCR, and make conclusions. To do that, ALDOT compared the percent of pavements in good, fair, and poor in the horizon year to the pavement condition in the baseline year and noted the difference.

7. Gap Analysis: Processes and Data

Establishing consistent effective processes related to data management is critical to the success of any agency's asset management program. ALDOT reviewed its current processes related to pavement inventory and condition, identified opportunities for improvement, documented its ideal future processes in both areas, and compared them. The differences between the two are the gaps.

ALDOT has identified some challenges with its pavement data and would like to make improvements so that it can become more confident in its year-to-year trends and pavement condition forecasts. Some of ALDOT's pavement-related goals for this TAMP are to determine a method for forecasting pavement conditions and highlight which pavements need preventive maintenance. Additionally, ALDOT would like to ensure that its data collection and reporting practices are consistent with the proposed federal pavement regulations.

a. Gap Identification and Strategies to Address Gaps

In the analysis of pavement management processes and data, ALDOT has identified gaps in its current processes and developed strategies for addressing these gaps. The gaps and strategies are presented in Exhibit 13.

Exhibit 13: Gaps in Current Pavement Condition Processes

#	Gaps	Strategies to Address Gaps
1	Difficult to maintain good data quality (since 1992). Automated data collection does not necessarily match ground truths.	• Pavement staff undertaking internal effort to review historical data and correct/update as needed. • Select vendor to collect pavement data using 3D laser imaging. • Improve integrity through sample-based QA process.
2	No easy way to show pavement condition trends across years (using current PPRs), which makes reliable forecasting difficult. This is because pavement condition data is not consistent year to year. This limits the ability to develop accurate pavement deterioration curves.	• Anticipate above study will improve possibility of pavement condition prediction.
3	Concrete pavement can be included, but only a small portion of concrete is rated “good.”	• Determine best method to address the concrete ratings.
4	Budget for resurfacing allocated to Regions based on square yards of roadway, not condition.	• Consider taking condition into account when allocating resurfacing budget.

B. Bridges

This section summarizes ALDOT’s processes related to bridge inventory and condition as well as its updated inventory and condition data, as of September 2017. The TAMP requirements state that ALDOT must coordinate and obtain necessary data from other NHS owners. ALDOT complies with this requirement by coordinating with other agencies as needed to ensure that all bridges are inspected and the data is entered into ALDOT’s bridge management system.

1. Inventory Processes and Current Inventory

ALDOT summarizes its bridge inventory in a variety of ways. The first method is to divide the bridges into three main categories related to NHS designation: bridges that carry Interstate highways, those that carry other NHS roads, and those that carry non-NHS roads. The bridges that carry NHS and non-NHS roads can be further divided into two categories, state-owned and non-state-owned roads, for a total of five categories. Exhibit 14 shows the bridge inventory within Alabama according to these categories.

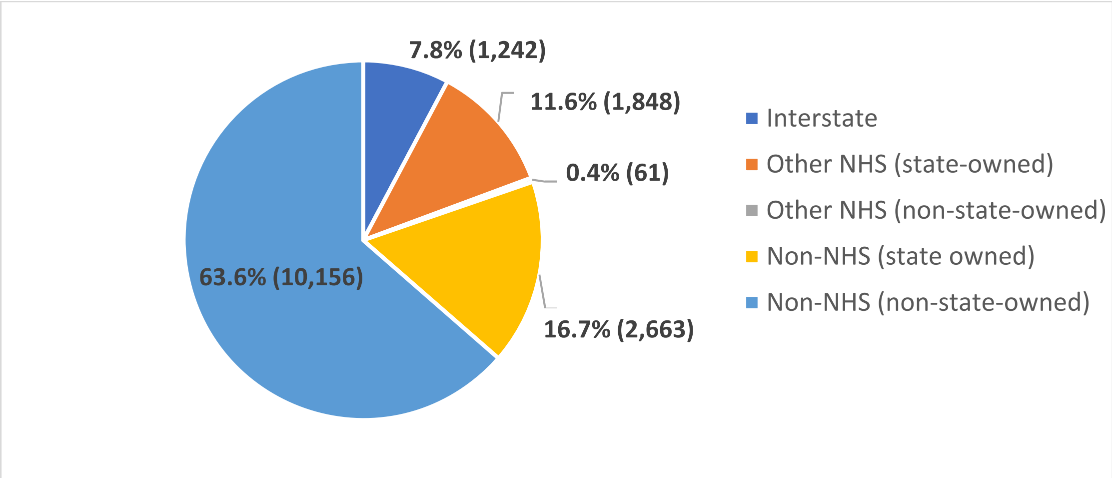
Exhibit 14: Alabama Bridge Inventory by Category According to Number and Deck Area

Category	Inventory	Deck Area (sq ft)
Interstate	1,242	34,967,870
Other NHS (state-owned)	1,848	25,158,842
Other NHS (non-state-owned)	61	535,546
Non-NHS (state-owned)	2,663	22,980,876
Non-NHS (non-state-owned)	10,156	29,031,880
Total	**15,970**	**112,675,014**

Source: (September 2017). ALDOT Maintenance Bureau.

Secondly, ALDOT summarizes bridge inventory data by the number of bridges in each category. Exhibit 15 includes the total population of Alabama bridges (15,970), divided into NHS groups. The number of bridges in each group is expressed as a percentage of the total number of bridges.

Exhibit 15: Alabama Bridge Inventory by Category (% of Bridges)

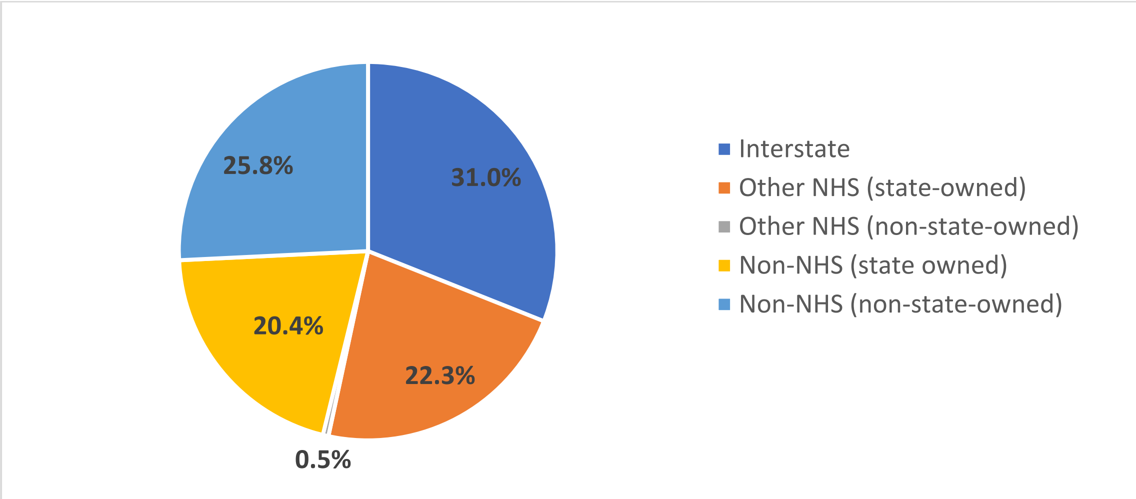


Source: (September 2017). ALDOT Maintenance Bureau.

Using the bridge count method, non-NHS (non-state-owned) bridges make up the largest share, with more than 10,000 bridges in this category. Non-NHS (state-owned) bridges make up the second largest share (approximately 2,660 bridges), and state-owned NHS bridges (other than Interstate highways) make up the third largest share (approximately 1,840 bridges).

Exhibit 16 illustrates Alabama's bridge inventory divided into the same categories by deck area rather than bridge count.

Exhibit 16: Alabama Bridge Inventory by Category (% of Sq. Ft. of Deck Area)



Source: (September 2017). ALDOT Maintenance Bureau.

While Exhibit 15 shows a large difference between categories in terms of bridge count, Exhibit 16 shows less disparity in terms of deck area. Using this method, Interstate highways make up the largest share of bridges, and three categories make up roughly similar shares: non-NHS (state-owned and non-state-owned) and Other NHS (state-owned) bridges. Like bridge count, Other NHS (non-state-owned) bridges make up the smallest portion of Alabama's bridge inventory in terms of deck area.

Together, non-NHS (state-owned and non-state-owned) and Other NHS (state-owned) bridges comprise approximately 92 percent of Alabama's bridges in terms of bridge count and approximately 69 percent of Alabama's bridges in terms of deck area.

The remainder of this TAMP will focus on state-owned bridges and NHS bridges. Bridge deck area is the proposed unit of measure for reporting structurally deficient (SD)[ix] bridges, according to FHWA's Notice of Proposed Rulemaking (NPRM). The next section discusses SD bridges in greater detail.

2. FHWA Bridge Condition Performance Measures and Targets

On January 18, 2017, FHWA published a rulemaking (23 CFR 490) that established requirements for pavement and bridge reporting and targets, as follows.

a. Performance Measures

State DOTs must assess bridge condition according to the following performance measures:

- Percentage of NHS bridges by deck area classified as in good condition
- Percentage of NHS bridges by deck area classified as in poor condition

The classification is based on National Bridge Inventory (NBI) condition ratings for the elements included in Exhibit 17.

Exhibit 17: NBI Condition Thresholds - Bridges and Culverts

NBI Element	Good	Fair	Poor
Bridge Deck *(Item 58)*	≥7	5-6	≤4
Bridge Superstructure *(Item 59)*	≥7	5-6	≤4
Bridge Substructure *(Item 60)*	≥7	5-6	≤4
Culvert *(Item 62)*	≥7	5-6	≤4

Source: FHWA. NBI Data Dictionary. http://nationalbridges.com/nbiDesc.html.

Historically, many state DOTs, including ALDOT, have tracked the condition of “structural deficiency.” In January 2018, the definition of structurally deficient (SD) was changed and it is now the same as the “poor classification, per the NBI condition ratings.

This rulemaking (23 CFR 490) includes the following minimum penalty: If more than 10 percent of a state DOT’s NHS bridges (in terms of bridge deck area) are classified as SD for three consecutive years, the state is required to set aside and obligate NHPP funds for eligible bridge projects on the NHS. The rule applies to bridges carrying the NHS, including bridges located on on-ramps and off-ramps connected to the NHS. In the case of bridges that border two states, the deck area counts toward the total for both state DOTs.

b. Performance Targets

23 CFR 490 also states that state DOTs must establish targets for all bridges carrying the NHS, which includes on- and off-ramps connected to the NHS within a state, and bridges carrying the NHS that cross a state border, regardless of ownership. States must establish statewide two- and four-year targets by May 20, 2018, and report targets by October 1, 2018, in the Baseline Performance Period Report. States may adjust their four-year targets in the Mid Performance Period Progress Report (October 1, 2020).

This rulemaking also states that MPOs must support the relevant state DOT’s four-year target or establish their own targets by 180 days after the state DOT’s target is established.

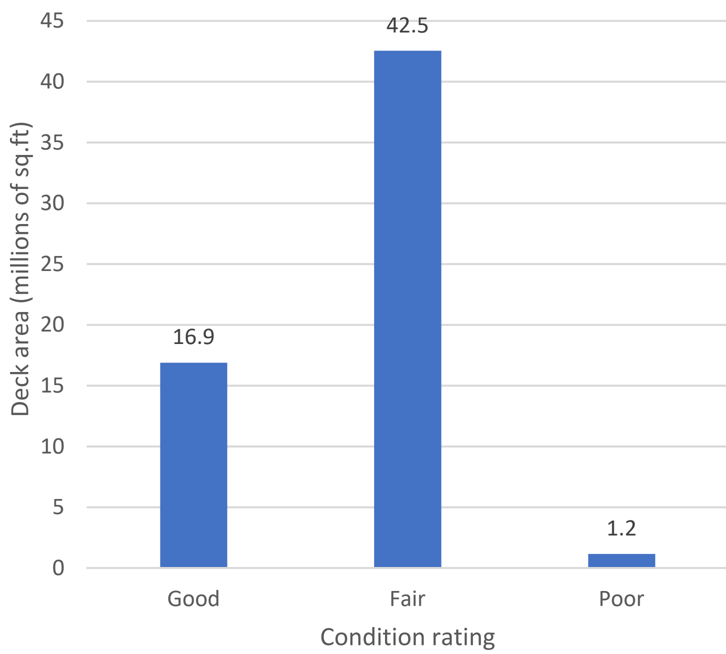
3. Current Condition

ALDOT tracks the conditions of its bridges on a scale from zero to nine, where nine is a new bridge and zero is a bridge so badly deteriorated that it must be closed. Generally, condition ratings from seven to nine are equivalent to excellent condition, with relatively little corrective action required. Condition ratings of six or five are where deterioration starts to become quite evident and where the possibility of repair work should be considered. Once a bridge deteriorates to level four or below, it is considered poor or SD.

Federal standards divide a bridge into up to four components – deck, superstructure, substructure, and culvert – which are rated separately in each inspection, typically once every two years. The condition of the inventory is described by recognizing the worst of these four components on each bridge and summing up the deck area of all bridges found to be at each condition level. The deck area (in square feet) is used because costs of rehabilitation and replacement tend to be proportional to the size of a bridge when measured in this way.

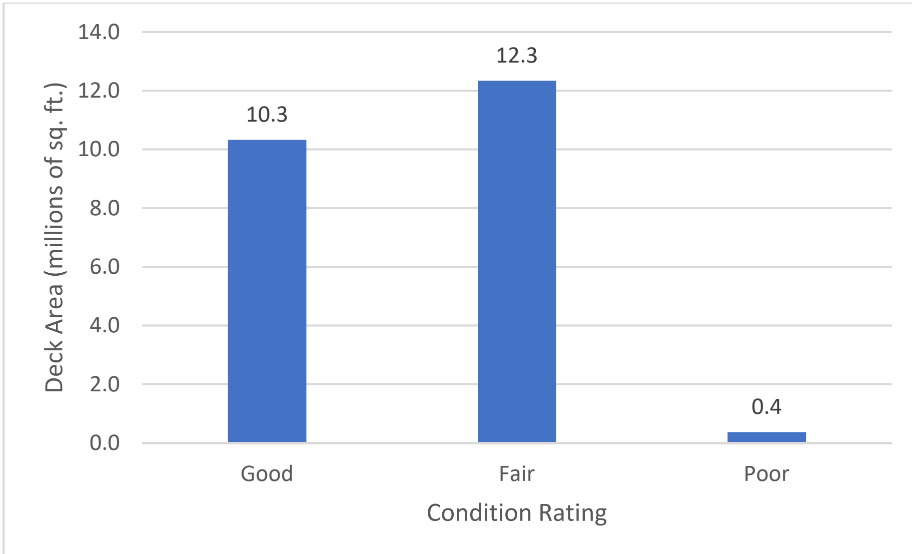
Exhibit 18 shows the current (September 2017) distribution of bridges among these condition categories for state-owned bridges on the NHS. Exhibit 19 presents the same information for state-owned bridges not on the NHS.

Exhibit 18: Condition of State-Owned Alabama Bridges on the National Highway System in 2017



Source: 2017. Alabama Department of Transportation

Exhibit 19: Condition of State-Owned Alabama Bridges not on the National Highway System in 2017



Source: 2017. Alabama Department of Transportation

The amount of deck area classified as condition levels five and six is increasing and warrants significant attention to avoid new structural deficiencies. This is especially true on the NHS, where bridges tend to be larger and more critical to the state economy.

a. Condition Summary

The existing condition of all bridges in Alabama is shown in Exhibit 20, according to the thresholds in Exhibit 17. Structural deficiency is shown in Exhibit 21. NHS and state-owned bridges are totaled for each table.

Exhibit 20: Alabama Bridge Condition Summary

	Good		Fair		Poor		Totals
	Deck Area*	Percent	Deck Area*	Percent	Deck Area*	Percent	Deck Area*
Bridges carrying Interstate highways	5,955,000	17.0%	28,081,388	80.3%	931,481	2.7%	34,967,871
Bridges carrying other NHS roads (state-owned)	10,900,910	44.1%	13,997,670	54.4%	260,263	1.5%	25,158,842
Bridges carrying other NHS roads (non-state-owned)	346,494	64.6%	189,052	35.3%	0	0.0%	535,546
Bridges carrying non-NHS roads (state-owned)	10,390,020	45.2%	12,256,746	53.3%	334,110	1.5%	22,980,876
Bridges carrying non-NHS roads (non-state-owned)	15,175,741	52.3%	12,604,045	43.4%	1,252,095	4.3%	29,031,880
Total	**42,768,165**	**38.0%**	**67,128,901**	**59.5%**	**2,777,949**	**2.5%**	**112,675,014**
NHS Bridges	**17,202,404**	**28.4%**	**42,268,111**	**69.7%**	**1,191,743**	**2.0%**	**60,662,258**
State-Owned	**27,245,930**	**32.8%**	**54,335,804**	**65.4%**	**1,525,854**	**1.8%**	**83,107,588**

Source: ALDOT Maintenance Bureau. September 2017.
Note: *Deck area is expressed in square feet.

Exhibit 21: Alabama Bridge Inventory and Structural Deficiency Summary

	Inventory Totals		SD Bridges (#)		SD Bridges (%)	
	Count	Deck area (sq. ft.)	Count	Deck area (sq. ft.)	By count	By deck area
Bridges carrying Interstate highways	1,242	34,967,870	18	931,481	1.4%	2.7%
Bridges carrying other NHS roads (state-owned)	1,848	25,158,842	26	260,263	1.4%	1.0%
Bridges carrying other NHS roads (non-state-owned)	61	535,546	0	0	0.0%	0.0%
Bridges carrying non-NHS roads (state-owned)	2,663	22,980,876	46	416,251	1.7%	1.8%
Bridges carrying non-NHS roads (non-state-owned)	10,156	29,031,880	1,059	1,888,032	10.4%	6.5%
Total	**15,970**	**112,675,014**	**1,149**	**3,496,027**	**7.2%**	**3.1%**
NHS Bridges	***3,151***	***60,662,258***	***44***	***1,191,744***	***1.4%***	***2.0%***
State-Owned	***5,753***	***83,107,588***	***90***	***1,607,995***	***1.6%***	***1.9%***

Source: ALDOT Maintenance Bureau. September 2017.

b. Structurally Deficient (SD) Bridges

Currently, SD has the same definition as poor with regard to bridge condition. Before January 2018, ALDOT tracked SD bridges according to a previous definition, but moving forward, ALDOT will adhere to the current definition and only track poor bridges. However, the following analysis was completed before January 2018 and is included in this TAMP, for reference. Previously, to determine whether a bridge was SD, ALDOT used the NBI bridge condition thresholds as a guide. According to the NBI data dictionary[x], the three criteria that determined the SD designation are as follows:

- **Bridge Condition (NBI):** If any of four components – bridge deck, bridge superstructure, bridge substructure, or culvert – receive a score of 0-4, or if items 67 (Structural Evaluation) or 71 (Water Adequacy) score a two or less, the bridge will be deemed SD.
- **Inventory Rating:** Expressed in tons, this measures the load level that can safely use the bridge unrestricted. A bridge can be deemed SD if its inventory rating is below specific load levels based on the average daily traffic.
- **Waterway Adequacy:** Expressed on a zero to nine categorical scale, this measures the likelihood of water overtopping a bridge.

As presented in Exhibit 21, there are 1,149 SD bridges in Alabama, the majority of which carry non-NHS roads (1,105 bridges). Forty-four of those SD bridges—1.4 percent, in terms of bridge count—carry Interstate or other NHS roads.

Exhibit 22 displays Alabama’s SD bridges by category in terms of bridge deck area. The total SD deck area is approximately 3.5 million square feet. The category that makes up the largest share of SD deck area is non-state-owned non-NHS bridges, at 54 percent and approximately 1.9 million square feet. Interstates are the second highest group, at 27 percent, with approximately 0.9 million square feet of SD deck area. The remaining bridge deck area belongs to state-owned non-NHS roads at 12 percent (0.4 million square feet) and state-owned NHS at 7 percent (0.3 million square feet). Alabama has zero SD bridges in the non-state-owned NHS category.

Exhibit 22: SD Bridges by Category

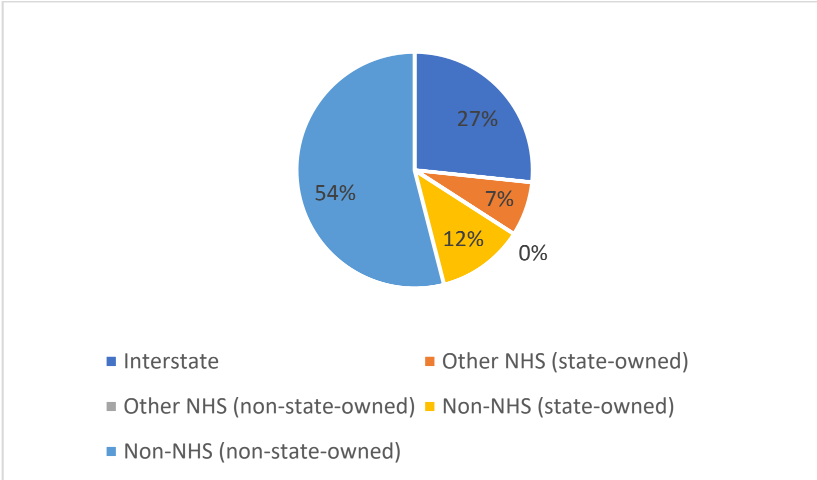
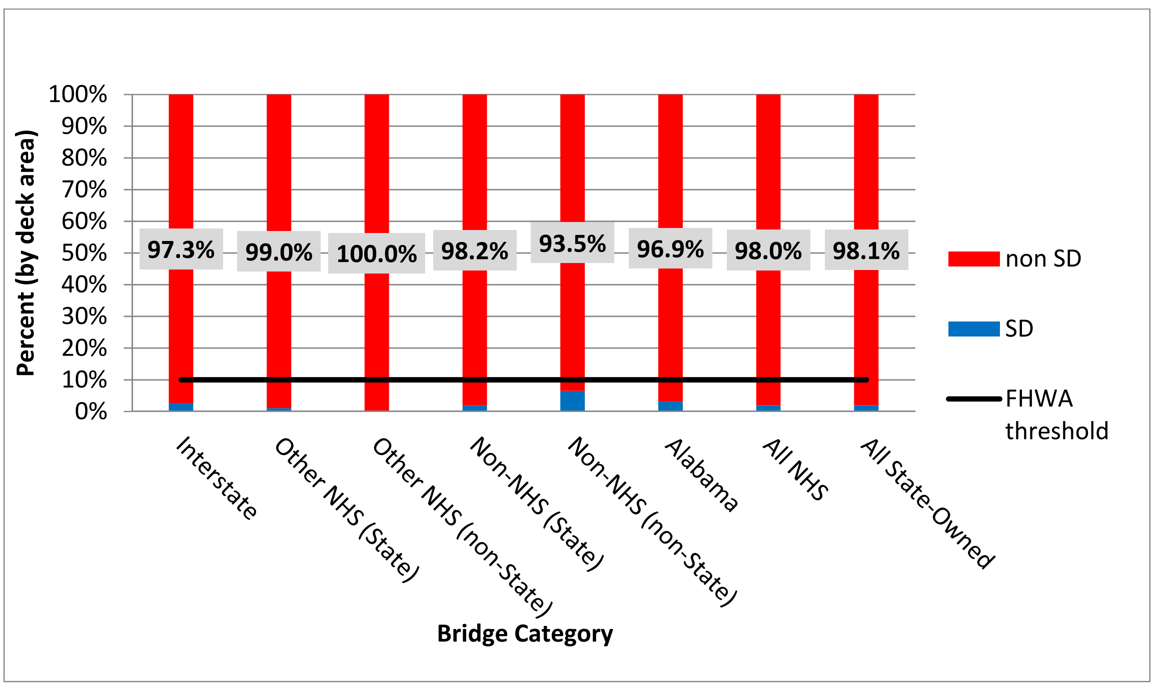


Exhibit 23 presents the deck area of the SD and non-SD bridges as percentages within several categories, as follows: each of the five bridge categories, the entire state, all NHS bridges, and all state-owned bridges. The solid black line labeled "FHWA Threshold" represents that, according to 23 CFR 490, no more than 10 percent of the total deck area of NHS bridges may be SD.

Exhibit 23: Percentage Comparison of SD and Non-SD Bridges by Bridge Category and Deck Area



Source: (September 2017). ALDOT Maintenance Bureau.

4. Condition Targets

ALDOT's process for selecting bridge condition targets included:

- Reviewing historical bridge condition data.
- Conducting asset management analysis that considers deterioration trends, assesses any bridge-related risks, and reflects ALDOT's desire to achieve a state of good repair over the life cycle of its bridges while minimizing cost.
- Ensuring that the targets reflect ALDOT's overall asset management objectives.

ALDOT selected the following bridge condition targets for NHS bridges, measured in bridge deck area:

- 27% or more in good condition
- 3% or less in poor condition

5. Condition Projections

ALDOT has identified some needs related to bridge condition projections. Some of the assumptions included in the model ALDOT currently uses to project bridge replacement needs require updates, such as the cost to replace a bridge. Additionally, there is no deterioration model included as part of ALDOT's current model. This information will be part of the AASHTOWare Bridge Management (BrM) software system, but is not currently available. ALDOT is planning on having the deterioration models in BrM working by the end of 2020. To address these issues, the consultant team is working closely with the ALDOT bridge and maintenance team to create a bridge condition model based on more realistic unit costs that includes a deterioration model. The projections from the new model will be included in the TAMP when they are completed.

6. Gap Analysis: Current and Future Condition

Similar to the processes for conducting the pavement gap analysis, ALDOT conducted two gap analyses for its bridge assets: one for asset condition and one for processes and data.

The first step in conducting this analysis was to determine the time period to be used. ALDOT selected FY 2018-2028 for its analysis period and used historical funding data from FY 2012-2017 to create a projection for FY 2018-2028. It is expected that revenue increases over the next ten years will remain consistent with the past five years.

The second step was to summarize the baseline data to be used in the analysis. ALDOT selected the September 2017 dataset generated from ALDOT's BMS.

The third step was to run the four investment scenarios selected during the stakeholder workshops, which are described in greater detail in the Investment Scenarios section.

These scenarios used baseline data to estimate the future condition of Alabama's bridges.

The final step was to review the results, which were expressed in terms the NBI Bridge Condition Thresholds: Good, Fair, and Poor, and identify any gaps. To do that, ALDOT compared the bridge conditions in the horizon year to those in the baseline year and noted the difference.

7. Gap Analysis: Processes and Data

To determine gaps or areas in need of improvement, ALDOT reviewed its current processes related to bridge inventory and condition, identified its ideal future processes in both areas and compared them. The differences between the two are the gaps, summarized in Exhibit 24.

Exhibit 24: Gaps in Current Bridge Processes

#	Gaps	Strategies to Address Gaps
1	Current bridge model needs updated info (e.g., cost to replace a bridge).	• ALDOT is working with a consultant to update the model's assumptions.
2	Current bridge model lacks deterioration curves.	• AASHTOWare BrM software will include deterioration model; ALDOT awaiting its release. • ALDOT's work with the consultant includes the addition of a deterioration model.

C. Periodic Evaluations of Facilities Requiring Repair and Reconstruction Due to Emergency Events

1. Requirements and Data

According to the final rule related to asset management plans published on October 24, 2016 (23 CFR 515 and 23 CFR 667), state DOTs must "perform statewide evaluations to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events." An emergency event is defined as a "natural disaster or catastrophic failure resulting in an emergency declared by the Governor of the State or an emergency or disaster declared by the President of the United States." Repair and reconstruction is defined as "work on a road, highway, or bridge that has one or more reconstruction elements" and excludes the following emergency repairs as defined in 23 CFR 668.103: "temporary traffic operations undertaken during or immediately following the disaster occurrence for the purpose of: (1) Minimizing the extent of the damage, (2) Protecting remaining facilities, or (3) Restoring essential traffic."

To address this requirement, ALDOT uses event codes to designate emergency events on its work reports. An emergency event is defined as one in which any of the following three actions occurs: the Governor declares a state of emergency, ALDOT determines that there will be significant impact to the ALDOT network, or if the Emergency Operations Center (EOC) is activated. When any work is done at a given location, the Site ID is noted. To show the specific location where the work was completed, ALDOT runs a report that includes the event codes and Site IDs, which show locations as a unique identification number (e.g., 020-06-69-3) that corresponds to a specific route number and location (mile post).

ALDOT began using Site IDs in 2008, but because the TAMP requirements indicated that the required evaluation period begins on January 1, 1997, ALDOT had to obtain earlier data from FHWA. In 2018, ALDOT requested FMIS data from FHWA for the period between January 1, 1997 and 2008. Using this data, ALDOT conducted "statewide evaluations to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events."

2. Analysis Process and Results

In its analysis of these two data sources, ALDOT found thirty-six locations that "repeatedly required repair or reconstruction due to emergency events" between 1997 and 2018. ALDOT created a master Excel spreadsheet with all the events by merging the FMIS data with the ALDOT data. As part of the data compilation process, ALDOT created a set of standard codes to categorize each event. After creating a cohesive dataset, ALDOT summarized the analysis results.

A total of 78 events requiring repair and reconstruction occurred in these locations. In the majority of the locations, two events occurred, but in a few cases, three events occurred at a single location. Roughly one-third of the events occurred between 1997 and 2008 and approximately two-thirds occurred between 2009 and 2018.

Approximately one-third (33%) of these repair/reconstruction events were related to a tropical storm or hurricane, 63% were related to severe weather other than a hurricane or tropical storm, and the remaining three events (4%) were connected to a fire.

These events occurred across the state, but the greatest concentration was in the Southwest Region of Alabama, with 44 events occurring there, followed by 26 in the Southeast Region. Four events occurred in the East Central Region, two in the North, and 2 in the West Central Region. When looking at which counties were affected by the events, Mobile county had the highest occurrence at 24, followed by Clarke at 8. Emergency events occurred in seventeen other counties. However, fewer than 8 events occurred in each of those counties.

The type of repairs or reconstruction activities varied. Approximately 55% of the repairs were related to slope failures or slides, 9% were bridge and culvert repairs, and 9% were related to pipe or drainage repairs, environmental issues such as a stream bank failure, sinkholes, or washouts. The remaining 27% did not include descriptions beyond "emergency repairs."

ALDOT also reviewed available emergency event cost data from its Comprehensive Project Management System (CPMS), which is its Department-wide software system that houses project management and cost data, among other things. Based upon the CPMS data, ALDOT gathered the following cost information about these locations and facilities requiring repeated repair, to satisfy the evaluation requirements of 23 CFR 667.

For repairs related to slope failures or slides, cost data was available for 32 of the events. Based upon that cost data, the average cost to remedy this type of issue was approximately $59,000. The range of costs for emergency repairs related to slope failures and slides during the 1997-2018 time period was approximately $400 - $456,000. Bridge repair or replacement costs can vary widely, depending upon the severity of the issue, the size of the bridge, and if the bridge must be replaced. Costs for other types of repairs can vary widely as well. To provide a few examples, the following costs were gathered from CPMS and represent costs for individual events.

- Bridge scour - $117,000
- Cross drain failure - $108,000
- Culvert repair – In one instance, the cost was $36,000; in another instance, the cost was $1.3 million.

The analysis completed on these thirty-six locations will be considered in risk assessments for ALDOT’s future TAMP updates as well as in future planning and project development processes.

III. ALDOT TAM Systems and Data

■

This chapter summarizes ALDOT's current asset and maintenance management systems, as well as other related systems and data. It also outlines the available and accessible asset management information and management systems used for a comprehensive asset management plan. It builds on the results from Sections I and II by utilizing the identified data and performance gaps as well as department TAM goals and industry best practices. Information from the FHWA's recently published NPRM for Asset Management Plans[xi] is also included.

Exhibit 25 is a summary of ALDOT TAMP goals from Chapter I, with an asterisk (*) noting goals related to TAM data and systems. Chapter III.E identifies gaps between the TAM goals established by the Department and the data and systems necessary to achieve these goals.

Exhibit 25: ALDOT TAMP Goals

	Goal
1	Instill TAM as an integral part of the ALDOT business model to foster adaptation.
2	Utilize a risk management framework to identify threats and opportunities for projects and programs.
3	Preserve Alabama's transportation assets, such as pavement and bridges.*
4	Make sure the TAMP influences and is influenced by other plans.
5	Use the TAMP to identify and streamline processes shared by multiple Bureaus and unify activities to advance ALDOT collaboration.
6	Identify sustainable funding patterns for roads and bridges to address needs.
7	Stabilize the peaks and valleys of project schedules (design and lettings) to improve project delivery.
8	Improve data quality and knowledge/process retention to progress toward structured, data-driven decision-making processes.*

A. ALDOT TAM Systems

This section describes ALDOT systems as they relate to TAM.

1. Bridge Management Systems (BMS)

Alabama was one of the first states to implement a computerized bridge inventory, with the development of Alabama Bridge Information Management System (ABIMS) in the 1990s. ABIMS was a mainframe-based system compatible with the National Bridge Inspection Standards, supporting the biennial inspection of all of the state's bridges. Over the years, ABIMS was periodically updated and expanded by the addition of new reports and modules to serve changing management needs.

ALDOT recently transitioned from ABIMS to the new AASHTOWare Bridge Management (BrM) software system. BrM is intended to be the Department's enterprise platform to support all TAM functions concerned with bridges and structures. Future versions of BrM will incorporate state-of-the-art planning capabilities suitable for all ALDOT management requirements as well as federal TAM planning requirements.

Current BrM capabilities include:

- Web-based collection of bridge inventory and condition data. Visual inspection by trained inspectors has been the foundation of ALDOT bridge management since the 1970s. Using the latest technology, the Department is increasing the speed and reliability of data capture, thus reducing the amount of time it takes to respond to maintenance needs.
- Capture of detailed inspection of bridge maintenance elements, such as expansion joints, wearing surfaces, and paint systems, which have the greatest impact on long-term durability.
- Ability to import data gathered by partners in other parts of the Department, other departments, and the private sector; as well as the ability to export data to FHWA to satisfy legal requirements.
- Capture of data to assess functional performance of bridges and vulnerability to natural and man-made hazards.
- Features to initiate work orders for projects that will correct bridge deficiencies.

Future versions will also contain:

- Functionality to investigate alternative preservation strategies, calculate life-cycle costs, and decide on the most economical long-range strategy for each bridge.
- Tools to create projects with economies of scale by grouping similar needs on multiple nearby bridges.
- Forecasting models, which can anticipate future maintenance needs and help optimize the timing and priority of preservation work.
- Tools to analyze past inspection data to improve the accuracy of the forecasting models over time.
- Models to quantify risk in a more uniform and objective manner, and to weigh the safety and mobility impacts of bridge management decisions.
- Models to predict the long-term costs and outcomes of alternative preservation strategies, including the ability to set fiscally constrained performance targets.
- Models to fit the most efficient possible investment plan to any given funding constraint, and to adjust resource allocations to enhance the likely outcomes.
- A wide variety of reports to serve the needs of management, stakeholders, and the public.

While taking a leadership role in the design of BrM, ALDOT is also adopting the most up-to-date AASHTO (American Association of State Highway and Transportation Officials) and federal standards for bridge data and data collection processes. The training and manuals for all bridge management personnel and inspectors have been updated to correspond to the new element-level data and systems, per FHWA requirements.[xii]

2. Comprehensive Project Management System (CPMS)

CPMS[xiii] is central to ALDOT's daily operations and is used by staff across the Department to complete critical agency functions such as processing payroll, tracking different types of funding, and managing other resources such as fuel and warehouse inventory. Many application sub-systems reside in CPMS and allow staff to process data across numerous platforms. Major modules include:

- Financial Management
- Budget Management
- Payroll Processing
- Project Management
- Program Federal Funds Management
- Right of Way Management
- Storm Water Management
- Disadvantaged Business Enterprise (DBE) Management
- Fuel Inventory Management
- Warehouse Inventory

CPMS is important to the asset management process as it provides financial and budget outputs, namely information on historical expenditures. It also provides planners with financial analyses and budget forecasts.

3. Preliminary Prioritization Report (PPR) and Database

ALDOT maintains a PPR Database in Microsoft Access that serves as the data warehouse for all pavement condition data critical to the asset management process. The PPR Database is used to create the PPR, which is a series of reports and maps used to disseminate pavement condition scores and assist in identifying overlays most in need of attention in terms of routine and preventive maintenance.

Information items within the PPR Database are listed in Chapter II, ALDOT Asset Inventory and Condition. System limitations and strategies to address gaps are discussed in subsequent sections of this report.

4. RoadMAP

ALDOT uses a maintenance management system (MMS) from CitiTech Systems, internally referred to as RoadMAP. RoadMAP is an essential component to effective asset management that reflects industry best practices. The system utilizes historical maintenance activity cost, accomplishment data, and the level of effort (LOE) required to achieve the target level of service (LOS). It then determines the necessary funding to achieve the target LOS. With a complete asset inventory, RoadMAP can:

- Specify an overall budget amount, distribute the cost difference to the various activities, and "back into" the expected LOS grade for the various asset types.[xiv]
- Perform "what-if" scenario analyses based on budget constraints, personnel changes, material cost trends, and equipment purchases.
- Define the desired LOS. The annual maintenance programs are designed to provide that LOS, and the resulting conditions of maintenance assets are assessed to determine if the desired outcomes were achieved. This assessment of desired versus actual outcome is then used as the basis for refining the maintenance program for the following year.[xv]

B. TAM System Data Input and Integration Requirements

This section outlines the FHWA minimum requirements for TAMP acceptance. It also describes elements of a modern, comprehensive TAM system with examples of current ALDOT data integration, where applicable.

At a minimum, transportation departments are required to document current asset inventory and conditions on pavements and bridges on Interstate and NHS roadways. ALDOT meets the minimum inventory and condition data input requirements.

1. Asset Management Data Integration Requirements

As defined by the FHWA, "Data integration is the process of combining or linking two or more data sets from different sources to facilitate data sharing, promote effective data gathering and analysis, and support overall information management activities in an organization.[xvi]"

Pursuant to MAP-21, FHWA issued NPRM on February 20, 2015 addressing the requirements for TAMPs and associated management systems. It requires that bridge and pavement management systems be used to analyze conditions for asset management plan, including the following formal procedures (23 CFR 515.007(b)):

- Collecting and managing inventory and condition data
- Forecasting deterioration
- Determining life-cycle cost of alternative strategies
- Identifying short-term and long-term budget needs for managing condition

- Determining optimal strategies for project identification
- Recommending programs and implementation schedules within policy and budget constraints

While most analytical requirements of a TAMP are at the network level, covering asset classes or sub-groups, the FHWA management system requirements involve data and analysis at the asset level. For example, federal rules and regulations require uniformly high-quality bridge data. This data is element level and relies on other data repositories, but also helps ensure the safety and functionality of the highway network. The TAMP requirements help lead asset management plans to an immediate program of projects, which is ultimately represented in the STIP.

The important data for asset management and the benefits of successful data integration include:[xvii]

- **Asset inventory and condition data.** Up-to-date and accurate asset inventory and condition datasets are essential components to an effective TAMP. Standardized inventory and condition data promote confidence in asset management systems and improve their ability to evaluate current condition, forecast future condition, and develop plans to close that gap. State-of-the-art techniques to gather this data are discussed in Section D below.
- **Needs assessment.** Maintenance budget requests are based on needs identified during formal condition assessment processes.
- **Target LOS.** Departments establish statewide desired LOS for all asset classes. Without target LOS, an agency is not able to develop a performance-based budget necessary to close the gaps between current and desired asset performance.
- **Work accomplishment data.** Historical data on maintenance and contract work accomplishments is a valuable source for developing treatment cost and LOE. Such data is useful as part of life-cycle planning and will help ALDOT work toward condition targets in a fiscally constrained program.
- **Maintenance scheduling.** Departments can generate maintenance work orders based on need and available resources. To achieve target goals, an agency needs to set, schedule, and allocate resources properly to perform work in a prioritized order, instead of prolonging the improvement and losing the strategic advantage.
- **Geographic referencing.** Transportation assets are located by their latitude and longitude coordinates. Roadway characteristics and geography are captured in linear referencing systems. For bridges, this also includes their relationships to roadways passing over or under. Location information is used in the preparation of maps to communicate current asset conditions, mobility issues (e.g., clearance and weight restrictions for bridges), and project plans.
- **Traffic data.** Bridge management systems require traffic data to quantify the benefits of functional improvements and risk mitigation projects. The information also plays a role in work zone planning. Comprehensive TAM programs utilize traffic data when considering issues like congestion and mobility.

- **Clearance and load rating data.** Every state DOT maintains a detailed listing of clearance and load restrictions which they use when reviewing permit applications for oversize or overweight truck loads. This information is also used in quantifying the potential benefits and potential risk reduction if bridges are strengthened, raised, or replaced.
- **Hazard data.** Some DOTs, including ALDOT, maintain a detailed database of river bottom profiles, for example, in the BrM system. It monitors changes in streambed profiles to recognize potential vulnerabilities in bridge foundations and approach roads. Departments also gather data for decision making related to seismic and hurricane risks. Data can be through national agencies such as National Oceanic and Atmospheric Administration (NOAA) or state-maintained sources. These are important data sources for risk management activity.
- **Project planning.** Maintenance work is frequently combined with work on multiple assets on a corridor to gain economies of scale and minimize traffic disruptions.
- **Investment candidate information.** In a mature, data-driven programming process, project candidates related to all asset classes are associated with a consistent set of quantitative cost and benefit information. This forms the basis for setting priorities. Programs are evaluated for their effects on conditions, safety, mobility, life-cycle cost, risk, and other factors, to find a mix of projects that maximizes transportation system performance at minimum cost.

C. TAM System Process Requirements

The FHWA has outlined required processes for successful completion of a TAMP. Transportation departments are required to document current or planned processes for performance gap analysis, asset life-cycle planning, risk management analysis, financial planning, and investment strategies. Exhibit 26 summarizes these processes.

Exhibit 26: Required TAM System and Process Functionality

System Process	ALDOT Plan/Process in Place?	Comment
Performance Gap Analysis	Yes	
Life-Cycle Planning	No (for pavement assets)	No plans for pavement. Bridge management life-cycle planning currently in development.
Risk Management Analysis	Yes	Basic risk management framework planned. Opportunities exist to improve on the process.
Financial Plan	Yes	
Investment Strategies	Yes	

Except for life-cycle planning for pavement assets, ALDOT currently has established, or has planned, processes to meet these requirements. Phase II of the TAMP project includes the development of a risk register and associated mitigation strategies, financial planning exercises, and investment strategy formulation.

D. TAM Data, System, and Process Opportunities and Best Practices

This section summarizes current industry best practices related to TAM data and systems.

1. Pavement Management Systems (PMS)

The following information on asset management systems and functionality is taken from National Cooperative Highway Research Program (NCHRP) 545: Analytical Tools for Asset Management.[xviii] State DOT examples are also included.

a. Functionality

- Storage of inventory information and condition information, some linked to GIS
- Project future condition for different indicators (e.g., functional class and average daily traffic)
- Ability to apply decision rules (condition-based triggers) for when treatments should be applied
- Deterioration models and application of different treatments over time with and without budget constraints, which enables needs estimation and analysis of investment levels and projected performance
- Generation of candidate projects and alternatives to evaluate and select the most cost-effective projects within the simulation framework
- Candidate project ranking based on LOS, cost/benefit, or other measures

The state-of-the-art of pavement management has continuously evolved. This is due to technological advances in computing power, the development of various visualization and map referencing techniques, and the creation of more sophisticated and effective computational models, methods, and applications. Researchers and engineers from many states have published numerous reports on the subject, several of which are presented below.

(1) Louisiana Department of Transportation and Development PMS

The Louisiana Department of Transportation and Development (DOTD) established a PMS to collect and analyze data to improve the performance, planning, design, construction, rehabilitation, and maintenance of the state highway network. The Louisiana DOTD uses dTIMS CT software, an asset management application that Deighton Associates developed for the life-cycle planning component of their pavement network.

The dTIMS CT software maintains the PMS data and analyzes it to forecast future expenses for each asset and multiple class assets, establish priorities, and present a wide array of solutions and treatments based on user-defined budgets or resources. The system utilizes a heuristic optimization analysis based on a twenty-year analysis period with a ten-year treatment period. Given a discount rate and inflation rate, the software will use an incremental benefit-cost ratio technique to compare different network strategies to optimize pavement strategies. The PMS informs decision making for pavement asset management purposes, and when combined with other management systems' decision-making abilities, manages all Louisiana DOTD assets.[xix]

(2) Washington State DOT PMS

The Washington State DOT uses a PMS that contains annual pavement condition data and detailed construction and traffic history data for the state's 17,900 lane-miles of highways. The Washington State DOT uses pavement structural condition as a trigger value to identify candidate pavement projects. Analysts use this data, along with information from other Washington State DOT databases, for two purposes: to predict the optimal time for pavement rehabilitation activities, and to prioritize rehabilitations over a multi-year investment cycle.

The Washington State DOT has long utilized the PMS to conduct engineering and economic analyses to improve pavement performance and maximize the benefits of pavement investments. These analyses include various studies, among which are pavement smoothness, lowest life-cycle cost concept versus the worst-first methodology, impact of increased use of chip seal on highways, and performance of dowel bar retrofits.

State legislation requires projects to be selected according to the lowest life-cycle cost. The PMS evaluates programming and funding distribution policies to justify the incorporation of the lowest life-cycle cost concept into the project selection process, which replaces the worst-first methodology. After deriving the timing window for rehabilitation, the Washington State DOT extrapolates these costs to the entire state network, assuming a specific rehabilitation cycle (e.g., every four, eight, or ten years). A pavement rehabilitated too soon will have wasted pavement life, while a pavement rehabilitated too late will have higher associated repair and rehabilitation costs.

The Washington State DOT has seen dramatic and sustained improvement in the condition of its highway network in recent decades, concurrent with its use of regular pavement condition surveys and the PMS for engineering and economic analysis. The system enables the DOT to prioritize highway preservation and improvement projects to forecast future needs, conduct research that contributes to improved pavement performance, and maximize pavement investments. In addition, the PMS provides a rational basis by which to communicate with the state legislature and highway users about stewardship of the state's infrastructure.[xx]

b. Lessons Learned

Powerful PMS tools are available, but they are effective only if the agency performs the necessary implementation and research steps to populate them with reasonable predictive data, such as deterioration rates and accurate, up-to-date unit costs. Key features of a contemporary PMS as they apply to TAM include:

- Geographically-referenced inventory and condition information
- Accurate condition data that allows for the projection of future pavement condition and effective deterioration models
- Ability to apply decision rules (triggers) for when treatments should be applied
- Candidate project ranking based on LOS, cost/benefit, or other measures

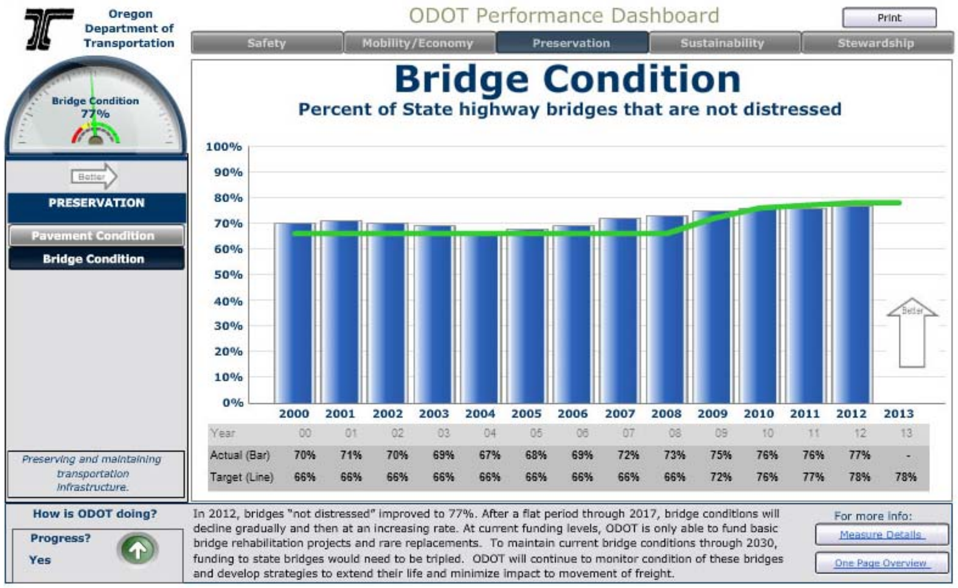
2. Bridge Management Systems (BMS)

In best-practice asset management, analytical tools are employed to forecast the future outcomes expected as a result of alternative decisions. Often these forecasts are uncertain at the asset level but much more reliable when aggregated to the corridor or network level. Several common tools used in bridge management are described below.

a. Levels of Service

Characteristics of a structure related to one aspect of performance are classified in ascending order of desirability. For condition, the classes are called condition states. For other types of performance, bridges are usually classified as acceptable or unacceptable. For example, the minimum acceptable vertical clearance may be defined for each functional class. BrM will provide a capability to describe LOS standards for functionality and risk, making it possible to quantify, network-wide, the percentage of bridges that are substandard according to any of the state or federal performance objectives. Trend lines and forecasts can be expressed in the same way, as shown in the example in Exhibit 27.

Exhibit 27: Example Performance Dashboard from Oregon DOT

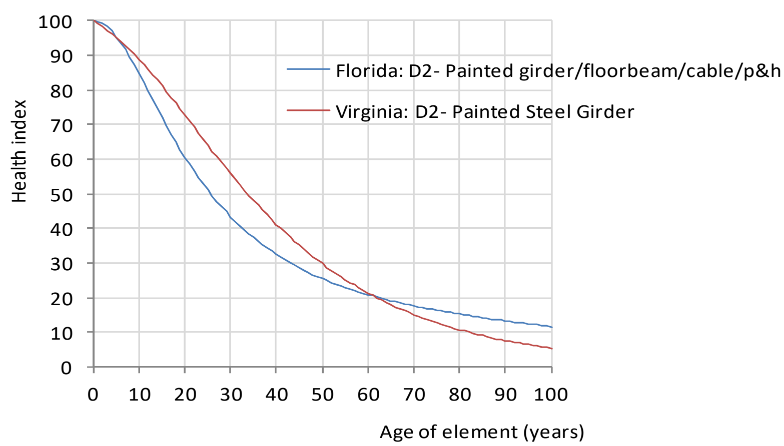


Source: Oregon Department of Transportation.
http://www.oregon.gov/ODOT/CS/PERFORMANCE/docs/2012dashboard.swf

b. Forecasting of Condition and Action Effectiveness

Deterioration rates are developed by statistical analysis of past inspection data, as shown in Exhibit 28. These rates are then used to forecast future condition. It is also necessary to quantify the effect of preservation actions on future condition. Development of such models will require some research by ALDOT, and the results can be supplied to BrM to support its planning capabilities.

Exhibit 28: Examples of Bridge Deterioration Models



c. Alternative Life-Cycle Activity Profiles

BrM can create reasonable projects based on current conditions and performance. If a given project is implemented, BrM can forecast the timing and cost of subsequent actions in the structure's life cycle. It can also forecast conditions and future costs if no current action is taken and identify the best timing and configuration of a replacement bridge at the end of its life.

d. Cost Estimation

Alternative life-cycle activity profiles are evaluated and compared using life-cycle planning. This standardized economic analysis tool relies on unit costs as a means of developing a rough programmatic estimate of the cost of any generated action. Cost estimates should include allowances for indirect costs such as mobilization, work zone traffic control, engineering, demolition, land acquisition, and bridge approach road work. ALDOT will need to develop unit costs by analyzing its historic project costs and estimation procedures.

e. User Cost

To combine a variety of performance concerns, a BMS employs user cost models. These models translate forecasts of accident rates, traffic delay, and risk into equivalent costs which can then be compared with normal agency costs. Using this tool, optimal projects and policies can be identified while minimizing life-cycle cost.

f. Utility Functions

If some of the performance considerations in decision making are not readily convertible into dollars, BrM provides a utility scoring system as an alternative. In fact, user cost models are merely a special case of utility.

g. Trade-Off Analysis

A BMS has functionality to prioritize life-cycle activity profiles under funding constraints, and then forecast future performance at the bridge, corridor, or network levels. Decision makers can examine the forecasts and adjust the amount of funding or the relative weight given to different performance concerns. This mechanism provides some control over future outcomes.

BrM, when completed, will have the ability to use these tools to generate projects and programs, and to estimate future performance at the corridor and network level.

3. Cross-Asset and Trade-Off Analysis

Cross-asset or trade-off analysis can enable transportation departments to support financial planning and tie investments to performance goals, which are two requirements of MAP-21. Cross-asset allocation and trade-off analysis tools describe project benefits using dollar values (agency cost and user cost savings) and prioritize candidate projects by benefit/cost ratio. Each project has a set of forecast effects on agency objectives such as safety, mobility, condition, and life-cycle cost. Decision makers can adjust the relative weight given to different objectives to achieve the desired performance outcomes in each District or statewide.

According to the FHWA's TAM Expert Task Group (ETG), cross-asset allocation is a gap limiting the ability of most DOTs to fully utilize comprehensive asset management. Many states are only beginning to address this gap so best practices are yet to be established. The ETG included cross-asset allocation as a focus area over the next five years to close this gap.

The systems described below are examples of cross-asset and trade-off analysis tools currently available.

a. Colorado DOT

The Colorado DOT is evaluating the expansion of trade-off capabilities. About four years ago, the Colorado DOT worked with a consultant to develop an Excel-based trade-off analysis tool for three areas: bridge, surface treatment, and maintenance service level. The tool relied on data from the agency's SAP software system. The results of this effort were not as effective as the Colorado DOT had hoped, so they looked into an alternative that would utilize both SAP (which supports financial planning systems) and a system from Deighton Associates.

Lessons Learned: Based on lessons learned while developing its TAMP, the Colorado DOT recommends the use of a holistic approach to manage assets. If a culvert fails, the pavement will fail as well. All of the data needed to support asset management should link together in a geospatial environment to support analysis and decision making.

b. Georgia DOT

The Georgia DOT has developed a trade-off tool with an online dashboard that combines analysis from individual tools to demonstrate anticipated performance levels, given funding allocation to different project areas. The tool extracts outputs from multiple analysis sources and presents them all in an easy-to-understand format. The outcome of these efforts is a series of program-level funding and performance targets, such as those that MAP-21 requires. These targets are also a fundamental element of a comprehensive TAMP.

Lessons Learned: The Georgia DOT's lessons learned about trade-off analysis include:

- The development of trade-off analysis tools can help DOTs evaluate where to allocate resources to meet performance needs.
- Dashboards are an effective tool to draw results from multiple source systems and display them in a way that supports trade-off decisions.

c. North Carolina DOT

The North Carolina DOT (NCDOT) has made the development of trade-off analysis capacity a key goal for asset management. The agency uses AgileAssets software that includes a PMS, BMS, and MMS. NCDOT's goal is to complete the investment scenario analysis within each module, and then combine the results. The pavement analysis is underway, and there are plans to use this approach for bridges and maintenance. They are working with the system vendor to make adjustments that, once complete, should be able to run scenarios to facilitate trade-off analysis across these different asset classes.

Lessons Learned: NCDOT's lessons learned about trade-off analysis include:

- NCDOT uses a single weighted index for pavement condition, but it may expand to include other indices (such as mobility, safety, and other assets like facilities and ports).
- NCDOT recognizes that agencies need to have buy-in from different organizational groups and will need to overcome difficulties involved in getting groups to think long range and embrace planning mentalities that are broader than their own interest areas.

If ALDOT has comparable tools for both pavements and bridges, it will be able to use the tools to perform cross-asset trade-off analysis. This capability supports decisions about resource allocation among pavements, bridges, and other asset classes, which may differ by District depending on current conditions and needs.

While several vendors advertise cross-asset allocation and trade-off analysis tools (AASHTOWare, AgileAssets, Deighton Associates, and VueWorks to name a few), implementations in state DOTs are extremely limited and more time is needed to fully evaluate their effectiveness and applicability to ALDOT.

4. Data Collection Technology

The availability of quality and relatively inexpensive technology has improved data collection and analysis for both inventory and condition assessment. GPS-enabled handheld data collectors; portable retroreflectometers; pavement sensors; roadway weather information systems (RWIS); and vans equipped with video and digital imagery, lasers, and ground-penetrating radar are examples of technology that is currently used to collect asset inventory and condition data.

The Mississippi DOT and West Virginia Parkways Authority are two examples of highway agencies that use GPS-enabled data collection devices. The Mississippi DOT uses handheld Windows-based PDAs, while the West Virginia Parkways Authority uses portable netbook computers. These devices possess real-time differential correction capabilities and can produce location accuracy to within ten to fifteen feet, which is generally sufficient for most LOS inventory purposes. More expensive survey-quality data collection devices are also commercially available for use when better accuracy is needed.

The Mississippi DOT uses portable retroreflectometers to evaluate pavement striping during its LOS surveys. Some states also measure sign retroreflectivity during routine sign inspections, but do not generally include that level of detail in their LOS condition assessments.

The West Virginia Parkways Authority and a few other state DOTs use RWIS, coupled with pavement and bridge deck sensors, to monitor weather and pavement conditions. RWIS has twenty-four-hour monitoring capability, enabling an agency to automatically activate variable message signs to alert motorists of hazardous conditions (e.g., icing or fog). Examination of this type of data after a winter storm event could also be useful to evaluate the LOS of the agency's response to such events. The Idaho DOT uses RWIS data to measure the intensity and duration of winter storms to improve its operations.

Many DOTs, including ALDOT, have used instrumented vans for several years to conduct pavement condition surveys. Some vans are equipped with lasers for pavement profiling (e.g., rutting) and ground-penetrating radar for density and depth measurement. In some states (e.g., Idaho, New Mexico, Utah, and Virginia), the vans have digital cameras with geo-spatial location referencing capabilities used to capture asset inventory data, such as signs and guardrail. In a few cases, pattern recognition computer programs that automatically extract inventory data are being evaluated.

Lessons Learned: As illustrated in these examples, readily available technologies should be considered when designing asset data collection and analysis programs. Proven technologies, such as GPS-enabled handheld data collection devices, reduce the time and cost involved and improve the usefulness of the data (e.g., GIS applications). It should also be noted that some tools, such as Light Detection and Ranging (LiDAR), have not yet demonstrated a clear advantage over digital photo-logging or more manual data collection methods.

E. TAM Data, System, and Process Gaps

This section describes the gaps between current department TAM data and systems and those required by the FHWA and indicated by best practices.

1. Pavement System Gaps

As noted in Chapter II, ALDOT has identified several challenges with its pavement condition data and is working to enhance confidence in the data before looking at year-to-year trends, forecasting pavement condition, or selecting a PCR condition goal.

Also noted in Chapter II, recent analysis of pavement management processes and data has identified gaps in current processes and developed strategies for addressing those gaps. The gaps are summarized in Exhibit 29.

Exhibit 29: Gaps in Current Pavement TAM Processes

	Gaps
1	Difficult to maintain good data quality (since 1992). Automated data collection does not necessarily represent ground truth.
2	No easy way to show pavement condition trends across years, which makes reliable forecasting difficult. This is because pavement condition data is not consistent year to year. This limits the ability to develop accurate pavement deterioration curves.
3	Concrete pavement can be included, but only a small portion of concrete is rated "good."
4	Budget for resurfacing allocated to Regions based on square yards of roadway, not condition.

2. Bridge System Gaps

The BMS capabilities described earlier are currently under development and the BrM software is still being developed. A simplified network-level spreadsheet analysis is used in this TAMP as a temporary measure to provide life-cycle planning and investment analysis until the inspection process and management system are finalized. Exhibit 30 outlines the current gaps in ALDOT's BMS capability.

Exhibit 30: Gaps in Current Bridge TAM Processes

	Gaps
1	AASHTOWare's BrM software is not yet complete. There are still aspects under development, as well as existing modules yet to be implemented by ALDOT.
2	No Alabama-specific bridge deterioration and cost models.
3	Need to develop risk analysis models for natural and man-made hazards, of which the most significant are river flooding and scour, hurricanes and storm surge, earthquakes, and vehicle and vessel collisions.
4	Need to develop benefit/cost prioritization models within BrM. These will consider life-cycle cost, risk, safety, condition, congestion reduction and travel time reliability, freight movement and economic vitality, and environmental sustainability (23 CFR 515.009(f)(4)). It is anticipated that this will be done by customizing, as necessary, the models expected to be included in BrM.
5	Completed bridge maintenance and capital project data does not yet identify bridge work as precisely as it could. Accomplishment data with materials and labor hours from past projects can be used to facilitate future improvement of forecasting models.
6	Fulfilling the MAP-21 reporting requirements related to bridges is challenging. The pavement management staff must be very careful in matching NBI location and Pathway bridge locations. If locations are not properly matched, the data will have more "poor" sections than it should because of where it is being reported.

These are viewed as the subjects of an ongoing process of continuous improvement, as the Department seeks to make deliberate progress in its management capabilities.

F. Conclusions and Next Steps

DMG worked with ALDOT to develop an implementation strategy to close gaps and move to a more comprehensive asset management program. The following strategies are the first step in the implementation.

1. **Implement an enhanced pavement management system.** An enhanced PMS will allow the Department to forecast future pavement conditions based on a variety of candidate projects and funding decisions. It will also enable ALDOT to provide centralized guidance to Regions for pavement projects based on data-driven methodologies and distribute funds to Regions utilizing a performance-based approach. Additional benefits include error reduction and a more user-friendly system. This represents the most significant gap in current ALDOT data and systems.

2. **Fully implement AASHTOWare Bridge Management software.** Complete the development, deployment, and implementation of BrM, including the new inspection process. Much of this is dependent on (and funded by) AASHTO. Portions of the work will need to be completed by internal ALDOT staff, likely with consultant help.

3. **Expand/enhance asset data collection.** ALDOT is using LiDAR technology to collect asset inventory data. Automated asset inventory and condition assessments can enhance confidence in asset data and allow the Maintenance Bureau to focus its efforts on preserving roadway assets. In addition, the data gathered via remote technologies can be leveraged across the Department. Based on these results, the project team can analyze the cost effectiveness of the LiDAR data collection effort and evaluate the prospect of statewide remote asset inventory and condition assessment processes.

4. **Enhance work accomplishment data.** Improve the capture of bridge maintenance and capital project data, particularly for improving unit cost and treatment effectiveness metrics. The recent implementation of RoadMAP has filled a large part of this gap, but there remains a need to refine the activity coding system and procedures to ensure that bridge data of sufficient quality are captured.

5. **Develop policy and performance measures to support cross-asset/trade-off analysis.** As part of the NPRM and this TAMP, ALDOT has an opportunity to improve its process by developing department policy and cross-functional performance measures that support cross-asset and trade-off analyses. Policy statements should reflect the Department mission and the federal goals in 23 USC 150(b), specifying performance measures and decision-making criteria which support best practice asset management.

   To help measure the effectiveness of cross-asset and trade-off analysis, the TAM ETG suggests the following performance measures:[xxi]

   - Percentage of assets (based on quantity or value) operating at "desirable" levels
   - Percentage of assets (based on quantity or value) operating at "minimum tolerable levels"

- Percentage of assets (based on quantity or value) designated as "high-risk" (for structural failure, operational failure, or hazard to the traveling public) where immediate action is needed

Using these suggested cross-functional performance measures as a starting point, the project team can begin to develop ALDOT-specific measures to most effectively monitor cross-asset performance.

6. **Improve risk management tools.** Analyze historical expenditures on natural and man-made disasters and other unexpected bridge failures to develop risk metrics for the likelihood and consequence of extreme events causing transportation service disruption. This would satisfy the proposed risk management requirements described in 23 CFR 515.019[xxii] and provide bridge management models to use in the risk evaluation portions of AASHTOWare BrM.

7. **Improve preservation practices.** Identify and adopt preservation practices which minimize life-cycle cost. This activity depends on the completion of life-cycle cost models and draws upon the experiences of the ALDOT Districts and other state DOTs. New techniques are usually adopted first by a pilot district or in pilot projects, then deployed more broadly if they are shown to be cost effective under Alabama conditions.

8. **Include additional assets in future iterations of the TAMP.** At present, FHWA requires a TAMP to address pavement and bridge assets on the NHS. The current TAMP development process provides an opportunity to proactively develop plans and processes to include additional assets in future iterations. The project team will continue to work with the Department to prioritize which assets to include in subsequent versions of the TAMP.

9. **Ensure organizational integration.** Integrate TAM information and processes into decision making and project delivery. This includes periodic self-assessment and other activities proposed in 23 CFR 515.017. This ensures the full implementation of modern TAM practices and data-driven decision making using asset management systems.

Exhibit 31 summarizes these implementation strategies.

Exhibit 31: Strategies for Implementation

Strategy	Purpose
Implement an enhanced pavement management system	To enable the Department to conduct pavement condition forecasting based on various funding levels; provide guidance for project selection; allocate funds based on need; provide a more user-friendly system; and help reduce errors.
Fully implement AASHTOWare™ Bridge Management software (BrM)	To enable candidate project and program generation and estimate future performance at the corridor and network level.
Expand/enhance asset data collection	Consistent asset inventory and condition assessment will improve the ability to develop performance-based budgets.
Enhance work accomplishment data	To improve the unit cost and treatment effectiveness metrics.

Strategy	Purpose
Develop policy and performance measures to support cross-asset/trade-off analysis	To understand and address performance measures across assets as ALDOT establishes specific targets and measures for each asset class. This is a first step to implementing effective cross-asset/trade-off analysis processes and TAM best practices.
Improve risk management tools	To assess the impact of negative events to state assets, particularly of bridge failures due to natural and man-made disasters. Provide management models and data to use in risk evaluation modules (e.g., AASHTOWare BrM).
Improve preservation practices	To minimize life-cycle costs to maintain assets.
Include additional assets in future iterations of the TAMP	To enable a more comprehensive approach to TAM.
Ensure organizational integration	To oversee the full implementation of modern TAM practices and data-driven decision making.

IV. Life Cycle Planning

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As defined in 23 CFR 515.5, life cycle planning is "a process to estimate the cost of managing an asset class, or asset sub-group over its whole life with consideration for minimizing cost while preserving or improving the condition." The life cycle of an asset begins with initial construction and ends with replacement. ALDOT understands that a worst-first mentality toward maintaining pavements and bridges is expensive. It is much more cost-effective to keep these assets in good condition than to let them fall into fair or poor condition.

The investment analysis portion of the TAMP was another area in which life cycle planning was a focus. ALDOT considered not only the overall cost of each scenario for this ten-year period, but also the condition of the assets at the end of that period and what that means in terms of cost and performance for the years beyond FY2028. For example, when ALDOT created its investment scenarios, they considered those such as the target levels of service scenario, that supports setting and maintaining condition targets that support good asset preservation practices.

The following section describes the different work types ALDOT applies to its pavement and bridge assets and how those work types align with the federal work types outlined in the TAMP regulations.

A. Work Types

The following section describes policies that guide ALDOT's decisions on which work types to apply to pavement and bridge assets and descriptions of these work types or treatments.

ALDOT has a Pavement Preservation Policy, updated in 2019, that defines the eligibility of two preservation strategies: Preventative Maintenance (PM) and Minor Rehabilitation (MR). The document defines preservation as "the planned strategy of cost-effective treatments to an existing roadway system that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system without significantly increasing the structural capacity of the pavement." The policy, included as Appendix G, includes a matrix that outlines the decision-making process and lists the funding sources that can be used for these types of projects, as follows:

- Federal Aid Resurfacing Program Funds (FM)
- State Maintenance Resurfacing Program Funds (99 or ST)
- State Special Maintenance Funds (99)
- Interstate Maintenance Program funds (IM)
- State Construction funds (ST)

ALDOT also has guidance in place to determine when to apply different work types to bridges. The bridge work types are known as "B Codes" and the complete list is included in Appendix H.

The following federal work types are included in 23 CFR 515: initial construction, maintenance, preservation, rehabilitation, and reconstruction. To align ALDOT's work types with these five federal work types, ALDOT created a "crosswalk", shown in Exhibit 32. ALDOT's understanding of the FHWA Work Types is as follows:

- **Initial construction –** Includes the construction of new assets such as a new bridge or a new roadway alignment. ALDOT plans for these types of projects in its STIP.
- **Maintenance –** Includes regular maintenance activities that are more minor in scale and tend to be reactive, such as pothole patching.
- **Preservation –** These include planned activities performed on pavements or bridges before any major deterioration occurs. The main purpose of these activities includes extending the functional adequacy and the useful life of the asset.
- **Rehabilitation –** For pavement, this includes the MR activities included in the Pavement Preservation Policy. Deck replacement and widening are included for bridges.
- **Reconstruction –** These activities are large in scale and include full-depth removal and/or replacement of pavements and replacement for bridges.

Exhibit 32: Work Types Alignment

	FHWA Work Type	ALDOT Pavement Work Type	ALDOT Bridge Work Type
1	Initial construction	Addition of new pavements/lanes	New bridge construction (No Existing Structure)
2	Maintenance	• Asphalt Pavement Repairs • Concrete Slab Repairs	• Guardrail Repair • Graffiti Removal • Servicing Navigation Lights
3	Preservation	• Crack Filling and Sealing • Fog Seal treatments • Chip Seal • Scrub Seal • Slurry Seal • Milling (not to exceed 2" in depth)	• Painting • Joint Repair/Sealing • Deck Repair • Girder Repair • Drift Removal • Slope Protection
4	Rehabilitation	• Minor rehabilitation projects extend the useful life of pavements through treatments that are more involved than those used for preventative maintenance. One example is flexible pavement milling (not to exceed 5" in depth). • Other types of rehabilitation projects include resurfacing and concrete rehabilitation.	• Deck Replacement (Partial or Full Depth) • Widening
5	Reconstruction	Typically removing & replacement of existing roadway pavement structure	• Full Replacement • Removal (Without Replacement)

B. Funding

As part of 23 CFR 515, ALDOT must indicate expenditures to fund improvements to NHS pavement and bridges by year and by the five work types. This is addressed in the Investment Scenarios chapter of the TAMP.

V. Risk Management and Analysis

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This chapter summarizes ALDOT's risk management and analysis process as it relates to TAM.

A. Introduction

The FHWA defines risk as "the positive or negative effects of uncertainty or variability upon agency objectives."[xxiii] Risks are more than just threats to objectives; they can also create new opportunities. Risks may include, but are not limited to:

- Threats
- Variability
- Change
- Uncertainty
- Opportunity

Risk management is an important and necessary component of any TAMP. The process is a sound business practice that is required by MAP-21 legislation. By proactively identifying risks, their causes, and consequences, and developing mitigation strategies for each, an agency can work to minimize threats and maximize opportunities. Exhibit 33 illustrates the relationship of risk management to TAM.

Exhibit 33: Risk Management Relationship to Transportation Asset Management[xxiv]

Source: FHWA. 2012. Transportation Risk Management: International Practices for Program Development and Project Delivery.

The first step, risk analysis, involves the quantitative or qualitative definition of the consequence (or impact) and the likelihood that a risk will occur. Next, risks must be evaluated. Evaluation involves comparing the results of the risk analysis with an agency's level of risk tolerance. This assumes that an agency has defined its risk tolerance and is prepared to take action if a risk's consequence and likelihood are too great. If risks are determined to be too great, risk treatment is taken.

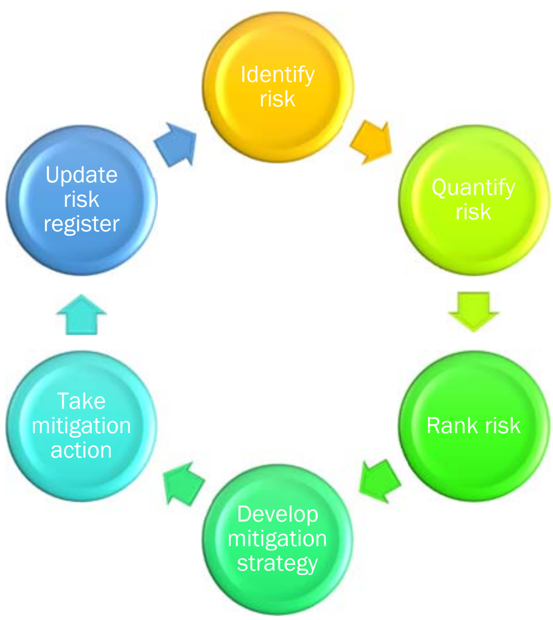
During risk treatment, risk response and risk modifications are performed. Risks can be managed through a variety of strategies, including:

- Reducing the risk by capital or maintenance expenditure
- Preparing emergency response plans
- Accepting a certain degree of risk
- Acquiring insurance

Finally, risk monitoring and review generally employ a risk management plan to monitor risk status and identify changes to each threat. In turn, risk monitoring and review assist in contingency tracking and resolution.

Exhibit 34 details the risk management process ALDOT followed as part of this TAMP.

Exhibit 34: Risk Management Process



B. Risk Identification

As part of the TAMP development, DMG identified several gaps in ALDOT business processes and systems related to TAM. These findings were a starting point for the risk management discussions.

An initial risk workshop was held with the TAMP Steering Committee on April 1, 2015 to introduce key ALDOT staff and executives to the risk assessment and analysis process. After the workshop, TAMP Steering Committee members provided feedback via e-mail on potential risks, consequences and likelihoods, and mitigation strategies. A second risk workshop was conducted on April 23, 2015 with the TAMP Steering Committee. As an outcome of this meeting, risks were refined, consequence and likelihood estimates were confirmed, and mitigation strategies were finalized.

DMG facilitated a Steering Committee meeting on December 5, 2017 to review the risk register and other topics. The complete risk register in Appendix B and the risk analysis in this chapter includes any updates made as a result of the Steering Committee discussion. No major changes were made to the risk register.

ALDOT is using a dual approach to risk management. One approach satisfies the federal legislative requirements of MAP-21, namely development of a risk-based asset management plan. The second approach is used internally to guide agency decisions based on the results of the risk management process. The internal approach focuses on specific risks and strategies to ALDOT (including those that may not be directly related to TAM) and provides a more detailed implementation plan for strategic risk management than the federal approach.

It is important to note that some of the risks identified are currently being addressed by ALDOT. As a general practice, the risk should not be removed until it is fully addressed. Progress on the risk treatment action can be monitored and the risk can be removed during the next update.

C. Risk Registers and Analysis

A risk register is a tool that agencies use to document and track risks. When ALDOT staff and executives identified potential risks, estimated consequences and likelihoods, and proposed mitigation strategies, the risks were categorized as follows:

- Business and System Performance
- Environmental
- Financial
- Health and Safety
- Legal and Compliance
- Reputation and Stakeholder Management

DMG developed risk ratings by determining the likelihood that a risk will occur in the next five years (on a scale of “Rare: less than one in 5,000 chance” to “Almost Certain: more than seven in ten chance”) and crossing it with the level of consequence if it did occur (from “Insignificant: almost no impact” to “Catastrophic: the impact is almost all-encompassing”). Each member of the TAMP Steering Committee estimated the consequence and likelihood of each risk. Consequences and likelihood estimates were assigned a number value from one to five, where Rare and Insignificant were assigned a one, and Almost Certain and

Catastrophic were assigned a five. The estimates were averaged, and each risk was assigned an overall rating from Low to Critical using the matrix in Exhibit 35.

Exhibit 35: Risk Rating Matrix[xxv]

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Rare	Low	Low	Low	Low	Low
Unlikely	Low	Low	Low	Medium	Medium
Possible	Low	Low	Medium	High	High
Likely	Low	Medium	High	High	Critical
Almost Certain	Medium	Medium	High	Critical	Critical

D. Results by Risk Category

This section summarizes ALDOT's six risk categories. The complete risk register is found in Appendix B: Full Risk Register by Category.

1. Business and System Performance

ALDOT identified eighteen risks in the business and system performance category, eight of which have high risk ratings. As such, ALDOT should focus on implementing mitigation strategies to reduce its risk exposure. Data availability and integrity was cited four times. General causes include variable pavement condition data, a lack of precise data for bridge maintenance, and no ratings for concrete pavement. Efforts are underway to improve pavement condition data, including implementation of 3D pavement data collection, which will lead to less variability in pavement condition data and increase the confidence in pavement condition forecasting. Also, the recent implementation of BrM version 5.3 and improvements to the element inspection data have enabled the Department to use bridge condition data in a life-cycle cost format to aid in agency decision making. Lastly, while concrete pavement is a minor portion of the system, a concrete rating algorithm is currently being developed with existing data.

2. Environmental

The one identified environment-related risk is that extreme weather events and climate change will damage and strain the transportation system. ALDOT has no control over this risk. However, it can employ strategies to reduce the impact. Up-to-date rapid response plans and continued coordination with the Alabama Safety Assistance Patrol (ASAP) can help ensure ALDOT is prepared to respond to weather emergencies.

3. Financial

The TAMP Steering Committee identified five risks in the financial category, including increases in vehicle fuel efficiency that reduce state revenues, and effects of inflation that reduce the ability to fund projects and perform maintenance. Additionally, the legislature has not increased the state gas tax since 1992. To mitigate financial risks, the

Department should work to educate and inform elected officials, decision makers, and the public on the importance of transportation funding and why additional revenue is needed. Development of this message is discussed in more detail in Section G below.

4. Health and Safety

Structure failure was the only risk identified in the health and safety category. The TAMP Steering Committee noted two general causes for structure failure: 1) river flooding, scour, hurricanes, and storm surge, and 2) ineffective weight enforcement and permit violations. To mitigate these risks, the Department should ensure rapid response plans are in place for these contingencies. Additionally, the Department should continue to coordinate with the ASAP and remain diligent with permit and weight enforcement.

5. Legal and Compliance

Changes in regulatory policy may require updates to ALDOT business practices. For example, wetlands and air quality regulation, additional National Environmental Policy Act (NEPA) requirements, and Americans with Disabilities Act (ADA) requirements can impact Department practices. ALDOT does not have control over these regulatory requirements. However, it can work to stay up-to-date on regulatory changes and react as necessary.

6. Reputation and Stakeholder Management

The TAMP Steering Committee identified adverse legislative actions and negative public opinion as risks in the reputation and stakeholder management category. Educating and informing elected officials, decision makers, and the public can help mitigate these risks.

E. Pavement Management Risks

The TAMP Steering Committee identified several risks related to pavement management which crossed multiple risk categories. The risks ranged from the lack of a comprehensive PMS to concerns with the methods and results of pavement condition assessments. Combined, these risks represent a significant threat to the Department and its ability to most effectively manage the transportation system. Pavement management-related risks and their risk ratings are summarized as follows:

- Lack of a comprehensive PMS that conducts pavement condition forecasting based on various funding levels, provides guidance for project selection, and allocates funds based on need (High)
- Lack of pavement deterioration model that divides data by AADT or NHS status (Medium)
- Variable pavement condition data leads to lack of reliable condition trends (Medium)
- Budget allocations to Regions not based on pavement performance (Medium)

The following mitigation strategies are proposed to address these risks:

- Investigate opportunities to implement a comprehensive PMS.
- Continue to address concerns with variable pavement condition data by utilizing advanced technologies (e.g. 3D pavement data collection).
- Continue to support the NCAT/MnROAD study on the life-cycle cost impacts of various pavement treatments.
- Develop and continually refine the pavement performance models to more accurately predict system performance.[xxvi]
- Continue to share pavement management best practices among district personnel and ensure the Department's investment strategies are aligned with these practices.

F. Risk of Underfunded Infrastructure

The risk of accelerated asset deterioration due to underfunding of infrastructure is a constant threat to most, if not all, transportation agencies. As an asset continues to deteriorate, it will require significantly greater investment to maintain it at an acceptable level of service. During the workshops, TAMP Steering Committee members identified several risks associated with the underfunding of infrastructure. Examples include:

- Lack of operating funding due to inflation and/or flat revenue streams
- Cut in federal funding due to Federal Highway Trust Fund insolvency
- Insufficient state match for federal funds due to state funding cuts
- Diminished fuel tax revenue due to increased vehicle fuel efficiency and/or reduced vehicle miles traveled

G. Message Design and Delivery

An effective public outreach campaign can help inform the public and elected officials about the importance of sound transportation policy and sustained funding sources for the system. The TAMP Steering Committee proposed this education approach as a mitigation strategy for a variety of risks, including:

- An increase in material costs that strains maintenance funds
- A significant increase in lane-miles without increases in maintenance funding
- A lack of operating funds
- Cuts in federal funding or insufficient match for federal funds
- Diminished fuel tax revenue

ALDOT has conducted customer surveys in the past to understand public expectations and desires, but another aspect of this is allowing those outside the Department to understand what limitations it might have. Often these limitations are the result of underinvestment in the transportation system. ALDOT should consider developing a proactive approach to deliver a message to elected officials, decision makers, and the public that demonstrates the need for additional funding by describing current system performance and investment gaps. It should also clearly demonstrate the impacts that increased funding can have on system performance. The TAMP documents these gaps and the potential impacts of increased funding and can provide a framework for the ALDOT message.

H. Future Risk Considerations

The risk management process enables ALDOT to anticipate threats and opportunities and implement strategies that deliver maximum benefit to the Department. The process should result in improved programming decisions and assist ALDOT in moving from a worst-first approach to a more proactive approach to asset management. ALDOT has made progress towards these goals. However, there is still work to be done. The following steps are recommended to ensure optimal results:

- Develop level of effort (LOE) estimates for implementing mitigation strategies.
  - The LOE required to implement the risk mitigation strategies varies. ALDOT should develop LOE estimates to further prioritize risks and their accompanying mitigation strategies.
  - The combination of risk rating and LOE should structure the Department's strategy to minimize threats and maximize opportunities. For example, a "High" risk rating coupled with a relatively low LOE to mitigate the risk offers an opportunity to reduce the Department's risk exposure.
- Promote mitigation strategies that address several risks, as they can significantly reduce risk exposure with minimal LOE.
  - Use mitigation strategies to provide input into ALDOT's investment strategies.
- Work with executive staff and key personnel from across the Department to develop risk-based investment strategies. This could be achieved during a workshop or via e-mail.
- Use the strategies outlined in Section E, Pavement Management Risks, to address pavement management-related risks.
- IT-related risks may require hardware/software procurement or upgrades. ALDOT should consider investing in systems that address risks with high risk ratings.

I. Risk Management Process Iterations

Like the TAMP process itself, risk management should be an iterative process. ALDOT should conduct annual risk management reviews to document and reevaluate existing risks and identify new threats and opportunities. A champion of the risk management process should be identified to lead the effort and coordinate the schedule to update the risk register. The schedule for these reviews should be formalized on the Department calendar and aligned with the TAMP report update timeline. Membership of the TAMP Steering Committee will change as people move in and out of the Department. As such, it may be necessary to periodically reintroduce the risk management approach so new members have a clear understanding of the process.

VI. Financial Analysis

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A critical component of ALDOT's TAMP is understanding current and future funding for maintaining Alabama's pavements and bridges. Knowing how much funding to expect can help ALDOT prioritize the maintenance, preservation, and replacement of assets. Additionally, being aware of funding uncertainties and their related asset performance outcomes can allow ALDOT to incorporate the associated risk into asset management planning.

For this TAMP, ALDOT conducted a thorough financial analysis. This chapter summarizes the processes ALDOT completed as part of this analysis along with the results. The main components include:

- Current and anticipated funding sources
- Recent trends and current funding
- Future revenue
- Estimated value of pavements and bridges

A. Current and Anticipated Funding Sources

This section describes the funding sources that support the maintenance of Alabama's state-owned pavements and bridges as well as how those funding sources are integrated into ALDOT's budget. The TAMP project team reviewed these sources with members of ALDOT's Finance & Audits Bureau and its Maintenance Bureau.

1. Funding Sources

ALDOT's pavements and bridges are maintained with the help of two main funding sources: Federal-Aid funding and state funding.

a. Federal-Aid Funding

Federal-Aid funding includes money allocated to ALDOT through federal authorization programs, such as MAP-21. MAP-21 streamlined the U.S. transportation system funding approach by decreasing the number of funding categories and placing an emphasis on performance.

ALDOT's highway and bridge improvements are funded by programs such as the NHPP, which includes maintaining the condition and performance of the NHS as well as new construction on the NHS, and the Surface Transportation Program (STP), which is used to preserve and improve the performance and condition of highway, bridge, and tunnel projects.

Many MAP-21 programs are funded through the Highway Trust Fund, which receives revenues from the federal gas tax, a user-based fee of 18.4 cents per gallon for gasoline fuel and 24.4 cents per gallon for diesel fuel.

b. State Funding

Alabama's state transportation revenue sources include a gasoline fuel tax of eighteen cents per gallon, a diesel fuel tax of nineteen cents per gallon, and a portion of vehicle license fees (seven dollars out of the thirteen-dollar base fee) plus additional fees by weight. Other cash flow mechanisms, such as bonds, could help support asset management by funding projects at the most appropriate time—according to the asset's life cycle—to avoid higher life-cycle costs. However, the disadvantages of using bonds include uncertainty, as their use must be approved before ALDOT can use them as a cash flow mechanism, and the obligation to repay the bonds in the future.

Alabama's transportation revenue sources are summarized in Exhibit 36.

Exhibit 36: Alabama Transportation Revenue Source Summary

State Revenue
- Diesel Fuel Tax - $0.19/gallon
- Gasoline Tax - $0.18/gallon
- Vehicle License Fees - $7.00 out of the $13.00 base fee plus additional fees by weight

Federal-Aid Funds

Other Funding Mechanisms and Sources
- Bond Proceeds
- Local Funding Agreements
- Miscellaneous (Permits, Map Sales, Bid Fees, etc.)

Source: 2017. Alabama Department of Transportation. Bureau of Finance & Audits.

2. ALDOT Budget Categories

Within ALDOT, work on pavements and bridges falls into three budget categories:

a. Routine Maintenance

Handles the maintenance activities for state roads and resurfacing for Federal-Aid highways, which include NHS highways and all other state-maintained highways. This funding also supports preservation activities on state bridges, emergency funds, and other traffic projects such as signal and sign upgrades.

b. Bridge Replacement (BR)

Includes the replacement and major rehabilitation of state-maintained bridges.

c. Interstate Maintenance (IM)

Activities are limited to Interstate routes but include resurfacing, restoring, rehabilitating, and reconstruction (4R); capital improvements; adding and modifying interchanges; rehabilitating rest areas; lighting projects; and preventive maintenance.

These categories will be used during analysis for the ALDOT-maintained system of pavements and bridges. Exhibit 37 outlines ALDOT's budget categories, funding sources, and the state and federal shares contributed to each source.

Exhibit 37: Funding Sources and ALDOT Budget Items for State-Maintained Pavements and Bridges

ALDOT Budget Category	Funding Source	Description	Federal/State Funding Split
Routine Maintenance	State gasoline and diesel taxes; state vehicle license fees	Funding for routine maintenance activities (except resurfacing) including roadway, bridge, and traffic-related activities as well as emergency activities	100% state
Resurfacing (Federal-Aid) [xxvii]	Federal-Aid; state gasoline and diesel taxes; state vehicle license fees	Resurfacing activities on Federal-Aid highway routes	90% federal/ 10% state
Interstate Maintenance	Federal-Aid; state gasoline and diesel taxes; state vehicle license fees	The following activities are eligible (on existing Interstate routes): • Resurfacing, restoration, rehabilitation, and reconstruction • Reconstruction or new construction of bridges, interchanges, and over crossings, including right-of-way acquisition • Capital costs for operational, safety, traffic management, or intelligent transportation systems (ITS) improvements • Preventive maintenance projects[xxviii]	90% federal/ 10% state
Bridge Replacement	Federal-Aid; state gasoline and diesel taxes; state vehicle license fees	Bridge replacement and major rehabilitation projects	80% federal/ 20% state

Source: 2017. Alabama Department of Transportation.

B. Recent Trends and Current Funding

This section describes state and federal trends in revenues to support ALDOT's pavement and bridge needs, as well as ALDOT's current funding structure.

1. State Trends

In Alabama, growth in vehicle-miles traveled (VMT) has been modest, with a compound annual growth rate of 1.49 percent between 2013 and 2016.[xxix] Regardless of the amount of growth, any increase in VMT means that pavements and bridges are getting more use, which contributes to increased deterioration of the state's transportation system.

In recent years, ALDOT's state funding has been stagnant. Most of ALDOT's state funding is from consumption-based sources: approximately 89 percent from gas and diesel taxes and 9 percent from vehicle registration fees. The remaining one percent is from permitting and other miscellaneous sources.[xxx] Trends in fuel efficiency have posed a challenge to these funding sources. Although there has been some VMT growth within Alabama in recent years, vehicles are becoming more fuel efficient and are consuming less fuel per mile,[xxxi] which counteracts possible increases in state revenue from gas and diesel taxes.

Additionally, the state gas tax was last increased in 1992 by five cents.[xxxii] This is a problem because the gas tax, which is a unitary tax measured in cents per gallon, has not kept pace with inflation. ALDOT's costs to maintain its assets have increased over time, while the gas tax has not. The Public Affairs Research Council of Alabama (PARCA) cited that Alabama is on a list of ten states in which the gas tax rate is "at an all-time low in terms of purchasing power."[xxxiii] ALDOT has received minor funding increases in the past few years, which are discussed below. Even with these small increases, a gap exists between needs and revenue.

In 2015, 2016, and 2017, the Alabama state legislature discussed, but did not pass, bills that would have enacted a gas tax increase. However, state legislators and ALDOT leadership continue to discuss the possibility of raising the gas tax to support infrastructure improvements.[xxxiv]

2. Federal Trends

Three federal trends that affect ALDOT relate to the federal gas tax, vehicle fuel efficiency, and the uncertainty of future federal funding. Currently, the federal gas tax is 18.4 cents per gallon and has not been raised since 1993. Because the tax has remained the same for nearly twenty-five years, it has not kept up with inflation.[xxxv] The total inflation from December 1993 to December 2017 is 69.09%; $1.00 in 1993 has the same buying power as $1.69 in 2017.[xxxvi] As vehicles become more fuel efficient, this trend will continue unless VMT increases.

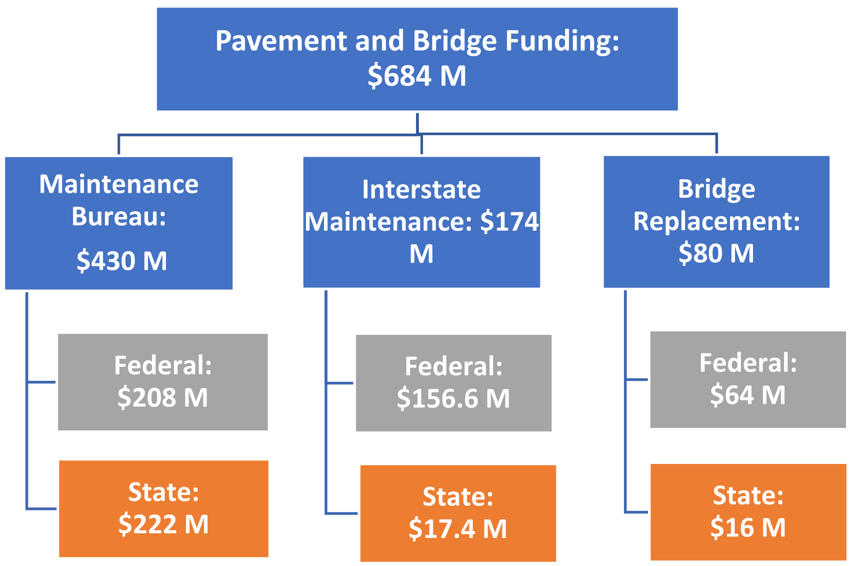
At the beginning of the TAMP development, MAP-21 was the federal surface transportation law. It was originally enacted in 2012 and extended multiple times. On December 4, 2015, President Obama signed into law a new transportation bill, the FAST Act,[xxxvii] which authorizes $305 billion over fiscal years 2016 through 2020. Overall, the FAST Act largely maintains current program structures and funding shares for highways and transit. Funding levels will increase slightly above projected inflation.[xxxviii] More importantly, however, this transportation bill solidifies long-term funding certainty for all transportation agencies. ALDOT will review the new funding allocations within the bill and integrate this new information into investment scenarios and analysis for future TAMP updates.

Together, these state and federal trends raise concerns about how Alabama will fund transportation programs. Will a consumption-based revenue source generate enough funding to maintain Alabama's pavements and bridges in the future? Chapter VI, Investment Scenarios, provides asset performance measures for several possible funding scenarios. Understanding the performance outcomes for each scenario will help ALDOT manage realistic performance expectations based on funding levels.

3. Current Funding

Exhibit 38 presents ALDOT's current budget for maintaining pavements and bridges, represented by budget program and divided into federal and state funding shares. The ALDOT Maintenance Bureau's budget includes the Routine Maintenance and Resurfacing categories described in Exhibit 37.

Exhibit 38: Detailed ALDOT Budget

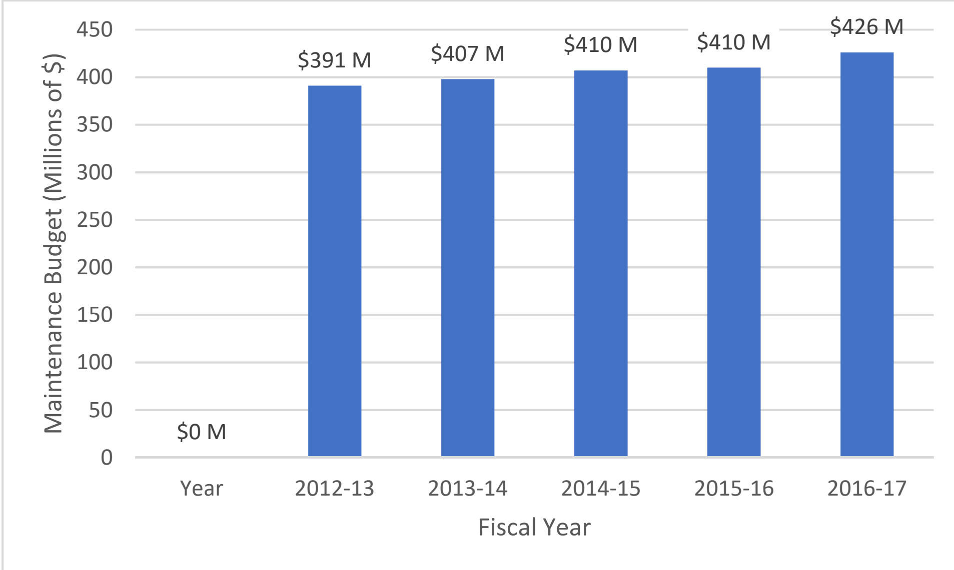


Source: 2017. Alabama Department of Transportation. Bureau of Finance & Audits.

4. Historical Funding

Recent funding trends provide some context for ALDOT's current and future funding expectations. Exhibit 39 shows that between FY 2012 and FY 2017, the budget for the Maintenance Bureau increased 9 percent from $391 million to $430 million. The greatest single increase between fiscal years was from FY 2015 to FY 2016 (an increase of 4 percent or $16 million).

Exhibit 39: ALDOT Maintenance Bureau Budget: FY 2012 - FY 2017



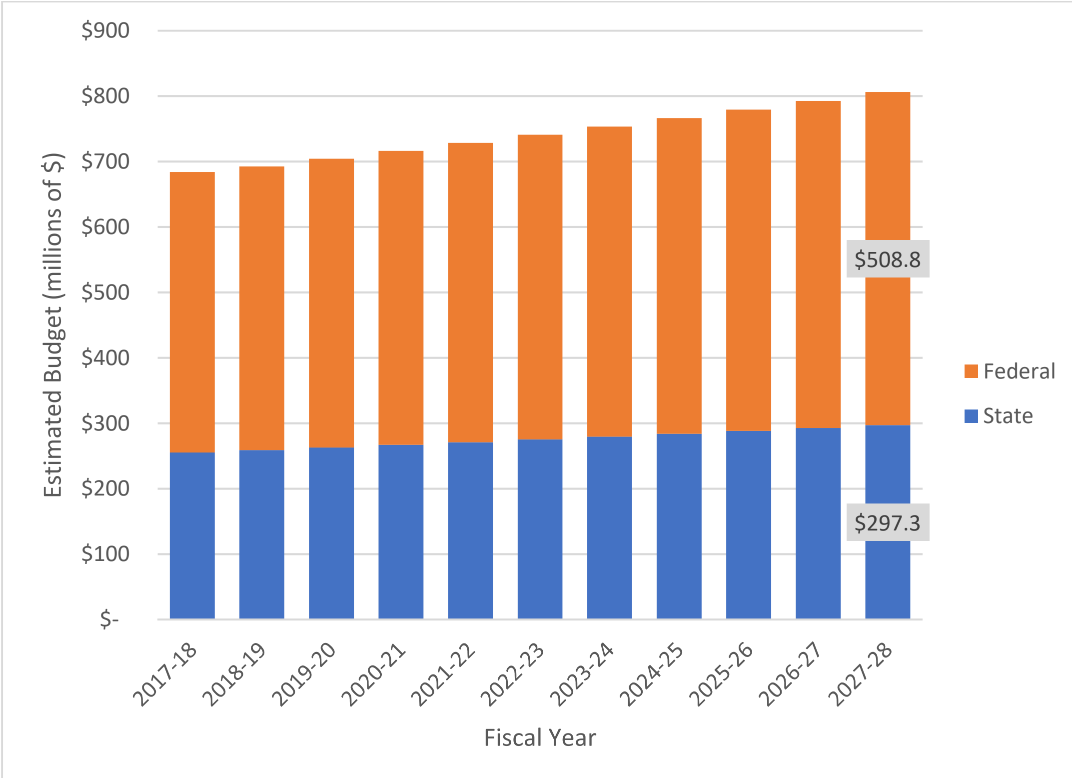
Source: Alabama Department of Transportation. Maintenance Budget and Maintenance Budget Recapitulation Memoranda. Fiscal Years 2012-2017.

C. Future Revenue

Based on discussions with the ALDOT TAMP Executive and Steering Committees, the current financial outlook is that ALDOT's funding sources will remain the same. It is expected that revenue increases over the next ten years will remain consistent with the past five years. Historical funding data from FY 2012-2017 was used to create a projection for FY 2018-2028.

Exhibit 40 shows the projected state and federal funding that ALDOT expects to receive. All values are expressed in year of expenditure. Year 1 is fiscal year 2019 and Year 10 is fiscal year 2028. Currently ALDOT lumps the five work types (Maintenance, Preservation, Rehabilitation, Reconstruction, & New Construction) into maintenance.

Exhibit 40: ALDOT Revenue Projections



Source: Alabama Department of Transportation (historical data), Dye Management Group, Inc.

The state share is anticipated to have a compound annual growth rate of 1.39 percent, with a projection of $258.9 million in FY 2019 to $297.3 million in FY 2028. During this same timeframe, the federal share is anticipated to have moderate increases of 1.57 percent per year, with projected funding of $433.6 million in FY 2019 and $508.8 million in FY 2028. This funding increase is due mainly to inflation rather than new funding sources.

D. Estimated Value of Pavements and Bridges

According to the final rulemaking on asset management plans, published on October 24, 2016, two required elements are the estimated value of pavement and bridge assets and the necessary annual investment to maintain the value of these assets.

The annual report ALDOT submits to the Government Accounting Standards Board (GASB), known as GASB 34, satisfies the rulemaking requirements. Alabama has elected to submit information about its assets using the Modified Approach, in which the state reports on the condition of its assets by road classification. The three classifications are: Interstate System, Non-Interstate National Highway System, and Non-Interstate Non-National Highway System. A detailed description of the measurement scales used for pavements and bridges is included in Appendix C.

Based upon the analysis used in the GASB 34 Modified Approach, ALDOT estimated that it would have to spend approximately $361.8 million in FY 2017 to preserve its roadway assets and approximately $10 million to preserve its bridges and culverts at or above the established condition levels.

Although ALDOT reports the estimated value of its assets using the annual GASB report, some definitions used in the GASB reporting system are different from those used by ALDOT for asset management. For example, under GASB reporting, replacing a bridge is considered a preservation activity, whereas ALDOT views it as a total replacement of that asset. ALDOT's budgeting processes reflect this distinction in that the budget allocation for bridge replacement is much greater than the amount for bridge preservation. Similarly, the measurement scale for assessing ALDOT pavement condition using the GASB reporting system is different from that used by ALDOT. ALDOT's PMS calculates a pavement condition rating (PCR) based on multiple metrics[xxxix], while the GASB 34 report assesses pavement condition based only on the International Roughness Index (IRI).

Because ALDOT uses different definitions and metrics from GASB in its day-to-day asset management processes, the estimated bridge and pavement preservation costs in the TAMP's investment scenarios will differ from the costs in ALDOT's GASB report.

E. Conclusions

The financial and investment information presented in this report provides the answers to three questions that are critical to transportation asset management in Alabama:

- What are ALDOT's existing sources for pavement and bridge maintenance funding?
- How much funding is expected for the next ten years?
- What are the estimated costs to preserve ALDOT's pavements and bridges?

Some key funding concerns highlighted by this report are:

- State funding is estimated to grow at a rate that is close to the rate of inflation.
- State and federal funding are largely tied to consumption-based revenue sources (such as fuel taxes). Given increases in vehicle fuel efficiency, these revenues have remained stagnant and could decrease in the future.
- These consumption-based, unitary revenue sources have not kept up with inflation and have lost purchasing power because they have not been raised in decades.

Understanding the funding challenges that ALDOT faces provides the Department with critical information to better prioritize its pavement and bridge spending. Additionally, this information underscores the importance of having systems in place to identify and prioritize its maintenance needs. Finally, it provides the support needed to seek additional revenue sources for ALDOT's asset management work.

VII. Investment Scenarios

■

The TAMP is an important document because it encourages states to think about its assets in a holistic manner and consider how different processes or decisions lead to different outcomes. The process outlined by FHWA for creating a TAMP was helpful as it allowed ALDOT to work through each process methodically and consider how each component or process affects the other components and its transportation system as a whole.

For example, it was helpful to complete the life-cycle planning section early in the process because it highlighted that a worst-first approach to maintaining pavements and bridges is expensive. Having that recent discussion fresh in our minds led ALDOT toward investment choices that supported good asset preservation practices.

It was also helpful to complete the performance gap analysis before creating the investment scenarios because it highlighted some key gaps that ALDOT hopes to address through strategic investments. Additionally, the risk analysis discussion provided some valuable insight into key risks to address or keep in mind when considering investment scenarios.

A. Performance-Based Projections

The condition of ALDOT's assets in ten years depends upon several factors. To help ALDOT predict how funding could affect the condition of its pavement and bridge assets, the project team developed and analyzed alternative investment scenarios for asset preservation. Target levels were established for use in the scenarios.

1. Target Levels

As part of the first phase of the TAMP process, the TAMP Steering Committee met on September 15, 2015 to establish target performance levels for use in the pavement and bridge scenarios. The Steering Committee met again during the second phase, in December 2017, and confirmed that the same targets should be used for the investment scenarios in this TAMP update.

a. Pavement

Exhibit 41 shows the pavement target levels used in the investment scenarios. The values reflect the percentage of asphalt pavement in each condition range (based on the PCR score) per road category. These internal pavement condition targets are different from the official good/fair/poor targets that ALDOT has included in this report to comply final rulemaking on pavement and bridge condition performance measures and targets.

Exhibit 41: ALDOT's Internal Pavement Condition Targets

Road	Good	Fair	Marginal
Interstate	70%	20%	10%
Non-Interstate NHS	70%	20%	10%
Non-NHS	60%	25%	15%

Source: Alabama Department of Transportation and Dye Management Group, Inc.

b. Bridges

Bridge target levels focus on the percentage of good or fair for each bridge category. The Steering Committee views this as the most important indicator for these scenarios. ALDOT wants to keep the deck area for all state-maintained bridges at 97 percent good or fair condition. These targets were agreed upon for the bridge investment scenarios.

2. Investment Scenarios

a. Pavement

The project team worked with ALDOT's Bureau of Materials & Tests to develop three investment scenarios based on state-maintained lane-miles (29,405 total). A dataset from December 2017 was used for the pavement scenarios. The numbers are very similar to those included in the 2017 PPR, an older dataset summarized in Chapter II, ALDOT Asset Inventory and Condition. The lane-mile total for the December 2017 dataset is 29,405, which is 890 more lane-miles than the 2017 PPR data. Most of the additional miles are Interstate. The three scenarios are as follows:

- **Achieving Target Levels** – This scenario assumes ALDOT achieves the pavement target levels that reflect an acceptable level of service for the following roadway categories: Interstate, Non-Interstate NHS, and Non-NHS. This scenario requires a budget of $492.8 million annually to achieve the target levels individually for each road and improve the current road conditions.
- **Current Pavement Spending** – This scenario continues ALDOT's current budget levels for each of the next ten years (FY 2019-2028), as outlined in Chapter V. The budget is adjusted for inflation at a rate of 2.1 percent, which is the federal target rate as of December 2017. This results in a budget of approximately $434 million per year across the ten-year period. The FY 2018 budget for pavement was $452 million, which includes an Interstate Maintenance (IM) budget of $192 million and a Resurfacing budget of $260 million. However, because the IM budget is often lower than $192 million, ALDOT opted to proceed with $434 million for the current pavement spending scenario. When adjusted for inflation, the average annual budget is approximately $473 million.
- **Budget Increase of Ten Percent** – This hypothetical scenario reflects the possible impact if new funding opportunities were realized or an increase in current funding occurred. Like the Current Pavement Spending scenario, the

funds are adjusted for inflation increases across the ten-year period. The annual budget for this scenario is assumed to be approximately $517 million.

b. Bridges

Similarly, the four bridge scenarios vary based on funding availability and the desire to reach a target level:

- **Current Bridge Spending –** This scenario continues with ALDOT's current budget of $91 million annually, which comes from the $80 million Bridge Replacement funding plus a portion of Routine Maintenance funds, into the next ten years (FY 2019-2028). The budget was adjusted for inflation.
- **98 Percent Good or Fair (Current Condition) –** This scenario assumes that existing bridge conditions will remain the same throughout the ten-year period. In other words, the percent poor in 2028 would equal the percent poor in 2017. This illustrates what it would take to keep the current condition ratings constant, without accounting for funding and other resources.
- **Budget Increase of 20 Percent –** This hypothetical scenario increases funding to $109 million annually for NHS and non-NHS bridges.
- **97 Percent Good or Fair –** This scenario evaluates a target level of 97 percent good or fair for all bridges in the state inventory (5,753 bridges). Current conditions place the system's percent poor at 2 percent (2017). This scenario would allow for incremental deterioration while maintaining an acceptable level of service.

B. Analysis Results

1. Pavement Analysis Results

This analysis uses 2017 pavement data from ALDOT and a single deterioration equation — developed by ALDOT's Bureau of Materials & Tests, Pavement Management Section[xl] — across the three highway categories. Once the PCR deteriorates to an unacceptable level, according to the scenario, a major improvement is scheduled for that section. Pavement overlays are the only improvement type used in the scenarios. "Mill and fill" resurfacing cost for Interstates is $450,373 per lane-mile, while other state roads use a $147,000 per lane-mile cost.[xli] All project costs are expressed in 2017 dollars.

While most roads are asphalt, a few concrete roads are part of the analysis. Interstate concrete lane-miles total 743.7. It is expected that one hundred lane-miles will need to be replaced within ten years.

ALDOT's current pavement conditions by NHS class are shown in Exhibit 42 for comparison with the analysis in the next section.

Exhibit 42: ALDOT Pavement Condition 2017

Rating	Interstate	Non-Interstate NHS	Non-NHS
Good	78.4%	66.4%	60.1%
Fair	13.3%	21.1%	16.6%
Marginal	8.3%	12.6%	23.3%

Source: Alabama Department of Transportation. Bureau of Materials & Tests. (2017.)

a. Analysis of Pavement Investment Scenarios

The results of the pavement investment scenario analyses are provided in Exhibit 43 - Exhibit 46. Exhibit 43 illustrates the results of the ten-year analysis based on financial constraints or target level aspirations, depending on the scenario. The percentages shown reflect the lane-miles in each condition range per roadway category and the average budget spent on that category. The base year is FY 2018 and the horizon year is FY 2028.

Exhibit 43: Pavement Analysis Scenarios - Predictive Condition in FY 2028

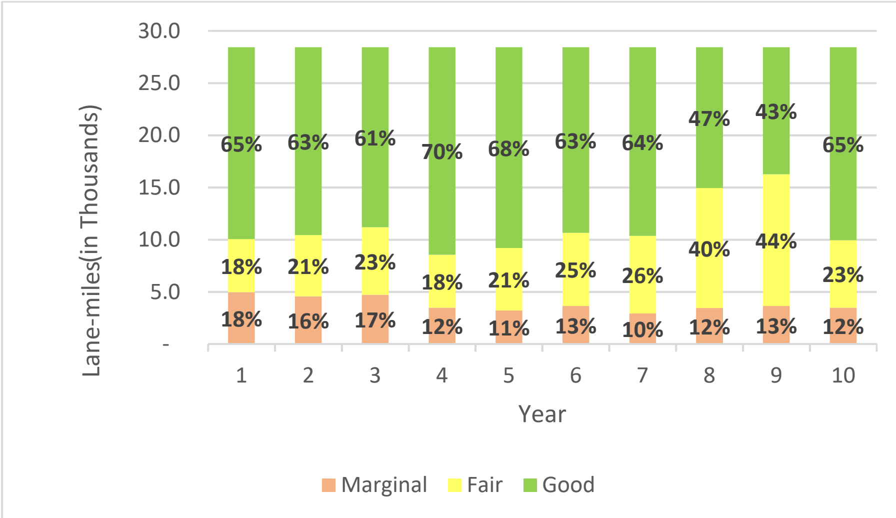
Scenarios		Begin			End			Budget	
		Interstate	Non-Interstate NHS	Non-NHS	Interstate	Non-Interstate NHS	Non-NHS	$M/year	
Achieving Target Levels	Good	78.0%	66.3%	60.0%	70.0%	70.0%	60.1%	$ 210.2	Interstate
	Fair	13.5%	21.1%	16.6%	20.2%	20.0%	25.4%	$ 145.7	Non-Interstate NHS
	Marginal	8.4%	12.6%	23.4%	9.8%	10.0%	14.5%	$ 136.9	Non-NHS
								$ 492.8	***Target Total***
Current Budget	Good	Same as above			61.9%	45.1%	45.5%	$ 190.1	Interstate
	Fair				36.8%	47.2%	45.6%	$ 130.3	Non-Interstate NHS
	Marginal				1.3%	7.7%	8.9%	$ 152.5	Non-NHS
								$ 472.9	***Current Budget Total***
Budget Increase 10%	Good	Same as above			77.3%	64.0%	54.0%	$ 195.0	Interstate
	Fair				19.6%	30.3%	43.1%	$ 164.1	Non-Interstate NHS
	Marginal				3.1%	5.7%	2.9%	$ 157.7	Non-NHS
								$ 516.8	***Budget Increase Total***

Ranges for the target levels are described in Chapter II. Subcategories were added to illustrate greater detail of the fair and marginal categories. The PCR breakdown is as follows:

- Good 100 – 70
- Fair + 69 – 65
- Fair 64 – 60
- Fair - 59 – 55
- Marginal + 54 – 30
- Marginal 29 – 0

Exhibit 44 presents the results of the Achieving Target Levels scenario. The graph shows the total system condition, which combines the Interstate, Non-Interstate NHS, and Non-NHS pavements.

Exhibit 44: Achieving Target Levels Pavement Scenario - Total System Condition



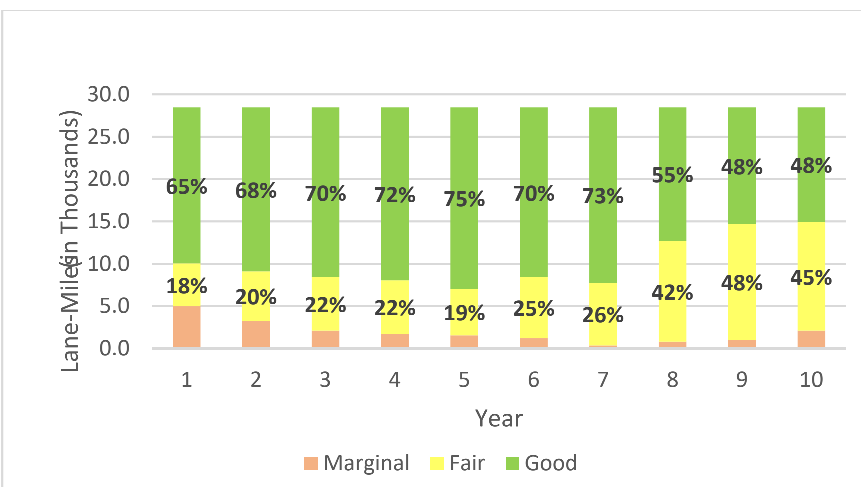
Source: Alabama Department of Transportation, Dye Management Group, Inc.

This scenario shows ALDOT maintaining pavement conditions at the target levels through Year 7. At that point, an increasing number of lane-miles move from good to fair. As a result, required funding spikes in Year 9 to regulate the pavement back to acceptable levels. An average annual budget of $492.8 million is necessary to achieve the target condition levels in Year 10.

While this scenario was only constrained by the desired condition level targets, the next two scenarios are constrained by available funds.

Exhibit 45 presents the results of the Current Pavement Spending scenario. The graph shows the total system condition, which combines the Interstate, Non-Interstate NHS, and Non-NHS pavements.

Exhibit 45: Current Pavement Spending Scenario - Total System Condition

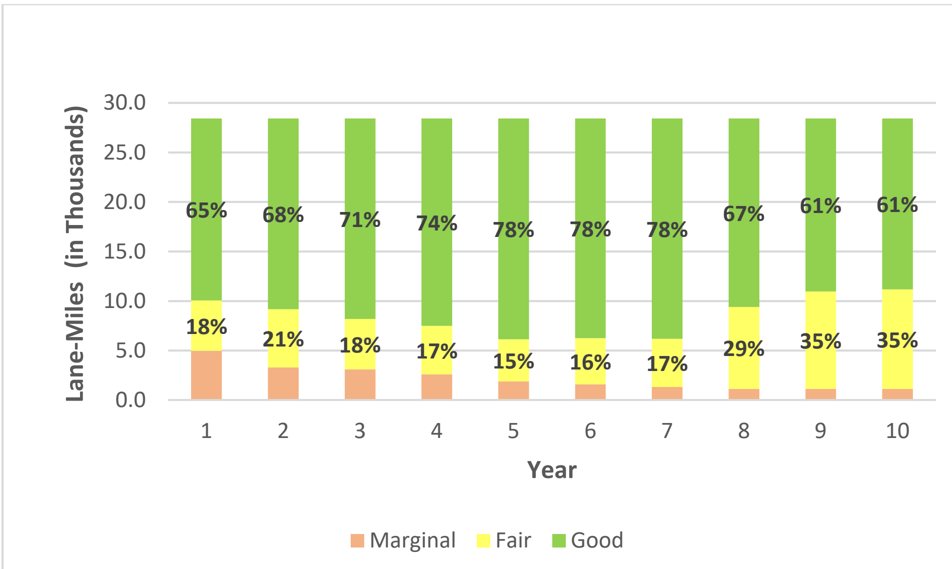


Source: Alabama Department of Transportation, Dye Management Group, Inc.

Current pavement spending for ALDOT is approximately $434 million annually. When adjusted for inflation over the ten-year period, the average annual budget total is $473 million. Over the ten-year period, the percentage of good and marginal pavement decreases, 17 and 10 percent respectively, while the amount of fair pavement increases by 27 percent. The greatest percentage changes in a single year occur between Year 7 and Year 8, when the fair pavement increases by 16 percent and good pavement decreases by 18 percent.

Exhibit 46 presents the results of the Budget Increase of Ten Percent scenario. The graph shows the total system condition, which combines the Interstate, Non-Interstate NHS, and Non-NHS pavements.

Exhibit 46: Budget Increase of Ten Percent Pavement Scenario - Total System Condition



Source: Alabama Department of Transportation, Dye Management Group, Inc.

The budget increase scenario provides sufficient funding to achieve the target goals by Year 10 for all pavement NHS groups – Interstate, Non-Interstate, and Non-NHS. An increased budget ($517 million annually for the scenario, when adjusted for inflation) allows ALDOT to improve the condition of the system, with the majority of pavement in good condition and only 4 percent marginal pavement at the end of the period.

b. Metropolitan Planning Organizations and Other Considerations

As part of the TAMP development process, ALDOT considered the requirements related to coordination with other agencies such as MPOs. Per federal requirements established by Title 23 of the U.S. Code, MPOs must integrate the goals, objectives, performance measures, and targets described in state transportation plans and processes into their metropolitan transportation planning processes. Additionally, the final asset management rule requires MPOs to include the asset management plan developed by the state into their metropolitan planning process. Finally, the pavement and bridge condition performance measures and targets rulemaking states that, in addition to the requirement that state DOTs set performance targets, MPOs must also set performance targets. MPOs may establish their own targets or adopt the state DOT's targets. As part of that process, ALDOT coordinated with Alabama's MPOs about any needs and questions they had related to bridge and pavement data, target setting, and questions about the TAMP development and associated asset management processes. As of the time of this report publication, all of Alabama's MPOs have adopted ALDOT's targets.

The TAMP guidelines require assessment of all NHS lane-miles regardless of which agency maintains them. Three percent of NHS roads are not in ALDOT's 2017 data. This totals 187 centerline miles according to the 2017 HPMS data.[xlii] Using GASB 34 to compare IRI to PCR scaling, and repeating the predictive analysis methods discussed previously, it is estimated that 208.4 lane-miles of the 450.5 lane-miles (46.3 percent) will need replacing over the ten-year timeframe at a cost of $35.6 million. Annually, this is $3.5 million and approximately twenty-one lane-miles. However, this analysis is not reflected in the results above because ALDOT did not feel the IRI and PCR results should be combined, even though the methodologies were similar, because it was based on a different data source.

2. Pavement Analysis Conclusions

The results of the three pavement investment scenarios can be summarized as follows:

- **Achieve the target levels**[xliii] **established by the TAMP Steering Committee:** This scenario requires a budget of $492.8 million annually to achieve the target levels individually for each road class and improve the current road conditions.
- **Continue current budget levels for the next ten years (FY 2019-2028):** Current pavement spending for ALDOT is approximately $473 million annually, adjusted for inflation. Over the ten-year period, this scenario predicts that ALDOT will achieve the pavement condition target levels for all NHS groups (Interstate, Non-Interstate NHS, and Non-NHS pavements).
- **Increase the existing budget by 10 percent to assess the impact on highways:** This scenario provides sufficient funding to achieve the target goals for all NHS groups. An increased budget (approximately $517 million annually, adjusted for inflation) allows ALDOT to improve the condition of the system after ten years, with the majority of pavement in good condition.

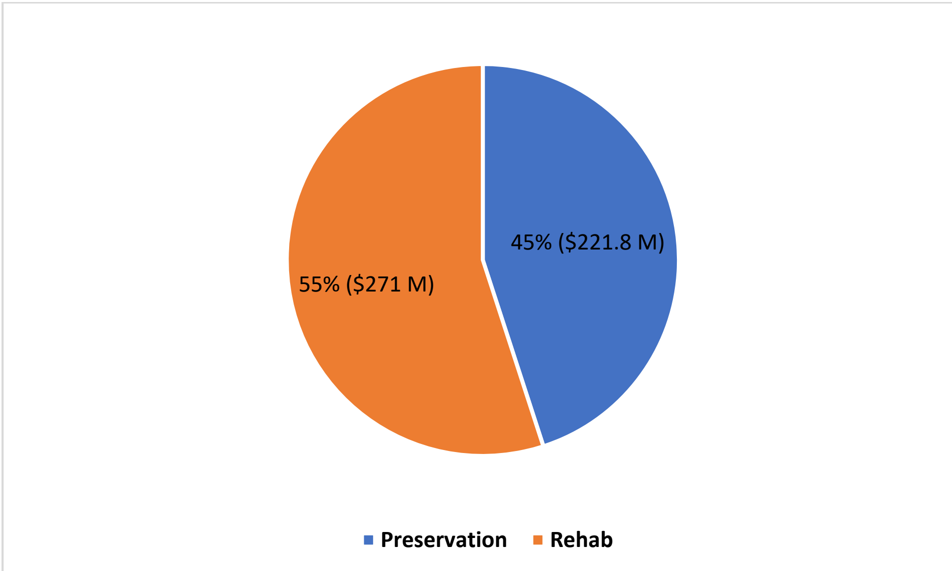
The "achieve target levels" scenario fares best when considering life-cycle planning because it does the best to maintain the assets in a state of good repair while minimizing cost.

3. Pavement Expenditures by Work Type

According to 23 CFR 515, state DOTs must specify their projected expenditures for funding improvements to NHS pavements by year and by federal work type. Historically, ALDOT has not categorized its projects into the five work types outlined in the TAMP regulations but has done so as part of this planning process.

Exhibit 47 shows the projected annual expenditures for the preferred pavement preservation scenario ("achieve target levels") for the 10-year planning horizon. It is divided by relative work type; work type details are shown in Exhibit 32. ALDOT's process for creating these projections is described in the following section. Because this process relates to the annual consistency determination that ALDOT must prepare as part of the TAMP requirements, both processes are documented in this section.

Exhibit 47: Projected Pavement Expenditures by Work Type



To prepare the annual consistency determination, ALDOT first obtains pavement project expenditure data from the appropriate 12-month time period and analyzes the data by work type using the crosswalk in Exhibit 32. ALDOT then calculates and reports the total expenditures for each work type to determine if the actual and planned levels of investment for the federal work types are in alignment.

To estimate the projected pavement expenditures by work type for the TAMP planning period, ALDOT first reviewed historical pavement expenditure data alongside pavement project data in the current STIP. ALDOT categorized its pavement projects into two main programs: Federal-Aid Maintenance and Interstate Maintenance (IM) and reviewed the project information in both programs. In a process similar to the one used for the annual consistency determination, ALDOT reviewed the project data and assigned a federal work type to each project, according to Exhibit 32. The next step was to summarize the project costs by work type and fiscal year to provide a breakdown of the projected spending. ALDOT then summarized that data into the chart shown in Exhibit 47. While ALDOT reviewed the STIP as part of this process, it does not provide a complete vision that covers the remainder of the TAMP period, from 2023 – 2028. For the years beyond the STIP period, ALDOT considered any factors that might affect future expenditures such as new funding sources. In this TAMP, ALDOT assumed that the work type breakdown for the years 2023-2028 will be similar to the earlier years in the planning period, so we estimated that the breakdown of expenditures by work type to be roughly the same for each year of the planning period.

4. Bridge Analysis Results

This section provides some context and additional analysis related to bridge needs, followed by the results of the investment scenarios.

a. Context

The following are important factors to consider when planning for future bridge needs.

(1) Recent Bridge Expenditures and Funding

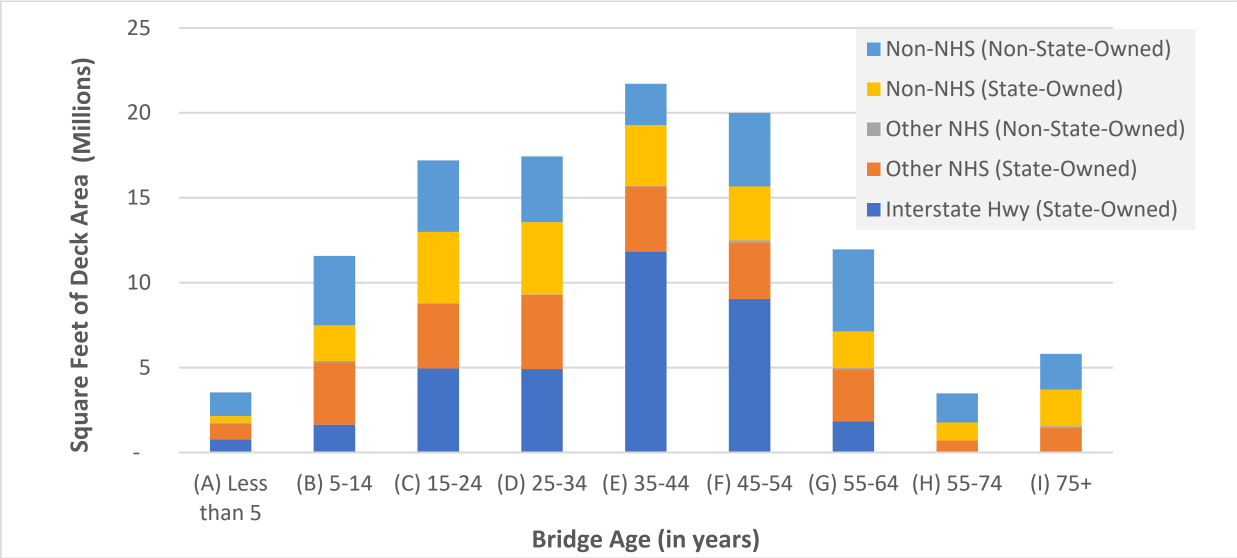
In recent years, expenditures on bridge maintenance, repair, rehabilitation, and replacement in Alabama have remained relatively constant at approximately $80 million per year for federally-funded rehabilitation and replacement, and $11 million for state-funded maintenance and inspection, for a total of $91 million. Even with a robust preservation and rehabilitation strategy, this funding level is enough to address only about 1 percent of the most deteriorated bridges in the inventory of 5,753 state-maintained bridges. A significant number of bridges are nearing, or have already exceeded, their original fifty-year design life and will soon need to be replaced.

(2) ALDOT's Aging Bridges

Although expenditures on bridge maintenance, repair, rehabilitation, and replacement in Alabama have remained constant, the bridge population is aging and ALDOT should review its investment strategy to determine if historical funds are sufficient. ALDOT has benefited from the relative youth of a bridge inventory constructed during the Interstate era of the 1960s and 1970s. Now those bridges are reaching an age where the costs of maintaining their continued health are increasing.

Exhibit 48 shows the current age breakdown of the bridge deck area across five classifications, completed in 2017. Most apparent is the 12 million square feet of deck area on Interstate highways in the 35-44 age group and the 9 million square feet in the 45-54 age group.

Exhibit 48: Age of Alabama Bridge Population by Ownership Classification (Sq. Ft.)



Source: (2017). Alabama Department of Transportation, Dye Management Group, Inc.

As discussed previously, the majority of state-owned bridges are in fair” condition, with 65.4 percent of deck area in 2017, while 32.8 percent are good and 1.8 percent are poor. Interstate bridges have a higher percentage of fair and poor deck area with 17 percent good, 80.3 percent fair, and 2.7 percent poor. With the amount of aging deck area and the fact that most are in the mid-condition range, ALDOT must look at bridge needs over the next ten years.

(3) Value of Preservation

Although most of Alabama’s bridges currently in service were designed for a fifty-year life, in many cases the lifespan can be significantly extended using appropriate preservation treatments, such as:

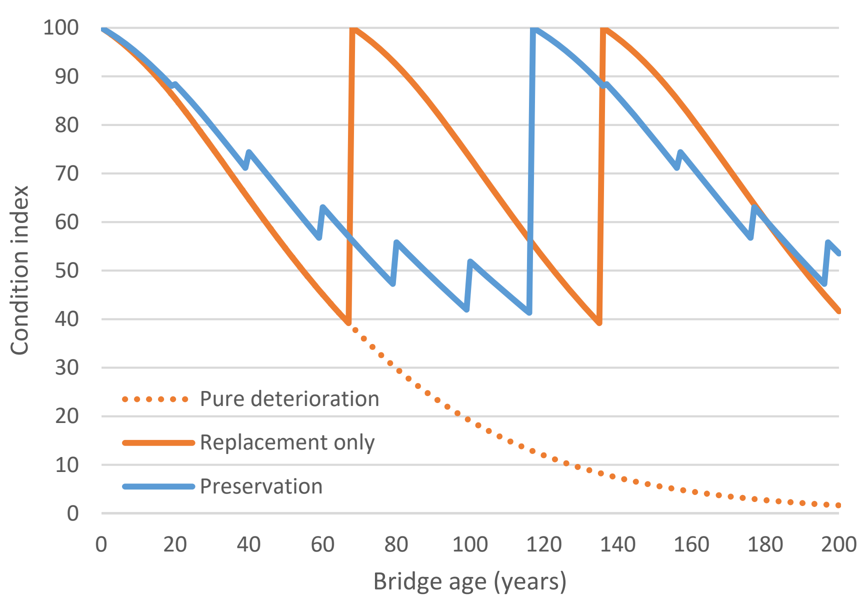
- Routine interval-based treatments such as washing, lubrication and adjustment of bearings, deck flushing, joint sealing, and deck sealing
- Condition-responsive corrective actions such as painting, patching, bearing and joint repairs, and deck overlays

Routine maintenance treatments in the first category can be applied to whole classes of bridges on a scheduled basis, regardless of their condition, to slow the rate of deterioration. Treatments in the second category must be evaluated on a case-by-case basis, depending on condition, deterioration rates, and costs. A bridge management system with life-cycle planning capability can serve this need. AASHTO is developing this type of system, which ALDOT plans to implement when it is complete.

The main goal of a preservation strategy is to reduce costs in the long term by postponing the more expensive replacement costs for as long as it is cost effective to do so. Cost effectiveness is evaluated using standard life-cycle planning. Exhibit 49 shows typical long-term condition profiles expected for Alabama bridges, using typical ALDOT treatments, deterioration rates, and costs. The condition index in this graph is a combination of deck, superstructure, substructure, and culvert condition, scaled so 100 is brand-new condition and zero is the worst possible. The three preservation strategies are:

- **Pure deterioration** shows how bridge condition would change over time if the bridge received no attention at all. The bridge would have to be load restricted at a condition index in the thirty-five to forty-five range and would become impassable by the time it reached a condition index of twenty-five.
- **Replacement only** allows a bridge to deteriorate with no maintenance until it reaches a condition where it must be replaced to maintain service. The bridge would have a typical lifespan of sixty to seventy years before it would have to be replaced.
- **Preservation** applies periodic routine maintenance treatments, and performs well-timed repairs when conditions warrant it. Each repair causes a modest improvement in condition, but these improvements have a significant effect on the life expectancy of the bridge, extending its life to nearly 120 years.

Exhibit 49: Preservation Extends the Service Life of a Typical Alabama Bridge



Source: AASHTO

(4) Mega-Bridges

The analysis of 5,753 state-maintained bridges includes fifteen that were deemed too large for routine maintenance dollars. The replacement or rehabilitation of these mega-bridges could not be paid for out of regular routine funding. This means that special funding would need to be secured, apart from the $91 million annual bridge budget, to address these bridges when maintenance needs arise.

Exhibit 50 presents a list of the mega-bridges that are more than 400,000 square feet in deck area. This table identifies bridges by ALDOT Region.

Exhibit 50: List of Mega-Bridges (2017)

Bridge ID	Region	Area	Facility Carried	Feature Intersected	Year Built	Highway Type	Deck Area (sq ft)	NHS
11930	Southwest	Mobile	I-10 WB	M. BAY, 90, 98, I10WB RAMP	1978	Interstate	1,668,366.00	On
11931	Southwest	Mobile	I-10 EB	MOBILE BAY * US 90	1978	Interstate	1,668,576.00	On
15508	Southwest	Mobile	I-165 NB	MULTIPLE STREETS, STREAMS	1994	Interstate	1,438,916.30	On
15574	Southwest	Mobile	I-165 SB	MULTIPLE STREETS, STREAMS	1994	Interstate	1,428,409.00	On
12322	Southwest	Mobile	I-65 NB	MOBILE RIVER DELTA	1980	Interstate	1,338,816.10	On
12321	Southwest	Mobile	I-65 SB	MOBILE RIVER DELTA	1980	Interstate	1,338,503.30	On
12835	Southwest	Mobile	SR 193	MISS. SOUND * D.I. BAY	1982	State Hwy	753,529.90	Off
15430	Southwest	Mobile	US 90/COCHRANE BR	MOBILE RIVER	1991	U.S. Hwy	670,772.00	On
15820	North	Guntersville	I-565; ALT US 72	NORFOLK SOUTHERN	1991	Interstate	552,710.50	On
15821	North	Guntersville	I-565; ALT US 72	NORFOLK SOUTHERN	1991	Interstate	548,222.70	On
12907	West Central	Tuscaloosa	I-359	US 43, US 11	1983	Interstate	514,078.60	On
10671	East Central	Birmingham	I 59/20	US 31 CTY STRS RR S	1972	Interstate	470,872.00	On
10670	East Central	Birmingham	I-59/20	US 31, RRS*CITY STREETS	1972	Interstate	467,372.40	On
10882	North	Tuscumbia	I-65	TENNESSEE RIVER	1973	Interstate	428,533.70	On
10883	North	Tuscumbia	I-65	TENNESSEE RIVER	1973	Interstate	428,533.70	On

Source: Alabama Department of Transportation.

Some bridges built in the early 1970s may need attention within ten years as they will be just over fifty years in age. Based on recent preservation actions and expected expenditures, no improvement costs are assumed during this ten-year timeframe. They should, however, be reviewed in the next TAMP cycle.

b. Analysis of Bridge Investment Scenarios

The four bridge investment scenarios reflect a need to develop a strategy to look at bridge needs over the next ten years. The scenarios break down the system into on-system and off-system NHS bridges that are the responsibility of ALDOT. To develop the scenarios a spreadsheet model was developed at the level of NBI components (deck, superstructure, substructure, and culvert) to perform a network level life cycle cost analysis over a 200-year time horizon with a 2.1% discount rate. The deterioration model used in this exercise was developed from elicitation of expert judgment, but costs were derived from actual ALDOT work records and cross-checked with other comparable agencies. The model was used for the purpose of quantifying the long-term value of bridge preservation. This model was developed only for the purpose of the 2018 TAMP, since ALDOT was simultaneously developing an element-level deterioration model for future use in its bridge management system.

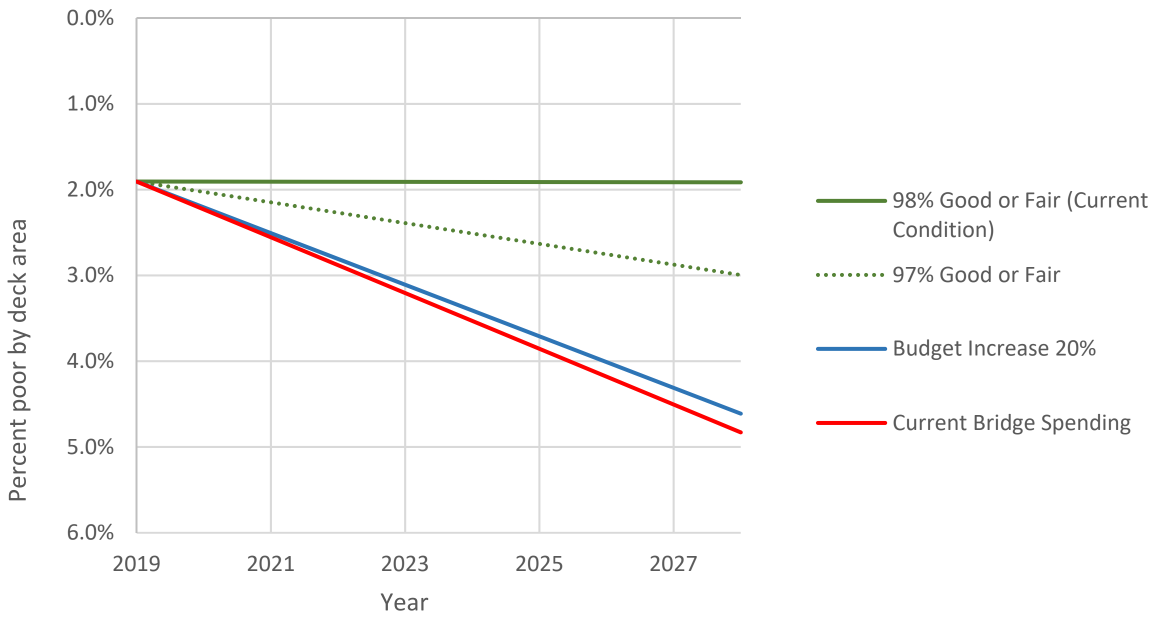
Exhibit 52, Exhibit 53, and Exhibit 55 show the results of the four bridge scenarios. Exhibit 51 compares the percentage of deck area in good or fair condition at the end of the ten-year planning period (FY 2028) and the annual budget required to achieve it.

Exhibit 51: Ten-Year Projection of Deck Area in Good or Fair Condition for Selected Funding Scenarios (for All State Bridges)

		Current Bridge Spending	Budget Increase 20%	97% Good or Fair	98% Good or Fair (Current Condition)
% Deck Area in Good or Fair Condition (in 2028)	State - NHS	95.2%	95.4%	97.0%	98.1%
	State - Off NHS	96.6%	96.7%	97.0%	98.4%
	State - All	95.6%	95.8%	97.0%	98.2%
$M/Yr Required	State - NHS	$ 66	$ 80	$ 166	$ 223
	State - Off NHS	$ 25	$ 30	$ 38	$ 74
	State - All	**$ 91**	**$ 110**	**$ 204**	**$ 297**

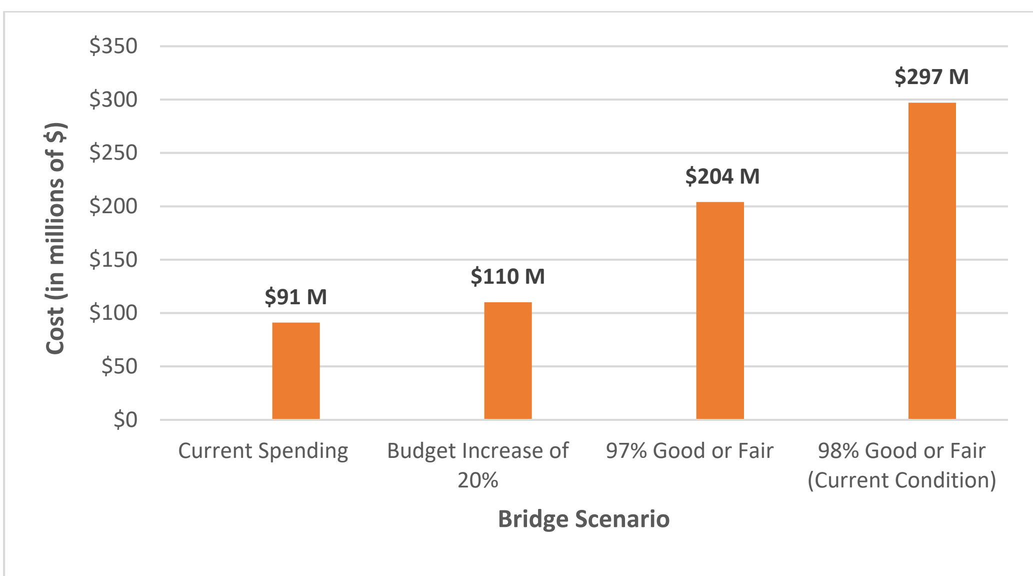
Source: (December 2017). Alabama Department of Transportation, Dye Management Group, Inc.

Exhibit 52: Results of All Bridge Scenarios (10-year Horizon)



Source: (December 2017). Alabama Department of Transportation, Dye Management Group, Inc.

Exhibit 53: Bridge Scenario Cost



Source: (December 2017). Alabama Department of Transportation, Dye Management Group, Inc.

5. Bridge Analysis Conclusions

The results of the bridge scenario analysis show that, to maintain the 2017 condition of state-owned bridges – 98 percent good or fair – over the next ten years, ALDOT would need to spend $297 million annually, more than triple the current funding level. To achieve the target level of 97 percent good or fair, ALDOT would need to spend $204 million, more than twice its current funding. If the current funding is continued at $91 million annually and adjusted for inflation, ALDOT can expect to achieve 95.7 percent good or fair. There are only nominal gains by adding 20 percent to the budget, as the resulting condition only increases by one-tenth or two-tenths of a percent for good or fair. Therefore, the selected scenario is the 97% good or fair scenario because it best supports life-cycle planning and preservation.

While a 2 percent decrease in the percentage of bridges in good or fair condition may not appear to be substantial, it is a 100 percent decrease over current conditions. Combined with the current bridge age distribution and an inability to address those older bridges, this is a mounting concern for ALDOT. The cost to maintain these structures on average will increase as the age increases. The purchasing power of funding is being depleted by inflation and the increased cost of materials or labor. This only has the potential to escalate further as bridges continue to deteriorate. During the TAMP development process, ALDOT discussed the importance of maintenance and life-cycle planning at length and places a lot of importance on maintenance and preservation practices for all of its assets.

6. Bridge Expenditures by Work Type

As noted in the *Pavement Expenditures by Work Type* section (VII-B-3), historically, ALDOT has not categorized its projects into the five federal work types, but we conducted a work types alignment process as part of this TAMP. The following section describes the processes for creating the ALDOT and federal work types crosswalk, preparing the annual consistency determination, and projecting the expenditures by work type for bridges.

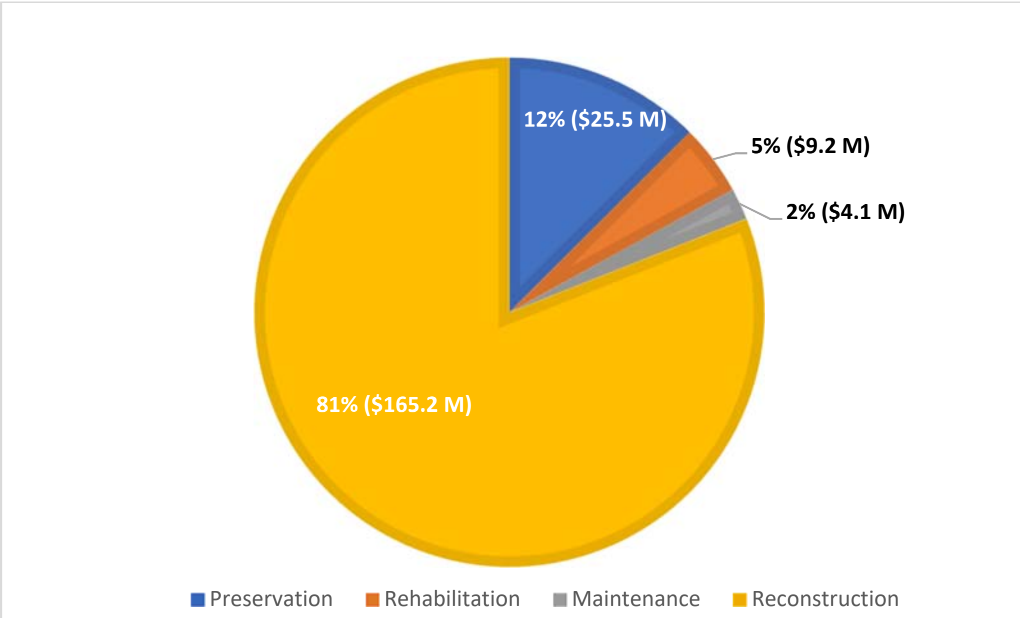
To create the crosswalk between ALDOT and federal work types, ALDOT bridge maintenance staff met to review the B Codes and determine how they align with the federal work types. After a thorough review and discussion, the group added the ALDOT bridge work types and their relationship to the five federal work type to the crosswalk shown in Exhibit 32.

To prepare the annual consistency determination, ALDOT first obtained bridge project expenditure data from the appropriate 12-month time period. We then analyzed the data by work type using the crosswalk in Exhibit 32. After that, we calculated and reported the total expenditures for each work type to determine whether actual and planned levels of investment for each work type are aligned.

To project the expenditures by work type for bridges, the group first gathered historical bridge project data and project data from the current STIP. After that, they reviewed the bridge project data. ALDOT categorizes its bridge projects into two major groups: state-funded bridge work and the bridge program; the group reviewed both sets of data. After that, they assigned a federal work type to each project, according to the crosswalk in Exhibit 32.

The final step was to summarize the project costs by work type and fiscal year to provide a breakdown of the projected spending by work type, as shown in Exhibit 54. This chart shows the projected annual expenditures for the preferred bridge scenario ("97% good or fair") for the 10-year planning horizon. While the bridge group reviewed the STIP as part of this process, it does not provide a complete vision that covers the remainder of the TAMP period, from 2023 – 2028. For the years beyond the STIP period, ALDOT considered any factors that might affect future expenditures such as new funding sources. In this TAMP, ALDOT assumes that the work type breakdown for the years 2023-2028 will be similar to the earlier years in the planning period, so we estimate that the breakdown of expenditures by work type to be roughly the same for each year of the planning period.

Exhibit 54: Projected Bridge Expenditures by Work Type



7. Additional Steps

The following are some additional steps that would help ALDOT capitalize on the work done throughout the development of this TAMP.

- **Secure new funding** – This is easier said than done, but future funding uncertainty is a major risk for ALDOT. Legislative and public outreach on the need for other funding will assist ALDOT in the future and would help mitigate the risk of reducing existing funding.
- **Establish a comprehensive preservation program** – Understand the impacts and cost-saving ability of regular preservation activities on pavement and bridges, rather than replacement. Establishing a preservation program for assets will assist in minimizing the financial burden over time and help produce a better transportation system.
- **Implement better predictive models** – The use of historical data and a deterioration model specific to Alabama's pavement and bridge categories will

benefit the investment scenarios and decision making. Steps are being taken by ALDOT, but continuation and fulfillment of these actions is necessary.

- **Determine impact of improvements –** How long does a chip seal last? How long can ALDOT expect an overlay to remain in good condition? A lack of historical knowledge of preservation improvements limits analysis capabilities. An understanding of the improvements and what each action means to the system, both conditionally and financially, is necessary to help determine the correct strategies for ALDOT in the future.
- **Revisit investment scenarios annually –** The results of the investment scenarios show that ALDOT would need an additional $171.8 million annually, for the next ten years, to achieve the pavement and bridge condition targets used in this analysis. The pavement budget shortfall was calculated by subtracting the current pavement budget, not adjusted for inflation ($434.0 million), from the budget needed to achieve the target condition scenario ($492.8), which equals $58.8 million. The bridge budget shortfall was calculated by subtracting the current bridge budget ($91 million) from the budget needed to achieve the bridge target condition used in this analysis ($204 million), which equals $113 million.[xliv] To achieve its goals, ALDOT must select an investment approach that addresses the $171.8 million shortfall. This should be done through a mix of preservation optimization and an increase in funding. Over time, ALDOT will also need to assess its progress compared to the TAMP. ALDOT should revisit the investment scenarios annually as part of its TAMP update using the guidance outlined below:
  - **Conduct trade-off comparisons across functions** – Use the processes described in the AASHTO Asset Management Guide to allow investment trade-off comparisons across performance measures and highway assets. For example, ALDOT can model the outcome of funding allocations across assets if pavement received more funding halfway through the ten-year scenario. Processes and tools for trade-off analysis will illustrate the impact of comprehensive investment strategies and supply decision makers with more alternatives.
  - **Collaborate with other Bureaus –** The scenario work within the TAMP provides an opportunity for the Maintenance Bureau to collaborate with other Bureaus within ALDOT. ALDOT could capitalize on this work through the following actions:
    - Coordinate with the ALDOT long-range planning team to learn about the scenario work completed to date and use the data that is applicable to pavements and bridges.
    - Then, determine if more scenario work is needed for bridges and pavements and develop a plan to complete that work.
  - **Focus on data presentation –** Present results in a compelling fashion to decision makers.

VIII. Conclusions and Next Steps

■

The TAMP is not only a snapshot of ALDOT's current state of asset management, but also a guide for what ALDOT can do next to further its asset management program. One major benefit that came from developing this TAMP was identifying areas of improvement. Once those areas were identified, the project team created a list of specific action items to address these areas. The implementation plan in Appendix D provides guidance for implementing TAM best practices, integrating the TAMP into ALDOT's decision-making processes, and updating the TAMP in the future.

The implementation plan's list of action items for the next year also includes a potential timeframe for implementation and estimated cost for each action item. One near-term action item to schedule soon is the next TAMP update. Because of internal changes that occur within an organization and external events such as funding and policy changes, the TAMP must be updated frequently. This will help ALDOT track progress toward achieving its asset management goals and setting new ones.

A TAMP update involves many stakeholders and can take a significant amount of time to complete, so it is recommended that ALDOT begin the initial two steps of the update as soon as possible: Set a Schedule and Identify the Update Team. Identifying what is working and what is not, in terms of process and systems, will help ensure that decision makers are given the most useful information at the "right" time and ultimately, will help ALDOT make cost-effective decisions.

Appendix A: Data Quality Management Plan

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Data Quality Management Plan

Materials & Tests, Pavement Management Section
Alabama Department of Transportation

Data Quality Management Plan v 0.98
05/21/2018

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Minor Revision Change Log

- v. 0.98—05/21/2018—Submission of initial document to FHWA

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Materials & Tests, Pavement Management Section
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05/21/2018

Summary

This Quality Management Plan is intended to document the processes and procedures by which an acceptable level of quality of collected pavement condition data is ensured, both for in-house use (Preliminary Prioritization Report, GASB34, and SMART report) and FHWA TPM (Transportation Performance Measures) as reported in the Transportation Asset Management Plan (TAMP) and through the Highway Performance Monitoring System (HPMS) Report. This data is collected by a vendor (Pathway Services, Inc.) and quality assurance of the collected data is performed by ALDOT. These processes occur in four general phases of the collection process: pre-collection, collection, processing, and post-collection. Collection and processing of data may but need not occur simultaneously.

Pre-collection

In the pre-collection phase, the vehicle and its systems as well as the data reduction process are demonstrated to be capable of collecting quality data. Checks are also put in place to ensure that the vehicle remains in working condition throughout the collection phase. First, the data collection vehicle is certified with respect to IRI at the National Center for Asphalt Technology test track. Tests for accuracy (with respect to a known profile determined by an ICC SurPRO) and repeatability (with respect to the vehicle itself) using the FHWA's ProVAL software. The data vehicle then establishes a target IRI at ten of the IRI control sites maintained by the agency. These targets are used in the collection phase.

The rutting capabilities of the collection system are demonstrated at the same ten or more of twenty IRI control sites, where manual rut depth readings have been made at 52.8 ft increments. The vehicle will also establish targets at this time for production checks.

The ability of the system and the data reduction processes to detect cracking is demonstrated through the use of 10 calibration sites picked before data collection begins. In general, this occurs at vendor selection, but may be performed as needed before a cycle begins. A Pearson's r (more specifically, Pearson product-moment correlation coefficient) statistic for the sum of all transverse cracking, the sum of all wheelpath cracking, and the sum of all non-wheelpath cracking is determined. Significant differences in ratings are investigated and mutually resolved before data processing is begun.

The determination of faulting values from the inertial profiler (which has already been certified for IRI) is demonstrated by using ProVAL to compute faulting for at least two locations with jointed concrete pavement and comparing the values thus obtained to those from the profiler

Collection

While data is being collected, IRI and rutting values are checked weekly against one of the ten or more control sites established in the pre-collection phase. These values are provided to ALDOT along with the data files from the control sites.

Also, during collection, drives with ROW images are provided to ALDOT by Pathway. A list of the mileposts within the segments run is generated at ALDOT and the milepost signs located; for segments that do not contain a sign, the midpoint of the segment is located and the quality of the image assessed. The legibility word "milepost" on most milepost signs is the threshold for acceptance based on legibility. Though mileposts are not always in the correct location, they can be indicative of an LRS/DMI problem.

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Systematic location offsets are investigated to determine whether the start and end points of offending segments are incorrectly set; these start and end points are then corrected by the vendor. However, current Pavement Management practice is to use GPS points converted to either milepost (Pavement Management reports) or milepoint (for HPMS).

Processing

The bulk of these activities are done by Pathway, and include spatial alignment, completeness checks, and ROW image checks. In addition, automated crack analysis (including manual intervention where needed) is performed and the data reduced to 0.01-mi segments for reporting. This report (again, by Area or Region) is checked for completeness and quality, including year-over-year checks for IRI, rutting, faulting, macrotexture, cracking, and road geometry. This reduced data is provided to ALDOT in batches, by Region (where only the NHS is collected), or by Area (where 100% of the road mileage is collected).

Post-collection

It is in the post-collection phase that the bulk of the quality assurance activities are conducted by ALDOT. Data is accepted as final by Area or Region as appropriate.

First, reported LRS values are checked against GPS values provided as part of the delivered data using an ALDOT-developed program called WALDO. Route and GPS values are converted to route and milepost values and compared with the reported LRS values. Lists of segments where the converted LRS and reported LRS differ by greater than 0.1 and 0.25 miles are created. The causes of these errors are determined jointly by ALDOT and the vendor and resolved before final acceptance.

Also, time cycle checks are performed on the data by ALDOT staff in preparation for an in-house report that precedes HPMS. Year-to-year checks are made on overlays (segments with the same surface mix) on NHS routes, excepting those where the surface has changed due to a new overlay or preventive surface treatment. Checks are made on non-NHS state routes on a two-year basis. IRI, rutting, faulting, transverse sum, wheelpath sum, nonwheelpath sum, and the computed indices (including Pavement Condition Rating, or PCR) are compared with their previous values. Only a limited number of "improving" sections should be allowed to persist in the data. Significant differences from previous years' time cycle checks are investigated.

Further developments

In 2017, ALDOT began working with Auburn University on an SPR-funded project on assessing Pathway's data quality through ground truth surveys. Considerable progress has been made, including the collection and processing of approximately 375 0.05-mi ground truth sites collected by ALDOT personnel. Final recommendations are expect toward the end of 2018.

The reporting intervals from the processing phase were used to generate a list consisting of all possible 264-ft samples that can be selected from the data. Three percent of the collected mileage was used to determine the number of samples randomly chosen for field verification. Field visits are then made by the Pavement Parameters Manager (ALDOT) to determine the presence of transverse, wheelpath, and non-wheelpath cracking. Substantial differences in results are investigated and may require re-rating by the vendor.

We anticipate that statistical analysis will be used to determine vendor compliance. The analysis will likely be based on the differences in cracking observed between ALDOT raters and the Pavement

Data Quality Management Plan

Management Engineer; these differences are assumed to be typical of the rater-to-rater consistency of a manual survey; Pathway should be able to match these differences within a 95% confidence interval.

Data Collection/Reduction Process

The data collection process is outlined on the following page. A significant effort was expended when re-writing the primary procedure (ALDOT-414-04, rev 06/15), and the reader is referred to that document (included in Appendix A) for further details on the procedures followed and the acceptance criteria associated with each procedure.

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Materials & Tests, Pavement Management Section
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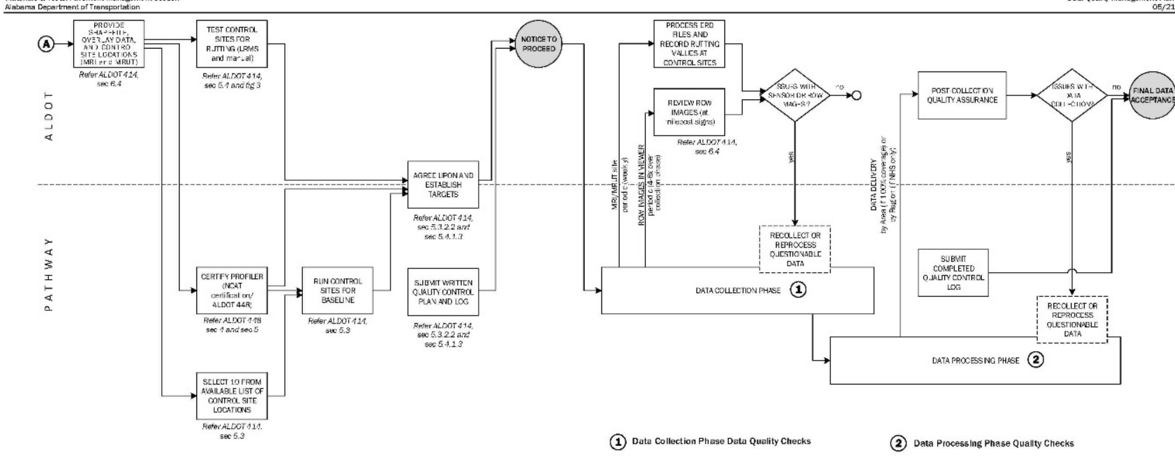

Figure 1. Data Collection Flowchart

(A) Vendor Selection Ground Truth Exercise

- Using prior 2 years' data and ROW images, ALDOT selects candidates with a variety of distresses that would also be suitable for lane closure.
- ALDOT makes field visits to each site to verify cracking extents/severities, to look for safety issues (sight distance, crossing streets), and to mark the sign locations according to MUTCD guidelines.
- ALDOT selects 10 0.3-mi sites for rating, beginning at physical milepost
- Pathway (and possibly other vendors) rates same sites, using painted lettering and/or physical milepost signs.
- Pathway, etc. rates images for cracking, as well as IRI and rutting at 52.8-ft intervals
- ALDOT performs manual ratings at 52.8-ft intervals using a wheelpath template (to help differentiate between wheelpath cracking and nonwheelpath cracking).
- Results are compiled, and Pearson's R is calculated for each vendor
- Typical results are in the mid to high 0.7's.
- Selected vendor will meet to discuss differences and determine resolution before procedure above begins
- Procedure may also be done with contract renewals, etc., or yearly if deemed necessary

Refer ALDOT 414, sec 6.1.1

(1) Data Collection Phase Data Quality Checks

- Crew follows system operation check list (verify boot-up and initialization of all equipment)
- Crew performs daily check for profiler
- Collection system performs real-time monitoring of laser output, accelerometer output, and corresponding IRI
- System performs real-time GPS checks
- Crew performs near-real-time right-of-way image quality checks (periodic throughout day): no bugs, water, etc. as well as monitors camera lighting settings as necessary in real time
- System performs real-time monitoring of macrotexture; crew conducts weekly block test checks
- "Set checks" (a set is a block of time of collection) are performed every 100 miles to review data quality (2-3 times/day)
- System performs automated completeness checks (end of day) for report to Pathway office
- Crew performs daily data backups

(2) Data Processing Phase Quality Checks

- Perform spatial align to ensure correct segment start and end
- Check data/images for completeness
- Check ROW image quality→assign redo segments where quality is lacking
- Perform automated crack analysis
- Perform manual edits where necessary on automated crack analysis
- Reduce data into report form (by 0.01-mi segment)
- Check report for completeness and quality
- Perform data comparisons such as year-over-year for cracking, rutting, IRI, faulting, road geometry, and macrotexture

Notes:

- References indicated as ALDOT 414 refer to ALDOT procedure ALDOT 414-04, "Network-Level Pavement Condition Data Collection Procedure," revised 06/15/2015
- References indicated as ALDOT 448 refer to ALDOT procedure ALDOT-448-12, "Evaluating Pavement Profiles," revised 03/12/2015

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Data Quality Management Plan

Deliverables, Protocols and Quality Standards

The primary deliverables are described in detail in ALDOT-414-04 (06/15/15 revision), "Network-level Pavement Condition Data Collection Procedure". The goal of the revision was to incorporate much of the data quality management practices suggested in the 2013 "Practical Guide for Quality Management of Pavement Condition Data Collection", along with best practices discovered since the 2010 revision. A data dictionary is included in Appendix B of that document and lists the elements that are included in the delivered Access database or text file. Also delivered is a working version of Pathview II with non-expiring license, which allows the viewing of collected ROW imagery (left, center, and right cameras) as well as the assembly of downward-collected 3D data into a viewable image. Both are presented every 26.4 ft (1/2 of reporting interval).

The other ALDOT procedure relied on in this document is ALDOT-448-12 (03/12/15 revision). It comprises the definition, certification, and operation of inertial profilers in Alabama, and relies heavily on AASHTO R 56, "Standard Practice for Certification of Inertial Profiling Systems".

Quality Assurance and Acceptance

Periodic checks (weekly for IRI and rutting, 5-6 times per collection for ROW images) are made by ALDOT during the collection phase, and the vendor maintains a quality log as described in notes (1) and (2) of the flowchart presented previously in this document. The weekly IRI and rutting tolerances are noted in the procedure: within 5% of established target (IRI) and within 0.1 in (rutting).

Distress ratings are checked in aggregate before the Preliminary Prioritization Report is prepared. It is the first (internal document) prepared by the Pavement Management Section, so the data is scrutinized in creating the report, primarily using the Interstate and non-Interstate NHS data to test for reasonableness. The pavements are grouped by like pavement section (overlay) and weighted by mileage. Excessive or significantly different values as compared to previous years warrant further, in-depth investigation and are done at the overlay or 0.1-mi level. Examples of histograms generated during this process are shown in the following figures:

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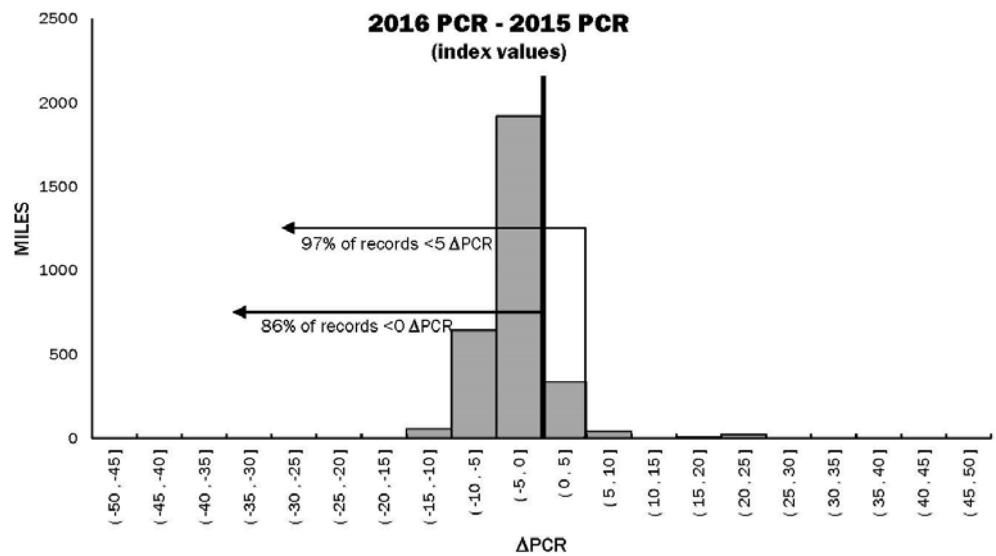

Figure 2. Mileage-based comparision of NHS Pavement Condition Rating scores

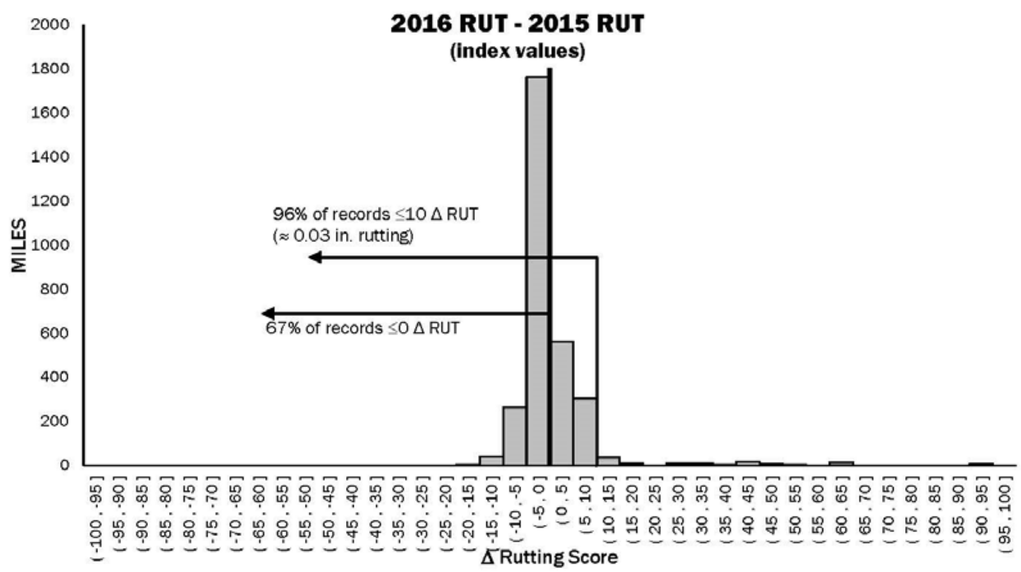

Figure 3. Mileage-based comparision of NHS rutting scores

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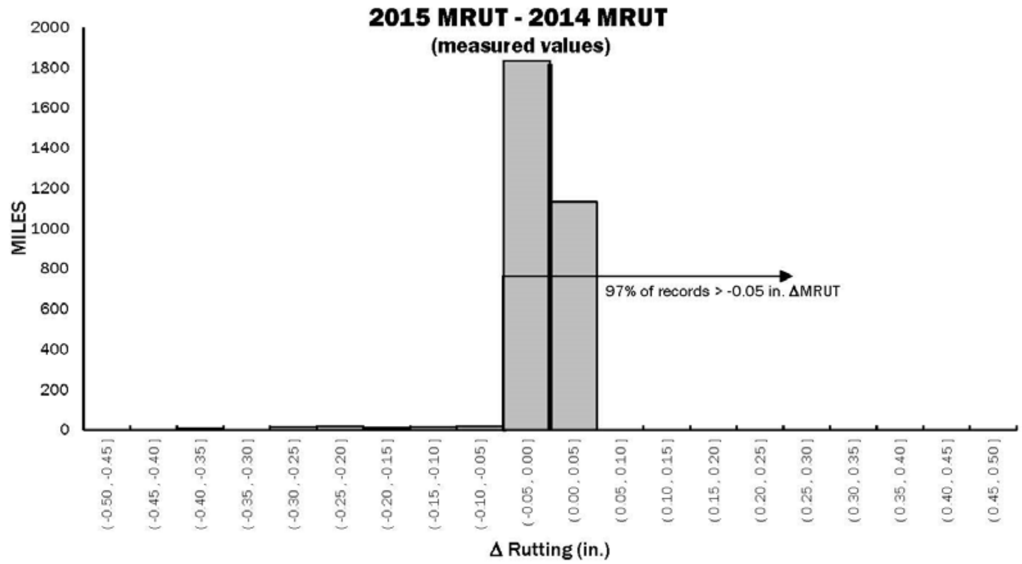

Figure 4. Mileage-based comparision of NHS rutting values

Data Quality Management Plan

Quality Team Roles and Responsibilities

ALDOT

Team Role	Assigned Resource	Quality Management Responsibilities
Agency Manager	Pavement Management Engineer	• Sets quality standards, acceptance criteria, and corrective actions. • Approves each deliverable per quality standards. • Approves resolution of quality issues. • Assesses effectiveness of QM procedures. • Recommends improvements to quality processes. • Communicates weekly with data collection manager and/or project data manager • Supervises manual measurement of control, verification, and blind sites. • Establishes reference values with data collection team. • Monitors schedule adherence. • Prepares QM report.
Agency Assistant Manager	Data Quality Analyst	• Monitors resolution of quality exceptions reported to data collection team. • Submits acceptance exceptions log to data collection team • Observes and maintains records of control, verification, blind site testing as appropriate. Analyze and document results. • Perform data acceptance checks and document results. • Maintain acceptance log and submit quality exceptions to agency assistant manager.
Agency Staff	Pavement Parameters Manager	• Collects IRI and rutting on 264-ft samples • Maintains IRI/rutting control sites (striping and periodic IRI checks) • Rates cracking on samples
Agency Staff	Assistant Pavement Parameters Manager, Pavement Parameters Technologists and Technicians	• Assists in correlation site rating (lane closures, etc.) • May assist in rating cracking on samples

Data Quality Management Plan

Team Role	Assigned Resource	Quality Management Responsibilities
Agency Staff	Senior Data Quality Technologist	• Perform right-of-way imagery checks • Submit acceptance exceptions log to data collection team • Assist in field verification site data collection

Pathway

Team Role	Assigned Resource	Quality Management Responsibilities
Project Data Manager	Vice President, Operations	• Ensure practice of QC measures in QM plan. • Ensure proper protocols used. • Ensure training plan addresses all personnel skill levels. • Assess reviews by Distress Rating Lead, Data Reduction Lead, and Video Lead. • Ensure performance of all quality audits and reporting of all data quality exceptions using QC log. • Ensure correction of all quality issues and changes in procedures as needed. • Perform and document final deliverables quality review. • Compile documentation of all QC activities.
Data Collection Manager	DCV Field Manager	• Ensure deliverables meet broad set of data quality requirements. • Communicate weekly with agency assistant manager. • Assure quality issue resolution and report results to agency assistant manager.
Project Engineer	Project Engineer 3	• Perform and document initial equipment configuration, calibration, and verification.
Field Crew Lead	DCV Field Manager	• Perform daily and/or periodic equipment start-up checks, tests, inspections, and calibrations. • Perform daily review of data logs and video samples. • Assure real-time monitoring of data and video quality • Assure performance of weekly control, verification, and blind site testing • Assure documentation of all field QM activities and reporting of any problems using QC log

Data Quality Management Plan

Team Role	Assigned Resource	Quality Management Responsibilities
Distress Rating Lead	**PCI Supervisor 1**	• Perform and document initial rater training and ensure raters are adequately trained in protocols • Document testing of raters on initial calibration site • Perform and document quality audits, including intra- and inter-rater checks. Report any problems using QC log. • Perform retraining as needed.

Quality Reporting Plan

Pathway's quality reporting information is kept in a written log that is given to ALDOT after the collection phase has ended, as per the flow chart.

ALDOT's quality reporting information is kept in at least three documents:

1. A ROW image database is kept of the images checked and any anomalies discovered. A final report can then be prepared to check for compliance at previously flagged sites.
2. A spreadsheet containing targets and weekly reported values for rutting and IRI.
3. A spreadsheet containing year over year and multi-year comparisons. Its primary output is the histograms as shown previously.

Additional documents may become pertinent as the research project with Auburn University comes to its conclusion.

Acceptance of QM Plan

Quality Management Plan accepted by Agency Manager

Frank Bell ________________________ *Date:* 05/21/2018

Frank Bell, P.E.
Pavement Management Engineer, ALDOT

Quality Management Plan accepted by the Project Data Manager:

________________________ *Date:* 05/21/2018

Scott Mathison
Vice President, Operations, Pathway Services, Inc.

Appendix A

Alabama Dept. of Transportation
Bureau of Materials and Tests

ALDOT Procedures
ALDOT-414
06/15/15
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ALDOT-414-04
NETWORK-LEVEL PAVEMENT CONDITION DATA COLLECTION PROCEDURE

1. Scope

1.1. This method describes the collected data and the quality assurance process for network-level pavement condition data collection.

1.2. The values stated in English units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced documents

2.1. "Highway Performance Monitoring System Field Manual," Office of Highway Policy Information, Federal Highway Administration, March 2014

2.2. AASHTO R 48-10(2013), Standard Practice for Determining Rut Depth in Pavements

2.3. AASHTO R 36-13, Standard Practice for Evaluating Faulting of Concrete Pavements

2.4. ALDOT-448-12 Evaluating Pavement Profiles

3. Description of distresses and other data items

3.1. Each distress or data item shall be collected for the entire length of each 0.01-mile (16.1 m) road segment, unless otherwise noted, and reported at 0.01-mile (16.1 m) increments.

3.2. Information to be collected/reported for all pavements:

3.2.1. Location information—route type, route, milepost, and direction.

3.2.2. Surface type—hot mix asphalt, jointed concrete, continuously-reinforced concrete. Reported surface type should reflect the predominant pavement type. Bridges are considered a part of the pavement section in which they lie. Type changes should be located at the point they occur in the travel direction being collected.

3.2.3. Other segment information—Is the 0.01-mile (16.1 m) segment on a bridge (binary)? Is the 0.01-mile (16.1 m) segment in a construction zone (binary)?

3.2.4. Slope data—The following shall be recorded for a single point at the beginning of each 0.01-mile (16.1 m) segment:

- Cross slope of the pavement lane as a percentage.
- Longitudinal grade of the pavement shown as a percentage.

3.2.5. Global Positioning System (GPS) coordinates—Longitude and latitude shall be recorded for a single point at the beginning of each 0.01-mile (16.1 m) segment. Elevation data shall be recorded at the same point. For each record, the vertical and horizontal dilution of precision (DOP) and date/time shall be included.

3.2.6. Right of Way (ROW)/shoulder images—Color digital images shall be collected at the beginning and midpoint of each 0.01-mile (16.1 m) segment from one or more cameras that show left and right shoulder and ROW. A file naming convention mutually agreed upon by the CONTRACTOR and DEPARTMENT shall be used such that imagery can be connected to route and location.

3.2.7. Events—The following events on the DEPARTMENT's highway network shall be marked on the corresponding 0.01-mile (16.1 m) record

3.2.7.1. Point events

- Every surface change—This event refers to noticeable changes in the age or type of the surface course, excepting bridges and patches.
- Every railroad crossing

3.2.7.2. Segment events

- Multilane sections (at least two lanes in each direction) shall be coded true, and otherwise coded false.
- Any period the test vehicle moves out of the collection lane (rightmost through lane) shall be coded true, and otherwise coded false.

3.2.8. International Roughness Index (IRI)—Mean ride quality for each 0.01-mile (16.1 m) segment shall be reported separately for the two wheel paths in the survey lane in units of in./mile. The data shall be Highway Performance Monitoring System (HPMS) compliant as described in the Highway Performance Monitoring System Field Manual.

3.3. Information to be collected for flexible pavements:

3.3.1. Lane width—Figure 1 shows the typical lane layout used for cracking categorization and rutting. Specifically, lane width shall be defined as the transverse distance between the inside of the left centerline striping (whether double or single) and the inside of the right edgeline or centerline stripe. In addition, for areas in which a right edgeline is not present, the right edge of the lane shall be defined as 6 in. (152 mm) from the edge of the asphalt pavement or 12 in. (305 mm) from the vertical face of a curb when asphalt is placed directly adjacent to the curb.

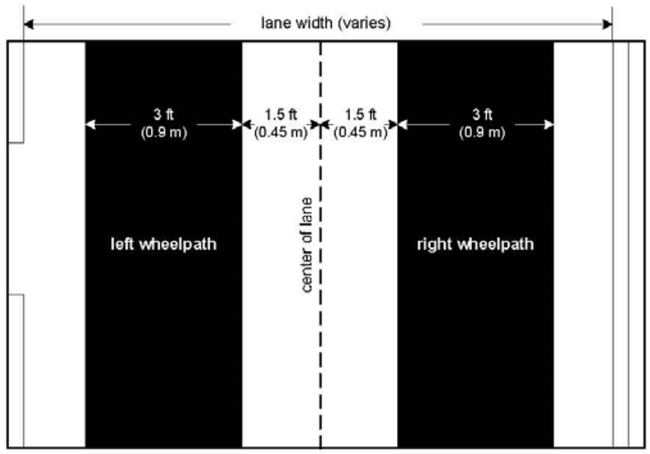


FIGURE 1. TYPICAL WHEELPATH DIMENSIONS

3.3.2. Transverse cracking—This type of cracking consists of cracks that occur at approximately right angles to the centerline. Transverse cracks shall be categorized as one of the following:

- Severity level 1: Cracks having widths > 1/25 in. and ≤ 1/8 in. (> 1 mm and ≤ 3 mm).
- Severity level 2: Cracks having widths > 1/8 in. and ≤ 1/4 in. (> 3 mm and ≤ 6 mm).
- Severity level 3: Cracks having widths > 1/4 in. (> 6 mm).

Transverse cracks shall be rated prior to other cracking, and shall be reported as feet of cracking per 0.01-mile (16.1 m) segment. In order for a crack to be categorized as transverse, a single crack must be greater than 6 ft (1.8 m) long and project within 30° of perpendicular to the pavement centerline. The crack shall be rated at the predominant severity level that occurs along the crack. A sealed crack shall be rated as level 1.

3.3.3. Load associated cracking—This type of cracking consists of any cracks longer than 1 in. (25.4 mm) found in the wheelpaths as defined in Figure 1 that were not previously identified as transverse cracks. Load associated cracking is categorized as follows:

- Severity level 1: Cracks having widths > 1/25 in. and ≤ 1/8 in. (> 1 mm and ≤ 3 mm).
- Severity level 2: Cracks having widths > 1/8 in. and ≤ 1/4 in. (> 3 mm and ≤ 6 mm).

- Severity level 3: Cracks having widths > 1/4 in. (> 6 mm).

Load associated cracking shall be reported as the number of linear feet (linear meters) of road segment containing such cracking. In each 0.01-mile (16.1 m) segment, the maximum length of load associated cracking that shall be reported is 52.8 ft (16.1 m). The length of cracking at each severity level shall be reported. If load associated cracking is present in both wheelpaths for the same length of road, the higher severity shall be reported. A sealed crack shall be rated as level 1. Further exposition is given in the Appendix to clarify the reporting of load associated cracking.

3.3.4. Non-load associated cracking—Non-load associated cracks are those cracks longer than 1 in. (25.4 mm) in the areas within the lane width not identified as wheelpaths, as described in Figure 1, that were not previously identified as transverse cracks. Non-load associated cracking shall be categorized as one of the following:

- Severity level 1: Cracks having widths > 1/25 in. and ≤ 1/8 in. (> 1 mm and ≤ 3 mm).
- Severity level 2: Cracks having widths > 1/8 in. and ≤ 1/4 in. (> 3 mm and ≤ 6 mm).
- Severity level 3: Cracks having widths > 1/4 in. (> 6 mm).

Non-load associated cracking shall be reported as the number of linear feet (linear meters) of road segment containing such cracking. In each 0.01-mile (16.1 m) segment, the maximum length of non-load associated cracking that shall be reported is 52.8 ft (16.1 m). The length of cracking at each severity level shall be reported. If non-load associated cracking is present in multiple locations for the same length of road, the highest severity shall be reported. A sealed crack shall be rated as level 1. Further exposition is given in the Appendix to clarify the reporting of non-load associated cracking.

3.3.5. Rutting—Report mean and maximum values for outside wheel path and report mean and maximum values for inside wheel path for each 0.01-mile (16.1 m) segment. Rut depths shall be determined according to AASHTO R 48-10(2013). The maximum distance between measurements shall be 0.001 miles (1.61 m). Data shall be filtered to exclude data outside of the lane width as defined in section 3.3.1.

3.3.6. High severity raveling—Instances in which the aggregate and/or binder has worn away and the surface texture is extremely rough and pitted, shall be reported, coded as yes (present) or no (not present).

3.3.7. Patching—Instances in which patching exists and is of a condition such that ride quality is affected shall be reported, coded as yes (present) or no (not present).

3.3.8. Macrotexture—The mean right wheelpath RMS amplitude of texture for wavelengths from 0.0196 in. (0.50 mm) to 1.196 in (50 mm) shall be collected for each 0.01-mile (16.1 m) segment.

3.4. Information to be collected for rigid pavements:

3.4.1. Transverse joint and crack faulting— The mean and maximum absolute values according to AASHTO R 36-13 shall be reported for each wheelpath for each 0.01-mile (16.1 m) segment.

3.4.2. Transverse Cracking — Transverse cracks shall be categorized as one of the following:

- Severity level 1: Cracks having widths < 1/8 in. (< 3 mm) and no spalling.
- Severity level 2: Cracks having widths ≥ 1/8 in. and ≤ 1/2 in. (≥ 3 mm and ≤ 12 mm) with or without spalling.
- Severity level 3: Cracks having widths > 1/2 in. (> 12 mm) with or without spalling.

Transverse cracks shall be reported as feet of cracking per 0.01-mile (16.1 m) segment. In order for a crack to be categorized as transverse, a single crack must be greater than 6 ft (1.8 m) long and project within 30° of perpendicular to the pavement centerline. The severity of the transverse crack is determined in terms of crack width and spalling, independent of sealant condition. The crack shall be rated at the highest severity level that occurs along the crack.

3.5. Additional information to be collected for rigid pavements—These data items are to be reported for 0.1-mile (161 m) segments to be specified by the DEPARTMENT.

3.5.1. Percent cracked slabs (jointed concrete pavement only). This represents the percentage of slabs exhibiting transverse (fatigue) cracking at any severity level over the 0.1-mile (161 m) segment. A crack need not extend the full width of the slab for the slab to be considered cracked. Sealed cracks are still counted as cracks. In determining the percent of slabs cracked, a slab with multiple cracks should still be counted as one cracked slab. Partial slabs shall contribute to the section that contains the majority of the slab length.

3.5.2. Punchout area (continuously reinforced concrete pavement only). The area over each 0.1-mile (161 m) segment should be reported for which punchouts, longitudinal cracking, and/or patching occur in the section at any severity level. A punchout is the area enclosed by two closely spaced (usually < 2 ft (0.6 m)) transverse cracks, a short longitudinal crack, and the edge of the pavement or longitudinal joint. Punchouts also include "Y" cracks that exhibit spalling, breakup, or faulting. The following figure illustrates conditions that constitute punchouts:

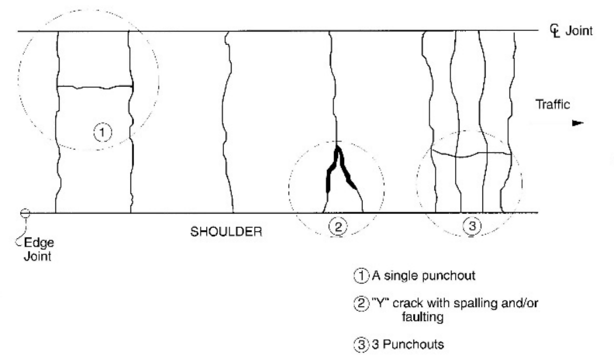


FIGURE 2. PUNCHOUT DEFINITIONS
Source: 2003 Distress Identification Manual for the Long-Term Pavement Performance Program

4. Data Quality Requirements

4.1. Pavement condition data—The following table describes the required resolution of the collected pavement condition data:

DATA ELEMENT	REQUIRED PRECISION
1. Ride quality (IRI)	1 in./mile (.016 m/km)
2. Cross slope, superelevation, and grade data	0.1%
3. Load associated cracking	0.1 linear ft (30 mm) per 0.01-mile (16.1 m) segment
4. Non-load associated cracking	0.1 linear ft (30 mm) per 0.01-mile (16.1 m) segment
5. Transverse cracking	0.1 linear ft (30 mm) per 0.01-mile (16.1 m) segment
6. Rut depth	0.01 in. (0.25 mm)
7. Faulting	0.01 in. (0.25 mm)
8. Raveling	present/not present
9. Patching	present/not present
10. Macrotexture	0.01 in. (0.25 mm)
11. Transverse joint faulting	0.01 in. (0.25 mm)
12. Percent cracked slabs	1%
13. Punchout area	1%

TABLE 1. DATA PRECISION REQUIREMENTS

4.2. GPS and elevation data—Latitude and longitude shall be reported in degrees, minutes, and seconds, with seconds recorded to four digits after the decimal; elevation data shall be reported in feet. Positional accuracy for latitude and longitude shall not exceed ±10 feet (±3 m).

4.3. ROW/Shoulder images—ROW images shall be taken at sufficient resolution to ensure 10 in. (250 mm) sign lettering is legible at a distance of 15 ft (4.5 m) from the edge of the travel lane while traveling at highway speeds. All exterior cameras shall be capable of collecting images during normally encountered fair weather conditions in Alabama. In addition, camera lenses or enclosures shall be cleaned regularly to prevent build up of road debris and insects.

5. Quality Control Requirements

5.1. The CONSULTANT shall develop a written quality control plan and log. The QC plan shall be submitted to the DEPARTMENT before collection, and a copy kept in the collection vehicle(s).

5.2. The QC log shall be maintained throughout data collection, with a copy provided to the DEPARTMENT upon completion of data collection.

5.3. International Roughness Index

5.3.1. Profiler and operator certification

5.3.1.1. The CONSULTANT's data collection vehicle and operator(s) shall be certified at the NCAT Pavement Test Track in accordance with ALDOT-448.

5.3.2. Pre-production verification

5.3.2.1. The CONSULTANT shall make five passes over at least ten of the twenty DEPARTMENT-selected 0.1-mile (16.1m) long IRI control sites. These sites will be distributed geographically throughout the state for use in production verification.

5.3.2.1.1. A cross-correlation using ProVAL of 88% or greater between runs is required.

5.3.2.1.2. The average of the five runs shall become the target IRI for the section during production.

5.3.2.1.3. All profiles obtained in pre-production verification shall be provided to the DEPARTMENT.

5.3.2.2. Any discrepancies will be jointly investigated by the DEPARTMENT and CONSULTANT; a mutual resolution is required before data collection begins.

5.3.3. Production verification

5.3.3.1. The CONSULTANT shall make a single pass over one IRI control site at least weekly and at the end of a collection cycle. These results shall be reported to the DEPARTMENT immediately. Typically, no single IRI determination should vary more than 5 percent from the original control section IRI. An .erd (ASCII format) file shall be provided to the DEPARTMENT when ROW images are delivered.

5.3.3.2. Sites visited should be varied throughout the collection period.

5.3.3.3. In the event of discrepancies, all data collected between verification runs is considered rejected. The DEPARTMENT will consider partial acceptance of the suspect data if a cause and time of occurrence can be established for the faulty equipment.

5.4. Rutting

5.4.1. Pre-production verification

5.4.1.1. The CONSULTANT shall make five passes over at least ten of the twenty DEPARTMENT-selected 0.1-mile (161 m) long IRI control sites.

5.4.1.2. For all 0.01-mile (16.1 m) segments, the CONSULTANT shall report mean and maximum rutting for both left and right wheelpath in a mutually agreed upon file format.

5.4.1.2.1. Repeatability: Mean rutting values for each 0.01-mi (16.1m) segment should be within 0.05 in. (1.3 mm) of the average of the five runs.

5.4.1.2.2. Accuracy: The DEPARTMENT will measure rutting using a manual rut depth gauge at 0.01-mile (16.1 m) intervals. CONSULTANT five-run average values shall be within 0.1 in. (2.5 mm) of DEPARTMENT values over at least 95% of the 0.01-mile (16.1m) segments.

5.4.1.2.3. Production targets: The average of the 0.01-mi (16.1 m) five-run averages results in an average over the 0.1-mi (161m) control site. This shall become the target rutting value for the section during production. The entire process is illustrated in Figure 3.

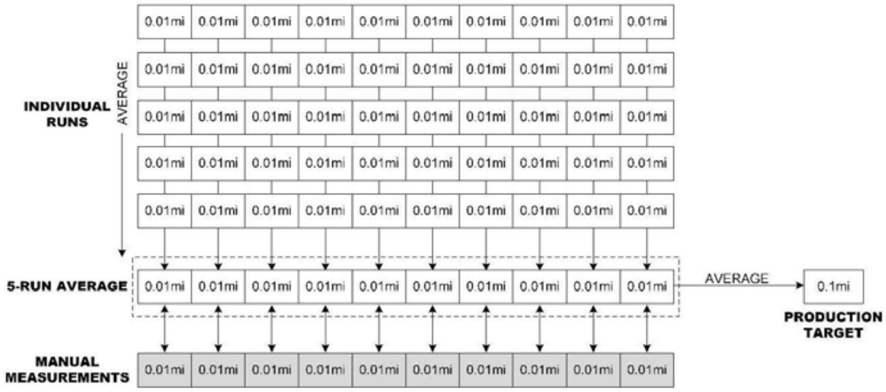


FIGURE 3. RUTTING AGGREGATION PROCESS

5.4.1.3. Any discrepancies will be jointly investigated by the DEPARTMENT and CONSULTANT; a mutual resolution is required before data collection begins.

5.4.2. Production verification

5.4.2.1. The CONSULTANT should make a single pass over one IRI control site at least weekly and at the end of the collection cycle. An electronic file shall be provided to the DEPARTMENT when ROW images are delivered. The average 0.1-mi (16.1 m) rut value should be within 0.10 in. (2.5 mm) of the target rut measurement.

5.4.2.2. In the event of discrepancies, all data collected between verification runs is considered rejected. The DEPARTMENT will consider partial acceptance of the suspect data if a cause and time of occurrence can be established for the faulty equipment.

5.5. General

5.5.1. Multiple vehicles may be used for data collection, but all must undergo the QC process outlined above.

5.5.2. If a vehicle leaves the state for any reason, the CONTRACTOR shall rerun at least a portion of the control sites for IRI, rutting, and faulting to be determined by the DEPARTMENT before resuming data collection.

6. Quality Assurance Requirements

6.1. Cracking data

6.1.1. Pre-production verification

6.1.1.1. The CONSULTANT shall run each DEPARTMENT-selected 0.3-mi long verification site and rate the pavement using the same methods that will be employed for production data reduction. Data should be reported to a 0.1-mile (16.1 m) resolution.

6.1.1.2. The DEPARTMENT will conduct manual cracking surveys at each verification site.

6.1.1.3. A Pearson's r correlation will be employed on the reduced data to determine whether the sample data is acceptable. Significant deviation from a positive linear relationship between DEPARTMENT ground truth and CONSULTANT data will be jointly investigated and resolved before data collection begins.

6.1.2. Production verification

6.1.2.1. The DEPARTMENT will rate up to three percent of pavement mileage collected and compare its results with production data.

6.1.2.2. A Pearson's r correlation and/or other statistical means will be used to determine whether the sample data is acceptable. Significant deviation from a positive linear relationship between DEPARTMENT-rated data and CONSULTANT-rated data will be jointly investigated and may require re-rating by the CONSULTANT.

6.2. Faulting

6.2.1. Calculation verification

6.2.1.1. The DEPARTMENT will select at least two segments of at least one mile in length and evaluate faulting over 0.1-mi sections from a CONSULTANT-supplied .erd file using Method A (ProVAL) of R 36-13.

6.2.1.2. CONSULTANT values shall be within 0.1 in. of DEPARTMENT values over at least 95% of the 0.1-mi samples. Deviation will be jointly investigated and may require re-rating by the CONSULTANT.

6.3. Right of way images

6.3.1. Pre-production verification—Right of way images taken at the cracking verification sites shall be provided to the DEPARTMENT for review and approval prior to the start of data collection.

6.3.2. Production verification

6.3.2.1. Images shall be delivered to the DEPARTMENT weekly using any practical means with sufficient supporting files to allow playback.

6.3.2.2. The CONSULTANT shall also provide a list of sections ran along with the images.

6.3.2.3. The DEPARTMENT will randomly sample and review images for clarity and brightness within two weeks of receipt and inform the CONSULTANT if the images are acceptable. If the images are not acceptable, all data shall be recollected for the affected pavement segments.

6.4. Location data

6.4.1. Pre-production

6.4.1.1. The DEPARTMENT will provide a WGS 84 shapefile of the road network to be collected prior to the beginning of data collection.

6.4.1.2. This shapefile will contain the route segments to be collected. Information provided will include route, beginning and ending milepost of the segment, beginning and ending events (such as route intersection or county lines), and centerline location.

6.4.2. Production—The DEPARTMENT will review linear referencing data as a part of the ROW image review process.

6.4.3. Post-production

6.4.3.1. Data with no (or manifestly faulty) GPS location data will not be accepted.

6.4.3.2. Data overlaps of greater than 100 feet by GPS location should be eliminated from the datafile before delivery. This requirement also includes overlaps between data submittals.

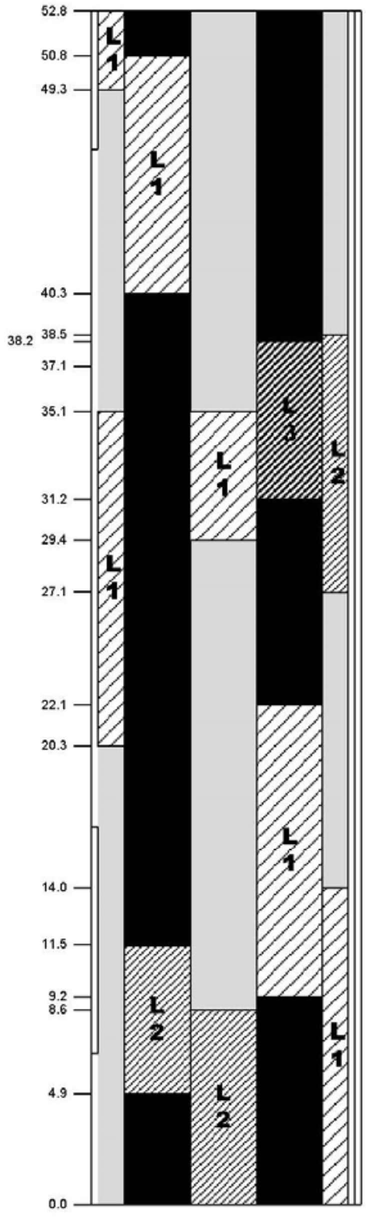
7. References

7.1. AASHTO R 56-14, Standard Practice for Certification of Inertial Profilers

7.2. AASHTO R 57-14, Standard Practice for Operating Inertial Profiling Systems

Appendix A

Tables 2 and 3 show the calculation steps required in determining load associated and non-load associated cracking over a hypothetical 0.01-mile (16.1 m) segment of roadway, shown in Figure 4.



FROM	TO	NONE	LEVEL 1	LEVEL 2	LEVEL 3
0.0	4.9	4.9			
4.9	11.5			6.6	
11.5	22.1		10.6		
22.1	31.2	9.1			
31.2	38.2				7.0
38.2	40.3	2.1			
40.3	50.8		10.5		
50.8	52.8	2.0			
Totals		18.1	21.1	6.6	7.0
				Grand Total	**52.8**

TABLE 2. LOAD ASSOCIATED CRACKING TOTALS FOR CRACKING EXAMPLE

FROM	TO	NONE	LEVEL 1	LEVEL 2	LEVEL 3
0.0	8.6			8.6	
8.6	14.0		5.4		
14.0	20.3	6.3			
20.3	27.1		6.8		
27.1	38.5			11.4	
38.5	49.3	10.8			
49.3	52.8		3.5		
Totals		17.1	15.7	20.0	0.0
				Grand Total	52.8

TABLE 3. NON-LOAD ASSOCIATED CRACKING TOTALS FOR CRACKING EXAMPLE

FIGURE 4. CRACKING EXAMPLE

Appendix B: Data Dictionary

FIELD NAME	DATA TYPE	UNITS	MIN	MAX	DESCRIPTION
ROUTE_TYPE	Text	N/A			Route type designation (Interstate or State)
ROUTE	Text	N/A	1	604	Route number designation
MILEPOST	Double	mi	0	650	LRS (map) milepost
DIRECTION	Text	N/A	5	6	Direction of travel (5=primary, 6=secondary)
VEHICLE	Text	N/A	N/A	N/A	Vehicle ID/serial
DATE_RATED	Date/ Time	mm/dd/yy	N/A	N/A	Date segment was rated (field)
SURFACE_TYPE	Text	N/A	F	R	Surface type (F=asphalt, R=jointed concrete, C=continuously-reinforced concrete)
BRIDGE	Boolean	N/A	0	1	Bridge flag (segment is located on bridge)
CONSTRUCTION	Boolean	N/A	0	1	Construction flag (segment is located in construction zone)
CROSS_SLOPE_PERCENT	Single	%	-15	15	Percent cross-slope
GRADE	Single	%	-10	10	Percent grade
LATDEG	Integer	°	30	35	GPS latitude (degrees)
LATMIN	Integer	'	0	60	GPS latitude (minutes)
LATSEC	Single	"	0	60	GPS latitude (decimal seconds)
LONGDEG	Integer	°	-85	-88	GPS longitude (degrees)
LONGMIN	Integer	'	0	60	GPS longitude (minutes)
LONGSEC	Single	"	0	60	GPS longitude (decimal seconds)
ELEVATION	Double	ft	0	2500	Elevation
VDOP	Double	N/A	1	6	Vertical dilution of precision
HDOP	Double	N/A	1	6	Horizontal dilution of precision
UTC_TIMESTAMP	Text	N/A	N/A	N/A	GPS Date/Time
SURFACE_CHANGE	Boolean	N/A	0	1	Pavement surface change flag (new overlay, etc.)
RAILROAD_CROSSING	Boolean	N/A	0	1	Railroad crossing flag (vehicle grade crossing)

FIELD NAME	DATA TYPE	UNITS	MIN	MAX	DESCRIPTION
MULTILANE_CHANGE	Boolean	N/A	0	1	Number of lane change flag (gain or lose lanes)
LANE_CHANGE	Boolean	N/A	0	1	Lane change flag (vehicle left data lane)
IRI_LWP	Single	in./mi	30	400	Left wheelpath IRI
IRI_RWP	Single	in./mi	30	400	Right wheelpath IRI
TRANSVERSE_1	Single	ft	0	200	Level 1 transverse cracking (width >1/25 in and ≤ 1/8 in)
TRANSVERSE_2	Single	ft	0	200	Level 2 transverse cracking (width >1/8 in and ≤ 1/4 in)
TRANSVERSE_3	Single	ft	0	200	Level 3 transverse cracking (width >1/4 in)
WHEELPATH_1	Single	ft	0	52.8	Level 1 wheelpath cracking (width >1/25 in and ≤ 1/8 in)
WHEELPATH_2	Single	ft	0	52.8	Level 2 wheelpath cracking (width >1/8 in and ≤ 1/4 in)
WHEELPATH_3	Single	ft	0	52.8	Level 3 wheelpath cracking (width >1/4 in)
NONWHEELPATH_1	Single	ft	0	52.8	Level 1 nonwheelpath cracking (width >1/25 in and ≤ 1/8 in)
NONWHEELPATH_2	Single	ft	0	52.8	Level 2 nonwheelpath cracking (width >1/8 in and ≤ 1/4 in)
NONWHEELPATH_3	Single	ft	0	52.8	Level 3 nonwheelpath cracking (width >1/4 in)
LWP_RUT_MEAN	Single	in.	0	3	Left wheelpath rutting (average of segment)
LWP_RUT_MAX	Single	in.	0	3	Left wheelpath rutting (maximum in segment)
RWP_RUT_MEAN	Single	in.	0	3	Right wheelpath rutting (average of segment)
RWP_RUT_MAX	Single	in.	0	3	Right wheelpath rutting (maximum in segment)
RAVELING	Boolean	N/A	0	1	Presence of raveling in segment
PATCHING	Boolean	N/A	0	1	Presence of patching in segment
MACROTEXTURE	Single	mm	0	7	Mean right wheelpath RMS amplitude
LWP_FAULTING_MEAN	Single	in.	0	2	Left wheelpath faulting (absolute average of segment)
LWP_FAULTING_MAX	Single	in.	0	2	Right wheelpath faulting (maximum of segment)
RWP_FAULTING_MEAN	Single	in.	0	2	Left wheelpath faulting (absolute average of segment)
RWP_FAULTING_MAX	Single	in.	0	2	Right wheelpath faulting (maximum of segment)

Appendix B

ALDOT-448-12
EVALUATING PAVEMENT PROFILES

1. Scope

1.1. This procedure covers the certification requirements and the use of a roadway surface inertial profiler for ride quality measurement for both quality control (QC) and quality assurance (QA) construction testing.

2. Referenced Documents

2.1. *AASHTO Standards*:

2.1.1. R 56, Standard Practice for Certification of Inertial Profiling Systems

3. Inertial Profiler

3.1. *Housing vehicle*, capable of traveling at consistent speeds while collecting pavement profile data.

3.2. *Distance measuring subsystem*, accurate to within 0.15 percent of the actual distance traveled.

3.3. *Inertial referencing subsystem*, capable of measuring the movement of the housing vehicle as it traverses the pavement under test.

3.4. *Non-contact height measurement subsystem*, capable of measuring the height from the mounted sensor face to the surface of the pavement under test.

3.5. Intergrated System

3.5.1. Shall include hardware and software capable of producing and storing inertial profiles by combining the data from the inertial referencing subsystem, the distance measurement subsystem, and height measurement subsystem.

3.5.2. Shall have the capability of measuring and storing profile elevations at intervals sufficiently frequent to meet the requirements of Section 4.

3.5.3. Shall have the capability of summarizing (computing) the profile elevation data into summary roughness statistics over a section length equal to 0.1 mile. The International Roughness Index (IRI) for each longitudinal path profiled is the summary roughness statistic prescribed in this procedure.

3.5.4. Shall have design to allow field verification for the distance measurement (longitudinal) subsystem and the height measurement (vertical) subsystem described in Section 6.

3.5.5. Shall be certified for use as described in Section 4.

3.5.6. Air pressure in the tires of the housing vehicle will fall within the vehicle manufacturer's recommendation. The housing vehicle and all system components shall be in good repair and proven to be within the manufacturer's specifications. The operator of the inertial profiler shall have all tools and components necessary to adjust and operate the inertial profiler according to the manufacturer's instructions.

4. Inertial Profiler Certification

4.1. This section provides minimum certification requirements for inertial profilers used for quality control for acceptance testing of surface smoothness on Department paving projects where the profile-based smoothness specification is applicable.

4.2. The certification process covers test equipment that measures longitudinal surface profile based on an inertial reference system mounted on a housing vehicle. The intent of minimum requirements stipulated herein is to address the need for accurate, precise, uniform, and comparable profile measurements during construction.

4.3. Minimum Requirements:

4.3.1. Operating Parameters:

4.3.1.1. The inertial profiler shall be capable of reporting relative profile elevations less than or equal to 4 inches that have been filtered with an algorithm that uses a cutoff wavelength of no less than 200 ft and no more than 300 ft.

4.3.1.2. The inertial profiler shall also be able to calculate and report the IRI (in inches/mile) from the corresponding measured profile, where the operator is permitted to automatically trigger the start and stop of data collection at the designated locations. Measured profiles shall be provided in electronic text files suitable for importing into the latest version of Profile Viewing and Analysis (ProVAL) Software as described in Section 9.

4.3.1.3. The inertial profiler shall also be verifiable for measurements in height and distance as described herein.

4.3.2. Equipment Certification:

4.3.2.1. Equipment certification involves using the inertial profiler to collect profile data on test sections designated by the Department for this purpose at the NCAT Pavement Test Track. NCAT certification personnel will administer this program. Before equipment certification, as a recommendation, the inertial profiler owner should verify the longitudinal and vertical calibration of his or her equipment following manufacturer's recommendations. This recommended verification should be conducted at the owner's facility prior to the scheduled date of certification testing.

4.3.2.2. On an annual basis, the inertial profiler shall undergo certification tests at the NCAT Pavement Test Track to establish that it complies with the minimum requirements for accuracy and repeatability set forth in this test method. At that time, the proficiency of certified operators will also be demonstrated as required in Section 5. An inertial profiler shall also undergo certification testing after undergoing major component repairs or replacements as identified in Section 7.

4.3.2.3. For certification, the inertial profiler's distance measurement subsystem shall be accurate to within 0.15 percent of the actual distance traveled.

4.3.2.4. Certification tests will be run on the swept inside lane of the NCAT Pavement Test Track on designated dense mix test sections with smooth, medium-smooth, and rough surface profiles, and on a designated open-graded mix test section with a smooth surface profile. Each section will be 528 ft in length with 300 ft of lead-in distance. Ten repeat runs shall be made of the inertial profiler with data produced for both test wheel paths in the prescribed direction of measurement. Inertial profilers will be evaluated by comparing results to those generated by the reference SurPRO profiler. The inertial profiler owner shall provide data to NCAT certification personnel that is suitable for importing into the latest version of ProVAL.

4.3.2.5. NCAT certification personnel will use the latest version of ProVAL to evaluate the repeatability of the owner's data and compare the accuracy of results generated by the owner's data to results generated by the reference SurPRO profiler. Performance will be differentiated between dense and open graded mixes. In order to earn certification for dense graded mixes, ProVAL generated values for accuracy and repeatability cannot exceed those values specified in AASHTO R 56. In order to earn certification for open graded mixes, a profiler shall have passed certification for dense graded mixes and shall also produce average IRIs within 5% of the SurPRO average in each wheelpath on the smooth OGFC section.

4.3.2.6. NCAT will report the results of the certification tests to include the following information:

- Make and manufacturer of inertial profiler tested.
- Unique hardware serial number of inertial profiler tested.
- Version number of software used to generate ProVAL import file.
- Operator of the profiler tested.
- Names of the NCAT certification personnel responsible for the evaluation.
- Date of data collection.
- Overall outcome of the testing process (i.e., pass or fail). A separate certification will be provided for dense and open-graded pavement

surfaces. It will be possible to pass on dense surfaces but fail on open-graded surfaces.

- The ProVAL report that shows the accuracy and repeatability of the tested inertial profiler on each of the four certification pavement surfaces.

4.3.2.7. A decal will be placed on the inertial profiler by NCAT certification personnel following successful certification. Separate decals will be used to designate acceptability for use on dense and open-graded pavement surfaces. Each decal will show the month and year of certification and the month and year the certification expires.

5. Operator Certification

5.1. Operators of inertial profilers used for testing of pavement ride quality shall pass a proficiency test and be certified to operate an inertial profiler in Alabama. NCAT certification personnel at the NCAT Pavement Test Track will administer the test for the Department. The test for the applicants for certification will include knowledge of Department's smoothness specifications, this ALDOT Procedure, verification of inertial profiler calibration, and collection of certification profile data.

5.2. To qualify as a certified inertial profiler operator in Alabama, the applicant shall pass the written examination with a score of 70 percent or higher, pass the practical examination for verification of inertial profiler calibration, and pass the practical examination for profile measurements. All practical examinations shall be demonstrated using the inertial profiler provided by the applicant.

5.3. The applicant shall demonstrate that he/she can perform the longitudinal and vertical verifications described under Sections 6.2, 6.3 and 6.4. Additionally, the applicant shall perform profile measurements along a given route established by NCAT. The route will be at least 2,500 ft long, with designated 0.1 mile test sections and "leave-out" segment(s). The applicant shall profile the designated wheel paths of the test route in the specified direction following the procedures given in this test method. The applicant shall provide the test data in electronic files suitable for importing into the most recent version of ProVAL. For the practical examination, the applicant's performance is evaluated as passing or failing.

5.4. Upon passing the written examination and proficiency test, the NCAT certification personnel will give the successful applicant an identification card, which will verify the certification to operate an inertial profiler for testing on Department paving projects. The card will identify the specific types or brands of inertial profilers for which the operator certification is valid. This card will also specify the expiration date of the operator certification. The Department has the authority to revoke the card and operator certification at any time because of misuse.

5.5. Recertification of the operator will require successful completion of another proficiency test as described in this section for initial operator certification. Proficiency of certified operators shall be demonstrated at the time of each inertial profiler's annual recertification. A new written examination for certifying operators shall be required every three years.

6. Verifying Calibration and Consistency

6.1. A longitudinal and vertical verification procedure shall be performed at least once before an inertial profiler is used for either QA or QC testing on a project. Although the specific steps to complete the verifications will vary in accordance with the manufacturer's recommendations, the basic procedures will not change. The results of all longitudinal and vertical verification checks shall be documented in a profiler log. The profiler log shall be a collection of the required equipment and operator certifications and BMT forms (BMT 202 through 207) found in the ALDOT Testing Manual. The Engineer will review the profiler log prior to use on the project.

6.2. Longitudinal verification

6.2.1. The longitudinal verification standard will be a straight roadway test section at least 528 ft in length. This distance shall be measured accurately to within 0.15 percent using a steel measurement tape or electronic measuring device. An analog measuring wheel or roll-a-tape is not sufficient for accurate measurement and will not be allowed. The inertial profiler owner shall establish the longitudinal verification standard and notify the Engineer prior to the first time the longitudinal verification is performed.

6.2.2. Air pressure on the tires of the housing vehicle shall be checked and maintained according to the manufacturer's recommendations and documented in the profiler log.

6.2.3. Perform the longitudinal verification by navigating the inertial profiler over a measured test section at least 528 ft in length.

6.2.4. If the inertial profiler's distance measuring subsystem measures the length of the test section to within 0.15 percent of its actual length, no additional verification is necessary.

6.2.5. If the inertial profiler's distance measuring subsystem fails to measure the length of the test section to within 0.15 percent of its actual length, the calibration shall be adjusted according to the manufacturer's guidelines and the longitudinal verification repeated.

6.2.6. The results of the longitudinal verification shall be documented on BMT 203 "Inertial Profiler Calibration Log."

6.3. Vertical verification - Block Test

6.3.1. The vertical verification standard will be flat plates or blocks of known thicknesses and low thermal expansion. As a minimum, two uniform base plates and three 1-in. measurement plates will be needed. Alternatively, a precisely machined block that provides all the required heights is acceptable. The actual thickness of the three measurement plates shall be measured to within 0.001 in. All vertical calibration plates shall be provided and maintained by the inertial profiler owner. The thicknesses will be certified by the NCAT certification personnel at the time of annual certification.

6.3.2. The vertical verification shall be performed on a flat and level area using a base plate and three flat 1-in. measurement plates. It is acceptable to perform the test indoors, which may be necessary when windy conditions exist.

6.3.3. Place a uniform base plate under the inertial profiler's non-contact height sensor. The inertial profiler's height measurement subsystem shall use this as the reference height for the first set of measurements.

6.3.4. Place the first 1-in. measurement plate on top of the uniform base plate below the non-contact sensor. The inertial profiler's height measurement subsystem shall measure this displacement to within 0.01 in. of the 1-in. plate's actual measured thickness.

6.3.5. Place the second 1-in. measurement plate on top of the two existing plates below the non-contact sensor. The inertial profiler's height measurement subsystem shall measure this displacement to within 0.01 in. of the 2-in. total thickness of the two measurement plates.

6.3.6. Place the third 1-in. measurement plate on top of the two existing plates below the non-contact sensor. The inertial profiler's height measurement subsystem shall measure this displacement to within 0.01 in. of the 3-in. total measured thickness of the three measurement plates.

6.3.7. Remove the three measurement plates and verify that the inertial profiler's height measurement subsystem returns to zero, within 0.01 in., on top of the base plate.

6.3.8. Vertical verification shall be performed for all non-contact height sensors.

6.3.9. The results of the Block Test shall be documented on BMT 203.

6.4. Vertical Verification – Bounce Test

6.4.1. With the base plates in position simultaneously under both wheel path sensors, place the vehicle in an operating mode that simulates longitudinal movement and initiate profile data collection. Data is collected with the vehicle as motionless as possible for the time required to travel 828 ft.

6.4.2. Without interrupting the data collection process, both sensors are repeatedly subjected to a vertical displacement of approximately 1 to 2 in. This bouncing motion shall be maintained and data collected for the time required to travel 528 ft.

6.4.3. Without interrupting the data collection process, continue to collect data with the vehicle as motionless as possible for the time required to travel 828 ft.

6.4.4. Measured profiles shall be saved and analyzed in ProVAL using the Ride Statistics Continuous analysis option with a 528 ft base length and 300 ft of lead in and lead out. Computed IRI values in the first and last (static) 528 ft segments shall not exceed 3 in. per mile, while the IRI for the middle (bouncing) segment shall not exceed 8 in. per mile. If the computed IRI values exceed 3 in. per mile for the static test and/or exceed 8 in. per mile for the bounce test, then the manufacturer's recommendations for performing sensor operational checks shall be followed. The static and bounce tests shall then be repeated. If the tests fail to meet these requirements, the inertial profiler will be deemed to be not certified and barred from use on ALDOT projects until it passes the certification program at NCAT.

6.4.5. The results of the Bounce Test shall be documented on BMT 203.

6.5. IRI consistency

6.5.1. The Department will designate at least one control section in each Division that will be used as a basis for consistency measurements the first time an inertial profiler is used on a given project. Control sections will be established by selecting 1000-foot sections with a maximum IRI of 120 inches per mile that will maintain a consistent ride profile over the time period when daily checks are needed. Information regarding the control section locations is available from the State Materials and Tests Engineer.

6.5.2. An inertial profiler certified within the past 90 days shall be used to determine the IRI of the section by making a series of at least five profile measurements. The average IRI of the measurements shall be used to establish the IRI of the control section; provided that the cross correlation of the measurements as determined using the latest version of ProVAL is at least 88 percent (dependent upon the filters used, spectral content of the measured surface, operator, etc.). Once established, this control section can be used to validate that an inertial profiler is operating properly at any time.

6.5.3. An inertial profiler is consistent when a single IRI determination does not vary more than 5 percent from the initial control section IRI established by the inertial profiler owner.

6.5.4. After an inertial profiler has been used for the first time on a project, it is acceptable to re-run 528 ft of pavement that was measured on the previous day for comparison purposes. An inertial profiler is verified to be consistent when the current day's value does not differ by more than 5 percent from the previous day's value.

6.5.5. If the contractor owns more than one certified inertial profiler, it is acceptable to compare separate runs made by the two devices. A certified inertial profiler is consistent when it does not differ from another certified inertial profiler by more than 10 percent.

6.5.6. The Department may also choose to run random consistency checks by bringing in a certified inertial profiler. A contractor's certified inertial profiler is consistent when it does not differ from the Department's certified inertial profiler by more than 10 percent. If the contractor's inertial profiler differs by more than 10 percent from the

Department's certified inertial profiler, then the contractor's inertial profiler will be deemed to be not certified and barred from use on Department projects until it passes the certification program at NCAT.

6.5.7. The results of the initial IRI consistency check shall be documented on BMT 207 "Control Site Target IRI Report."

6.6. Major component repairs of the type referenced in Section 7 may be needed when specified longitudinal or vertical verification tolerances are not met or consistency cannot be verified. Major component repairs shall require recertification as described in Section 4.

6.7. The profiler log shall be kept with the inertial profiler at all times that is subject to review by the Engineer. Verifications, calibrations, consistency checks, and certifications shall all be included in the profiler log.

7. Repair and Adjustment of Inertial Profilers

7.1. All repair and adjustment of inertial profilers shall be documented on BMT 204 "Inertial Profiler Maintenance Log."

7.2. Major component repairs or replacement to an inertial profiler require recertification of the equipment. These may include but are not limited to:

- Repair or replacement of the accelerometer and its associated hardware.
- Repair or replacement of the non-contact height sensor and its associated hardware.
- Repair or replacement of the distance measuring instrument.
- Repair or replacement of any printed circuit board necessary for the collection of raw sensor data or the processing of the inertial profiles and IRI.
- Modification of software parameters and scale factors as required by the manufacturer that are foundational to the certification process.

7.3. The operator of the inertial profiler may make minor adjustments to the equipment without having to complete the recertification process as long as the adjustments allow the equipment to fulfill the procedure in Section 5.

7.3.1. Inspecting, resoldering, or replacing connectors is considered a minor adjustment.

7.3.2. Cleaning components or normal adjustments to voltage levels as required by the manufacturer is considered a minor adjustment.

7.3.3. Setting software parameters and scale factors as required by the manufacturer is considered a minor adjustment as long as they are not foundational to the certification process.

8. Test Procedure

8.1. IRI measurements shall be in each wheel path, then averaged and summarized every 0.10 mile. Technically speaking, this average of the left IRI and right IRI is termed the Mean Roughness Index (MRI).

8.2. The Bounce Test, described under Section 6.4, and the IRI consistency check, described under Section 6.5, shall be performed daily before any data is collected. The results of the daily Bounce Tests and IRI consistency check will be documented by the Contractor and verified by the Project Engineer on BMT 202 "Daily Inertial Profiler Log."

8.3. Locate and mark all sections that will not be included in the evaluation of pavement smoothness for payment of bonuses or penalties. Sections that will not be used include the first and last 25 ft of the paving project, 25 ft either side of bridge ends, and those areas as directed by the Engineer.

8.4. Contractor shall provide the distances and descriptions of features that may be subject to exclusion using BMT-206 "Project Feature Log."

8.5. Clean the roadway path of all debris and other loose material before data is collected.

8.6. All data collected outside the certified speed range shall not be acceptable. Re-measure any pavement segment where the travel speed of the inertial profiler is less than or exceeds the manufacturer's recommended operational speed at any point during data collection.

8.7. A pre-section length of roadway of up to 450 ft may be required to stabilize the inertial profiler's filters and achieve the same accuracy in the first 0.1 mile that is achieved through the rest of the job. The pre-section length is dependent on the filter type, the grade change on entering the test segment, and the accuracy required of the first 0.1 mile of measured pavement. Typically, this pre-section shall be at least 300 ft in length and located immediately before the section of pavement to be tested. Shorter sections may be used at the discretion of the Engineer when the physical constraints of the project require it and other project conditions make it acceptable.

8.8. Inertial profiler measurements shall be made in both wheel paths of the paved surface using sensor path spacing of between 65 and 71 inches.

8.9. Measurements shall be made in the direction of traffic.

8.10. Data collection for payment purposes is meant to be performed at the end of the paving operation or staged as prescribed by the Department.

8.11. The contractor shall submit to the Engineer a table that identifies the lanes, wheel paths, and distance locations tested for each file created during profile testing on BMT-202 "Daily Inertial Profiler Log." Profile elevation data shall be presented to the Engineer in an electronic format on a USB flash drive with a file format as described in Section 9. The Engineer will use the latest version of ProVAL to calculate the IRI values and applicable tables to determine associated pay factors.

8.12. The Engineer will:

8.12.1. Determine all features that will be excluded from the pay computations.

8.12.2. Calculate and record the IRI from each longitudinal line profiled for a pavement travel lane (The payment schedule will be based on the MRI calculated from both wheel paths in a travel lane.).

8.13. The Engineer will use the latest version of ProVAL to calculate the pay adjustment for segment lengths no more than 0.1 mile long.

9. Test Data Description and Format

9.1. Report test data in .ERD format that can be read directly into the latest version of ProVAL. This will permit the Department to directly input profile data, collected with any inertial profiler, into its data reduction program for QA testing.

10. References

10.1 AASHTO Standards

- M 328, Standard Specification for Inertial Profiler
- R 54, Standard Practice for Accepting Pavement Ride Quality When Measured Using Inertial Profiling Systems
- R 57, Standard Practice for Operating Inertial Profiling Systems
- R 43M/R 43, Quantifying Roughness of Pavements

10.2 ASTM Standards

- E 867, Standard Terminology Relating to Vehicle Pavement Systems
- E 950, Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference

Appendix B: Full Risk Register by Category

Exhibit 55: Risk Register

Financial				
No.	**Risk Description**	**Cause**	**Mitigation Strategy**	**Risk Rating**
1	Lack of operating funding reduces the ability to fund projects and perform maintenance	Inflation, flat revenue stream, negative economic conditions, other budget demands, and alternative fuels/fuel efficiency	Develop new models for revenue (e.g. VMT tax, alternative fuel vehicle tax, increased gas tax). Increase focus on preventive maintenance, knowing that we're delaying an inevitable decline in overall condition. Educate and inform elected officials, decision makers, and the public on the impacts of underfunding transportation. Public-Private Partnerships (PPPs) are one method of transferring risk from the Department to a vendor/contractor.	High (3)
2	Cut in federal funding reduces the ability to fund projects and perform maintenance	Federal highway trust fund insolvency	Consider in-state sources of revenue. Present options to the public to explain why additional revenue is needed (e.g., no new gas tax since 1992, etc.). Educate and inform elected officials, decision makers, and the public on the impacts of underfunding transportation.	High (3)
3	Insufficient match for federal funds hinders the ability to leverage federal resources	State funding cuts	Educate and inform elected officials, decision makers, and the public on the impacts of underfunding transportation. Present options to elected officials, decision makers, and the public explaining why additional revenue is needed (e.g., no new gas tax since 1992, etc.).	High (3)
4	Diminished revenues from reduced annual VMT (i.e., less fuel tax revenue)	Increased vehicle fuel efficiency, reduced VMT/driver	Develop new models for revenue (e.g. VMT tax, alternative fuel vehicle tax, increased gas tax). Educate and inform elected officials, decision makers, and the public on the impacts of underfunding transportation.	High (3)
5	New revenue sources increase ability to fund projects and perform maintenance	Increase in gas/diesel taxes, license fees, registration fees	Educate and inform elected officials, decision makers, and the public on the impacts of underfunding transportation. Present options to elected officials, decision makers, and the public explaining why additional revenue is needed (e.g., no new gas tax since 1992, etc.).	Medium (2)

Business and System Performance				
No.	Risk Description	Cause	Mitigation Strategy	Risk Rating
6	Emerging technologies improve efficiencies	Technologies (pavement condition assessment, pavement management system, etc.) continue to improve	Invest in these technologies. Use the improvement in data to encourage more widespread adoption of TAMP models and strategies. New technologies (3-D pavement data collection) are currently being employed for the collection of PMS data that should reduce year-to-year variability and increase confidence in pavement condition forecasting.	High (3)
7	Loss of staff/loss of institutional knowledge strains the organization during times of staff turnover	Continual downsizing, aging population, reduced benefits for workers, funding, emphasis on privatization	State Office of Personnel has influence over this process. Focus on training, mentoring, and recruitment. Allow people opportunities for advancement without having to change areas of expertise. ALDOT needs to be able to keep employees in positions (promote within the position) after considerable effort has been expended to train the employee to perform the duties of the position. Develop and maintain a sustainable and transferable knowledge base. May not be directly TAM-related.	High (3)
8	Increased travel demand and congestion degrade system performance	Demand on the transportation system continues to grow	Departmental policy is set so that capacity projects are not an option until funding improves. Department emphasizes preservation and maintenance of current assets. Improve safety of existing roads. Look for cost-effective ways to improve capacity, e.g., US 280, good general access management practices. Identify technologies and best practices that improve traffic system efficiency without increasing physical capacity.	High (3)
9	Data availability and integrity negatively impact bridge asset management practices	ALDOT does not currently utilize its bridge condition data in a life-cycle cost format to aid in agency decision making	Currently being improved. Embarking on a project that will incorporate deterioration curves based on historical data and national best practices.	Medium (2)
10	Data availability and integrity negatively impact pavement asset management practices	Automated pavement data collection does not match ground truths	New technologies (3-D pavement data collection) are currently being employed for the collection of PMS data that should reduce year-to-year variability and increase confidence in pavement condition forecasting.	High (3)
11	Data availability and integrity negatively impact pavement asset management practices	Lack of pavement condition trends across years (using current PPRs) inhibits ability to reliably forecast condition. Data variable from year to year.	3-D pavement data collection is being implemented. Improvements in data collection methodology will lead to less variability in pavement data. Changes in pavement condition rating algorithm will also help.	High (3)

Business and System Performance				
No.	**Risk Description**	**Cause**	**Mitigation Strategy**	**Risk Rating**
12	Project scope creep increases project costs and/or time (bridge)	Lack of communication. Desire to modify project scope, etc. Scope creep for bridge projects has reduced the number of bridges ALDOT replaces in a given year.	More brainstorming and involvement from multiple groups at the beginning of project development. Needs to include consideration of impacts on asset management practices.	High (3)
13	Project scope creep increases project costs and/or time (non-bridge projects)	Lack of communication. Desire to modify project scope, etc.	More brainstorming and involvement from multiple groups at the beginning of project development. Needs to include consideration of impacts on asset management practices.	Medium (2)
14	Increase in material costs (e.g., salt, fuel, asphalt) strains maintenance funds	Fluctuations in material and petroleum prices drive up Department costs	Develop a more fuel-efficient fleet. Bulk purchasing of materials. Educate and inform elected officials, decision makers, and the public on the impacts of underfunding transportation.	High (3)
15	Structure damage	Vehicle damage to highway assets leaves roadway travelers at risk due to exposure to damaged assets. This puts a burden on maintenance budgets to repair non-routine items (overhead sign structures, guardrail, inlets, signs, etc.) without adequate funding to maintain.	Set up revolving project to charge repairs and fund with insurance reimbursements. Remain diligent on getting funds reimbursed.	High (3)
16	Current programming decisions do not optimize investments and negatively impact preventive maintenance practices	Budget allocations to Regions based on square yards of roadway, not performance. Bridge allocations also not based on need.	Not an optimum strategy but has worked to some extent for years. Will need change in culture as good performing districts are "rewarded" with less funding. Changes to PMS reporting and data collection hopefully will encourage more use at the Area/District level. Current outreach to Area/District personnel will help to better understand PMS. Data-driven solutions can help minimize subjectivity in road building and maintenance. MAP-21 performance measures impact Department maintenance strategies. Develop appropriate performance-based metrics. Modify budgeting processes to incorporate these metrics.	Medium (2)
17	Current programming decisions do not optimize pavement investments	No mechanism for programmatic trade-off analysis (pavement)	Less stove piping of projects, e.g., schedule bridge and roadwork on a section of road concurrently. Define business processes for trade-off analysis. Develop and implement appropriate systems and tools to support those practices.	Medium (2)

No.	Risk Description	Cause	Mitigation Strategy	Risk Rating
18	Current programming decisions do not optimize bridge investments	No mechanism for programmatic trade-off analysis (bridge)	Less stove piping of projects, e.g., schedule bridge and roadwork on a section of road concurrently. Ensure that current problem is fixed with recent implementation of BrM 5.2.3. Define business processes for trade-off analysis. Develop and implement appropriate systems and tools to support those practices.	Medium (2)
19	Imprecise asset deterioration rates and insufficient life-cycle planning tools negatively impact asset management practices for pavement	Lack of software capability. No ALDOT-specific deterioration models. (pavement)	Find a way to capture preventive maintenance treatments in the PMS. New technologies (3-D pavement data collection) are currently being employed for the collection of PMS data that should reduce year-to-year variability and increase confidence in pavement condition forecasting. Leverage external research such as that being done at NCAT/MnROAD to study the life-cycle cost impacts of pavement maintenance treatments and improve forecasting for preventive treatments. Research other state and national practices to determine a cost-effective strategy for implementing LCCA tools.	Medium (2)
20	Imprecise asset deterioration rates and insufficient life-cycle planning tools negatively impact asset management practices for bridges	Lack of software capability. No ALDOT-specific deterioration models. (bridge)	Leverage external research to improve forecasting for preventive treatments. Ensure that current problem is fixed with recent implementation of BrM 5.2.3. Research other state and national practices to determine cost-effective strategy for implementing LCCA tools.	Medium (2)
21	Data availability and integrity negatively impact bridge asset management practices	Lack of precise data for bridge maintenance and capital projects. Element inspection data is not currently reliable.	Element inspection data should improve over time with more experience and training.	Medium (2)
22	Significant increase in lane-miles and asset inventories increases long term preservation costs	New construction projects strain maintenance operations	Continue focus on system preservation until additional funding or cost savings from TAMP allows for increases in new construction. Educate and inform elected officials, decision makers, and the public on the impacts of increased lane-miles and asset inventories without increases in maintenance funding.	Medium (2)
23	No formal documentation for rigid pavements	No ratings for concrete pavement	What should our mitigation strategy be? Determine if a rating algorithm is needed.	Low (1)

Health and Safety				
No.	**Risk Description**	**Cause**	**Mitigation Strategy**	**Risk Rating**
24	Structure failure	River flooding and scour, hurricanes and storm surge, earthquakes, vehicle and vessel collisions	Develop a rapid response plan for these types of contingencies.	Medium (2)
25	Structure failure	Permit violators, ineffective weight enforcement, deterioration, lack of funding, negligence	Remain diligent with permit and weight enforcement.	Medium (2)

Legal and Compliance				
No.	**Risk Description**	**Cause**	**Mitigation Strategy**	**Risk Rating**
26	Changes in regulatory policy require updates to Department business practices	Wetlands mitigation, air quality regulation, water quality regulations, noise regulation, additional NEPA requirements, ADA requirements, wage rate requirements, Buy America provision, debris management, DBE (disadvantaged), SBA (small business)	Stay up-to-date on regulatory changes. React as necessary and include in asset management planning.	High (3)

Reputation and Stakeholder Management				
No.	**Risk Description**	**Cause**	**Mitigation Strategy**	**Risk Rating**
27	Adverse legislative actions to priority programs reduces Department effectiveness	Uninformed elected officials, parochialism, short-term thinking, worst first, “Not in My Back Yard” (NIMBY)	Adjust planning accordingly and increase public awareness through outreach. Educate and inform elected officials, decision makers, and the public on the impacts of underfunding transportation. Raise awareness within the Department in order to deliver a consistent message.	High (3)
28	Negative public opinion/loss of stakeholder support reduces confidence in the Department	The public and stakeholders may lack understanding of how Department funds are allocated. Could result in loss of buying power (funding), trust, fraud, incident (bridge failure), poor employee customer service, and system deterioration.	Use media to proactively deliver the ALDOT message to the public and stakeholders. Raise awareness within the Department to deliver a consistent message.	High (3)

Environmental				
No.	**Risk Description**	**Cause**	**Mitigation Strategy**	**Risk Rating**
29	Extreme weather events/climate change damage/strain the transportation system	Climate change, hurricane, subsidence, sea level rise, coastal erosion, flood events, drought, tornadoes	Develop rapid response plan for these types of contingencies. Perhaps a "rainy day" fund for emergencies. Coordinate with the Alabama Safety Assistance Patrol (ASAP).	Low (1)

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Rare	Low	Low	Low	Low	Low
Unlikely	Low	Low	Low	Medium	Medium
Possible	Low	Low	Medium	High	High
Likely	Low	Medium	High	High	Critical
Almost Certain	Medium	Medium	High	Critical	Critical

Likelihood

Rare = less than 1 in 5,000 chance
Unlikely = 1 in 5,000 to 1 in 50 chance
Possible = 1 in 50 to 1 in 5 chance
Likely = 1 in 5 to 1 in 2 chance
Almost certain = > 7 in 10 chance

Consequence

Insignificant = almost no impact
Minor = Noticeable, not significant
Moderate = Material effect on the area
Major = Threatens to seriously damage
Catastrophic = Almost all-encompassing

Appendix C: GASB 34 Reporting

This appendix describes the Modified Approach used by ALDOT for GASB 34 reporting, presented in Chapter VI.D: Estimated Value of Pavements and Bridges. To use the Modified Approach, ALDOT must comply with the following requirements:

- Include an inventory of eligible infrastructure assets in its asset management system;
- Conduct condition assessments of eligible assets and summarize the results according to a measurement scale;
- Each year, estimate the cost to maintain and preserve the assets and the condition level established by the state; and
- Illustrate through documentation that the assets remain at or above the established condition level.

The measurement scales and FY 2016 results for pavements and bridges are provided below.

A. Pavements

To measure and monitor pavement conditions, ALDOT uses the International Roughness Index (IRI), a metric for assessing the smoothness of pavements while traveling in passenger vehicles (the lower the IRI, the smoother the pavement). ALDOT adopted the U.S. Department of Transportation's suggested values for IRI, as detailed in Exhibit 56.

Exhibit 56: IRI Scale

IRI Rating	Condition	Description
>170 Interstates **>220 Other Routes**	Poor	Significant Maintenance Required (Resurfacing or Reconstruction)
120-170 Interstates **171-220 Other Routes**	Mediocre	Moderate Maintenance Required (Resurfacing or Reconstruction)
95-119 Interstates **95-170 Other Routes**	Fair	Routine Maintenance Required (Pavement Patching)
60-94 All Routes	Good	Negligible Maintenance Required
<60 All Routes	Very Good	No Maintenance Required

Source: Alabama Department of Transportation

ALDOT requires that all state-maintained roadways must be in fair condition or better. As shown in Exhibit 57, the average IRI rating for the state's pavements is 78.85, which translates to good condition. Therefore, ALDOT meets the established requirement.

Exhibit 57: Pavement Condition Assessment

Category	Miles	IRI Rating
Non-Interstate Non-National Highway System	6,704.50	84.16
Non-Interstate National Highway System	3,169.59	72.52
Interstate System	999.08	62.97
Summary Total and Average Rating	**10,873.17**	**78.85***

Source: Alabama Department of Transportation. FY 2016 GASB 34 Roadway Condition Report.
*This average is weighted by percentage of inventory.

B. Bridges

To assess bridges, ALDOT uses a weighted rating consisting of the major structural components and the deck area of a bridge or culvert. A zero-to-ten rating scale is used to rate each component. ALDOT then uses an algorithm developed by its Maintenance Bureau to calculate an average for each bridge asset classification. The algorithm uses the assessed weighted ratings, each bridge deck area, and the sum of all deck areas. Exhibit 58 displays the bridge measurement scale.

Exhibit 58: Bridge Measurement Scale

Rating	Condition	Description
1 – 4.99	Marginal	Structural elements have been seriously affected by deterioration.
5 – 6.99	Satisfactory	Structural elements are sound but have minor deterioration.
7 or Greater	Good	Structural elements show negligible signs of deterioration.

Source: Alabama Department of Transportation. FY 2016 GASB 34 Bridge Condition Report.

ALDOT requires that all state-maintained bridges and culverts must be in satisfactory condition or better. As shown in Exhibit 59, the average bridge rating for the state's bridges is 6.52, which is satisfactory. Therefore, ALDOT meets the established requirement.

Exhibit 59: Bridge Condition Assessment

Category	Structures	Rating
Non-Interstate Non-National Highway System	2,325	6.70
Non-Interstate National Highway System	1,845	6.67
Interstate System	1,261	5.99
Summary Total and Average Rating	**5,431**	**6.52***

Source: Alabama Department of Transportation
*This average is weighted by percentage of inventory.

Appendix D: Implementation Plan

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This implementation plan includes two parts: a summary of the proposed action items for ALDOT to undertake over the course of the next five years, developed as part of the Phase I TAMP work, and a plan for updating the TAMP.

A. Near-Term Action Items

Exhibit 60 includes a list of action items for the next five years. The estimated cost that is provided is subjective in many instances. For example, the pavement management system has many modules and capabilities that ALDOT may or may not want to utilize. These will heavily influence the final cost of the strategy. However, for strategic planning, these costs are good placeholders to understand the magnitude of the action.

Exhibit 60: Action Items for Next Five Years

No.	Action	Purpose	Expected Timeframe	Estimated Cost
1	**Formalize process for conducting periodic evaluation of facilities repeatedly requiring repair and reconstruction due to emergency events and reporting the information to FHWA**	To highlight assets that are especially vulnerable and comply with Part 667 of Asset Management Plan Rule.	By November 23, 2018	$200,000
2	**Expand/enhance PMS**	To enable the Department to conduct pavement condition forecasting based on various funding levels, provide guidance for project selection, and allocate funds based on need.	2-3 years	$2 million (software solution)
3	**Fully implement AASHTOWare BrM**	To enable candidate project and program generation and estimate future performance at the corridor and network level.	2 years	$500,000-$1 million
4	**Expand/enhance asset data collection**	Consistent asset inventory and condition assessment will improve the ability to develop performance-based budgets.	Pilot underway	Pending pilot results and statewide implementation cost estimates

No.	Action	Purpose	Expected Timeframe	Estimated Cost
5	**Improved/enhance bridge work accomplishment data**	To improve the unit cost and treatment effectiveness metrics.	2 years	$100,000-$200,000
6	**Develop policy and performance measures to prepare for cross-asset/trade-off analysis**	A first step to implementing effective cross-asset/trade-off analysis processes and TAM best practices.	1 year	Internal development costs $20,000-$50,000
7	**Evaluate/implement cross-asset/trade-off analysis software**	To enable the Department to evaluate the impact of different projects across asset classes.	5 years	$3 million-$4 million
8	**Evaluate/implement life-cycle planning tools**	To reduce costs of managing assets over their entire life cycle.	BrM in development. Pavement 2 years.	TBD
9	**Improve risk management tools**	Particularly of bridge failures due to natural and man-made disasters. Would provide bridge management models to use in risk evaluation modules of AASHTOWare BrM.	5 years	$200,000-$400,000
10	**Improve preservation practices**	Minimize life-cycle costs to maintain assets.	Year-to-year iterations	$200,000-$500,000 per year
11	**Include additional assets in the TAMP**	To enable a more comprehensive approach to TAM.	1-2 years	Internal development costs $25,000-$50,000
12	**Ensure organizational integration**	Ensure full implementation of modern TAM practices and data-driven decision making.	Ongoing	Internal development costs $50,000-$150,000

B. TAMP Update Plan

These are the steps and elements needed for updating ALDOT’s TAMP. For reference, the TAMP requirements as established by the MAP-21 legislation are summarized in Appendix E.

1. Set a Schedule

Like any project, determining when an update is necessary, understanding the time requirements involved with the update, and selecting a date for the final deliverable are important first steps. ALDOT should build upon the momentum of this TAMP process to prepare for future TAMP updates. Per the final asset management planning rule published October 24, 2016, ALDOT will update the TAMP processes at least once every four years.

2. Identify Update Team

A lead employee should be identified as the TAMP update manager. That individual should assemble a team of stakeholders to assist the update process. This team could originate out of or incorporate individuals from the ALDOT TAMP Steering Committee. Once the update team is formed, the remaining tasks should be executed to successfully update the TAMP.

3. Required Inputs

Several pieces of information should be collected and assembled as part of the TAMP update process, either by the TAMP update manager or by other members of the update team, including:

- **New inventory and current conditions –** Each year, additional lane-miles are added, and new bridges are built. In addition, roads are sometimes closed resulting in pavement and bridges being removed from the inventory. The need to understand the inventory of ALDOT is paramount to the TAMP, as well as the condition of those assets. Through the Bureau of Materials & Tests, ALDOT has an up-to-date pavement inventory. Likewise, within the Maintenance Bureau, the BrM software contains the bridge inventory. Both assets have condition ratings that should be used in the TAMP. There is also potential in the future to expand the highway assets included in the TAMP by enlisting the data (inventory and condition assessments) in the RoadMAP software.
- **Updated information on facilities requiring repeated repair and reconstruction due to emergency events –** Per 23 CFR 667, ALDOT will make reasonable efforts to obtain the data needed for the evaluations (to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events), and document those efforts in the evaluations if unable to obtain sufficient data for a facility. ALDOT will update the evaluations for NHS roads, highways, and bridges at least every four years and after each emergency event to the extent necessary to account for the effects of the event.
- **Changes in objectives and measures –** The Steering and Executive Committees have stated their expectations for bridge and pavement performance in ALDOT. If these expectations change, this should be captured before updating the TAMP.

Any outcomes or influence due to federal rulemaking should also be understood and incorporated in the update.

- **Updates to risk register –** Risks can change over time. As a result, the risk register should be adjusted accordingly (see Appendix B). To update the risk register, each team member should prepare a list of potential changes in risks applicable to his or her area of expertise. The TAMP update manager will collect these lists.
- **New projected funding scenarios –** Project funding projections will change, in some years more than in others. Efforts should be made to look at trends in both state and federal funding, as well as potential new funding sources.

4. Update Workshops

Once all necessary information has been assembled, the update team will participate in a working meeting to walk through the update process. In this meeting, the following six activities should be addressed, clarified, and delegated to team members. Each team member should leave the meeting with a list of personal action items to be completed and delivered to the update manager by a set date.

1. **Update inventory and conditions –** Once the data is collected, it will need to be updated in the TAMP.
2. **Update evaluation of facilities requiring repeated repair and reconstruction due to emergency events –** Once the data is collected, it will need to be submitted to FHWA and noted in the TAMP. ALDOT will note whether they were unable to obtain sufficient data for a facility.
3. **Reproduce pavement and bridge performance projections (based on new inputs) –** The process within this step will change from year to year due to changes in software and modeling capability. While the process changes, the goal is the same: the TAMP will need to show the projected performance scores for the following ten years based on current asset conditions and funding scenarios.
4. **Evaluate current risk register and update as necessary –** Each team member should bring with them to the meeting a list of potential changes to the risk register. These changes should be discussed by the group, and once agreed upon, be made to the TAMP risk register.
5. **Compare performance goals with current conditions –** Each year, pavement and bridge performance scores change. Ideally, they will be trending toward the stated goals. The performance scores should be compared to the stated goals, and this comparison should be updated in the TAMP.
6. **Perform gap analysis for future funding levels –** Based on the results of the revised performance projections, a comparison should be made between the stated goals and the projected condition scores based on projected funding levels. This comparison should be updated in the TAMP.

5. Finalize TAMP Update

Once the update team has conducted its working meeting, the update manager will receive all deliverables discussed in the meeting. The update manager will take the deliverables, verify their usefulness, and merge them into the TAMP. Once the content has been updated, the TAMP should be reviewed for publication. It should then be made available as ALDOT deems necessary.

Appendix E: MAP-21 TAMP Requirements – Asset Management Plans and Condition Measures

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A. Summary of Final Rulemaking: Asset Management Plans

The Asset Management Plan final rulemaking, which includes 23 CFR 515 and 23 CFR 667, was published on October 24, 2016. For the full text of the rule, refer to the following link: https://www.federalregister.gov/documents/2016/10/24/2016-25117/asset-management-plans-and-periodic-evaluations-of-facilities-repeatedly-requiring-repair-and

The following summary was provided by FHWA.

Asset Management Plans & Processes Fact Sheet

Final Rulemaking

The Federal Highway Administration (FHWA) on October 24, 2016, published its final rule on required state-approved asset management plans and processes.

Asset management is a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on engineering and economic analysis based upon quality information, 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.

In simple terms, asset management is a strategic process for managing physical assets in a state of good repair over their lifecycle at minimum practicable cost.

Visit www.fhwa.dot.gov/asset/index.cfm and www.fhwa.dot.gov/tpm/ for resources currently available or in development, including guidance, samples, and templates.

Key Dates	
By April 30, 2018	State DOTs submit initial plans describing asset management plan processes.
By June 30, 2019	State DOTs submit fully compliant asset management plans.
At least every 4 years thereafter	Updated processes submitted for recertification.
Not later than August 31, 2019, and not later than July 31 in each year thereafter	Annual determination by FHWA of whether the State DOT has developed and implemented a State asset management plan consistent with this final rule.
Beginning October 1, 2019, and in each fiscal year thereafter	If a State DOT has not developed and implemented a compliant asset management plan, the maximum Federal share on National Highway Performance Program (NHPP) projects and activities carried out by the State in that fiscal year shall be reduced to 65% for that fiscal year.

U.S. Department of Transportation
Federal Highway Administration

FHWA-HIF-17-06

Minimum Plan Requirements

- Summary listing and condition description of the NHS pavements and bridges
- NHS pavements and bridges targets
- Asset management objectives and measures
- Performance gap analysis--State DOTs must include performance gaps that affect NHS pavements and bridges regardless of physical condition or ownership.
- Risk analysis
- Life-cycle planning
- Financial plan (minimum 10 years)
- Developing investment strategies

Penalties

✓ The FHWA is preparing a final rule on NHS pavements and bridges performance target establishment (23 U.S.C. 150).
If a State DOT has not developed and implemented an asset management plan consistent with requirements and has not established NHS pavements and bridges targets within 18 months of that rule's effective date, the FHWA will not approve any further projects using NHPP funds until the State has done so.
The deadline may be extended if the FHWA determines the State has made a good-faith effort.

Background

The final rule addresses requirements established by the Moving Ahead for Progress in the 21st Century Act (MAP-21) and reflects passage of the Fixing America's Surface Transportation (FAST) Act:

✓ A requirement for States to develop and implement risk-based asset management plans for the National Highway System (NHS) to improve or preserve asset condition and system performance as part of the NHPP.

✓ FHWA must establish minimum standards for States to use in developing and operating NHS bridge and pavement management systems to carry out the NHPP.

U.S. Department of Transportation
Federal Highway Administration

FHWA-HIF-17-06

B. Summary of Final Rulemaking: Performance Measures

The rulemaking for the pavement and bridge condition national performance management measures, 23 CFR Part 490, was published on January 18, 2017. For the full text of the rule, refer to the following link: https://www.federalregister.gov/documents/2017/01/18/2017-00550/national-performance-management-measures-assessing-pavement-condition-for-the-national-highway

The following summaries for pavement and bridges including rulemaking highlights and key dates were developed by FHWA.

PAVEMENT
PERFORMANCE MEASURES

Final Rulemaking

The Federal Highway Administration (FHWA) published in the *Federal Register* (82 FR 5886) a final rule establishing performance measures for State Departments of Transportation (DOTs) to use in managing pavement and bridge performance on the National Highway System (NHS). The National Performance Management Measures; Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program Final Rule addresses requirements established by the Moving Ahead for Progress in the 21st Century Act (MAP-21) and reflects passage of the Fixing America's Surface Transportation (FAST) Act. The rule is effective **May 20, 2017**.

Performance Measures
✓ % of Interstate pavements in Good condition
✓ % of Interstate pavements in Poor condition
✓ % of non-Interstate NHS pavements in Good condition
✓ % of non-Interstate NHS pavements in Poor condition

About Condition

- **Good condition:** Suggests no major investment is needed.
- **Poor condition:** Suggests major reconstruction investment is needed.

Penalty Provisions

If FHWA determines the State DOT's Interstate pavement condition falls below the minimum level for the most recent year, the State DOT must obligate a portion of National Highway Performance Program (NHPP) and transfer a portion of Surface Transportation Program (STP) funds to address Interstate pavement condition.

U.S. Department of Transportation
Federal Highway Administration

Target Setting

State DOTs:

- Must establish targets, regardless of ownership, for the full extent of the Interstate and non-Interstate NHS.
- Must establish statewide 2- and 4-year targets for the non-Interstate NHS and 4-year targets for the Interstate by May 20, 2018, and report by October 1, 2018.
- May adjust targets at the Mid Performance Period Progress Report (October 1, 2020).

Metropolitan Planning Organizations (MPOs):

- Support the relevant State DOT(s) 4-year target or establish their own by 180 days after the State DOT(s) target is established.

PAVEMENT

PERFORMANCE MEASURES

TPM HOW WE GET THERE

Key Dates	
May 20, 2017	Final rule effective date.
January 1, 2018	1st 4-year performance period begins.
May 20, 2018	State DOT targets must be established.
January 1, 2018	State DOTs collect data for Interstate pavements that conform to the final rule (IRI, Rutting, Cracking %, Faulting, and Inventory).
Within 180 days of relevant State DOT(s) target establishment	MPOs must commit to support state target or establish separate quantifiable target.
October 1, 2018	Baseline Performance Period Report for 1st Performance Period due. State DOTs report 4-year targets for Interstate and 2-year and 4-year targets for non-Interstate NHS; etc.
April 15, 2019, and each April 15 thereafter	State DOTs submit first Interstate data that conform to the final rule.
January 1, 2020	State DOTs collect data for non-Interstate NHS pavements that conform to the final rules.
October 1, 2020	Mid Performance Period Progress Report for the 1st Performance Period due. State DOTs report 2-year condition/performance; progress toward achieving 2-year targets; etc.
June 15, 2021, and each June 15 thereafter	State DOTs submit non-Interstate NHS data that conform to the final rule.
December 31, 2021	1st 4-year performance period ends.
October 1, 2022	Full Performance Period Progress Report for 1st Performance Period due. State DOTs reports 4-year condition/performance; progress toward achieving 4-year targets, etc. Baseline Performance Period Report for 2nd Performance Period due. State DOTs report 2-year and 4-year targets for Interstate and non-Interstate NHS; baseline condition; etc.

U.S. Department of Transportation
Federal Highway Administration

Visit www.fhwa.dot.gov/tpm/ to learn about training, guidance, and other implementation-related information.

BRIDGE
PERFORMANCE MEASURES

Final Rulemaking

The Federal Highway Administration (FHWA) published in the *Federal* Register (82 FR5886) a final rule establishing performance measures for State Departments of Transportation (DOTs) to use in managing pavement and bridge performance on the National Highway System (NHS). The National Performance Management Measures; Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program Final Rule addresses requirements established by the Moving Ahead for Progress in the 21st Century Act (MAP-21) and reflects passage of the Fixing America's Surface Transportation (FAST) Act. The rule is effective **May 20, 2017**.

Performance Measures
✓ % of NHS bridges by deck area classified as in Good condition
✓ % of NHS bridges by deck area classified as in Poor condition

Condition-Based Performance Measures

- Measures are based on deck area.
- The classification is based on National Bridge Inventory (NBI) condition ratings for item 58 - Deck, 59 - Superstructure, 60 - Substructure, and 62 - Culvert.
- Condition is determined by the lowest rating of deck, superstructure, substructure, or culvert. If the lowest rating is greater than or equal to 7, the bridge is classified as good; if is less than or equal to 4, the classification is poor. (Bridges rated below 7 but above 4 will be classified as fair; there is no related performance measure.)
- Deck area is computed using NBI item 49 - Structure Length, and 52 - Deck Width or 32 - Approach Roadway Width (for some culverts).

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Target Setting

State DOTs:

- Must establish targets for all bridges carrying the NHS, which includes on- and off-ramps connected to the NHS within a State, and bridges carrying the NHS that cross a State border, regardless of ownership.
- Must establish statewide 2- and 4-year targets by May 20, 2018, and report targets by October 1, 2018, in the Baseline Performance Period Report.
- May adjust 4-year targets at the Mid Performance Period Progress Report (October 1, 2020).

Metropolitan Planning Organizations (MPOs):

- Support the relevant State DOT(s) 4-year target or establish their own by 180 days after the State DOT(s) target is established.

BRIDGE
PERFORMANCE MEASURES

TPM HOW WE GET THERE

Key Dates	
May 20, 2017	Final rule effective date.
January 1, 2018	1st 4- year performance period begins.
May 20, 2018	Initial 2- and 4-year targets established.
October 1, 2018	Baseline Performance Period Report for the 1st Performance Period due. State DOTs report 2-year and 4-year targets; etc.
Within 180 days of relevant State DOT(s) target establishment	MPOs must commit to support State target or establish separate quantifiable target.
October 1, 2020	Mid Performance Period Progress Report for the 1st Performance Period due. State DOTs report 2-year condition/performance; progress toward achieving 2-year targets; etc.
December 31, 2021	1st 4-year performance period ends.
October 1, 2022	Full Performance Period Progress Report for 1st performance period due. State DOTs report 4-year condition/ performance; progress toward achieving 4-year targets; etc. Baseline report due for 2nd performance period due. State DOTs report 2- and 4-year targets; baseline condition, etc.

Other Specifics

- State DOT targets should be determined from asset management analyses and procedures and reflect investment strategies that work toward achieving a state of good repair over the life cycle of assets at minimum practicable cost. State DOTs may establish additional measures and targets that reflect asset management objectives.
- The rule applies to bridges carrying the NHS, including bridges on on- and off-ramps connected to the NHS.
- If for 3 consecutive years more than 10.0% of a State DOT's NHS bridges' total deck area is classified as Structurally Deficient, the State DOT must obligate and set aside National Highway Performance Program (NHPP) funds for eligible projects on bridges on the NHS.
- Deck area of all border bridges counts toward both States DOTs' totals.

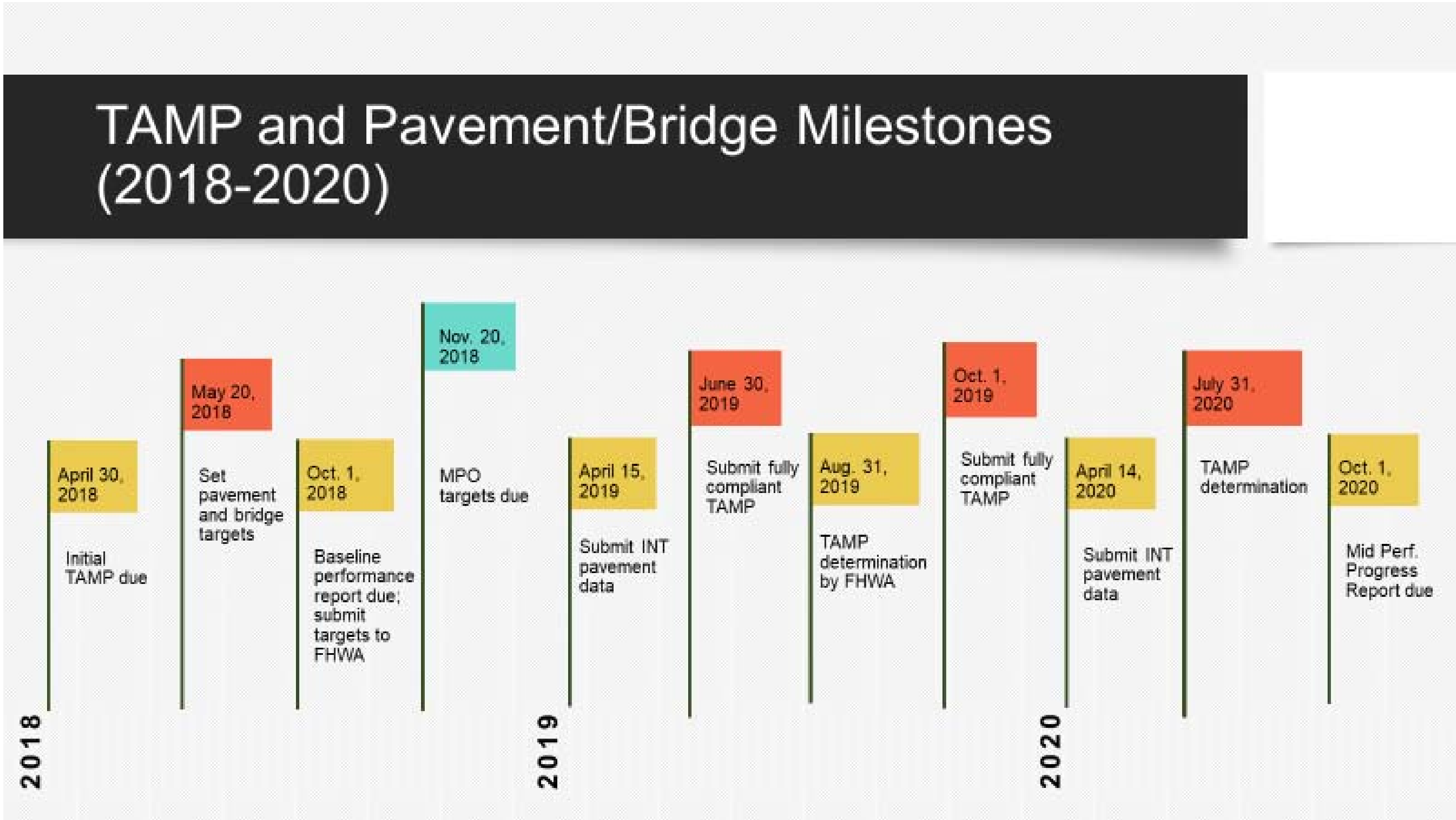
U.S. Department of Transportation
Federal Highway Administration

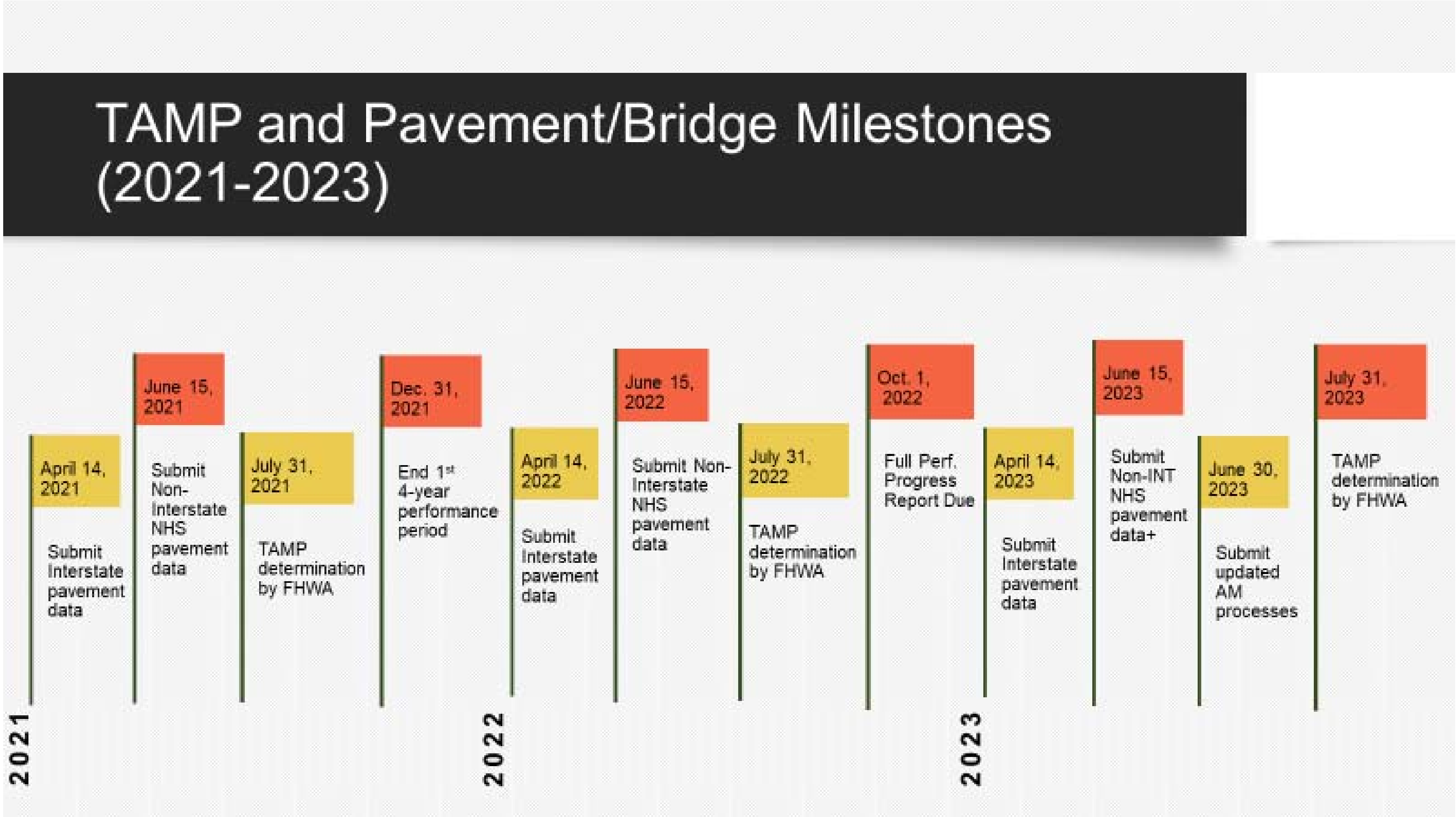
Visit www.fhwa.dot.gov/tpm/ to learn about training, guidance, and other implementation-related information.

C. Summary Timeline Graphic: TAMP and Pavement/Bridge Condition Milestones

Exhibit 61 displays the major milestones established in the TAMP and pavement/bridge condition rulemakings. For more detailed descriptions of each milestone, refer to the key dates on the rulemaking summaries on pages E-1 – E-6.

Exhibit 61: TAMP and Pavement/Bridge Milestones: 2018 – 2023




TAMP and Pavement/Bridge Milestones (2021-2023)
April 14, 2021
Submit Interstate pavement data
June 15, 2021
Submit Non-Interstate NHS pavement data
July 31, 2021
TAMP determination by FHWA
Dec. 31, 2021
End 1st 4-year performance period
April 14, 2022
Submit Interstate pavement data
June 15, 2022
Submit Non-Interstate NHS pavement data
July 31, 2022
TAMP determination by FHWA
Oct. 1, 2022
Full Perf. Progress Report Due
April 14, 2023
Submit Interstate pavement data
June 15, 2023
Submit Non-INT NHS pavement data+
June 30, 2023
Submit updated AM processes
July 31, 2023
TAMP determination by FHWA
2021
2022
2023

Appendix F: List of Duplicate ER Locations

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Location Code	Region	County Name	Route ID	Beg. Mile Post	End Mile Post	Event_Code	Issue_Code
1	North	Franklin	SR17	299.5		Fire	Slope/slide repair
1	North	Franklin	SR17	300	300.1	Severe Weather	Slope/slide repair
2	East Central	Blount	SR3	304	309	Severe Weather	Debris removal
2	East Central	Blount	SR3	306.2	306.2	Severe Weather	Slope/slide repair
3	East Central	Jefferson	IN59	124.5	124.5	Fire	Bridge replacement
3	East Central	Jefferson	IN65	260.5	260.5	Fire	Bridge replacement
4	West Central	Bibb	SR25	80.3	80.3	Tropical Storm / Hurricane	Pipe failure
4	West Central	Bibb	SR25	80.5		Tropical Storm / Hurricane	Sinkhole
5	Southeast	Dallas	SR5	47.636	47.636	Severe Weather	Slope/slide repair
5	Southeast	Dallas	SR5	47.6	47.65	Severe Weather	Slope/slide repair
6	Southeast	Lowndes	SR263	0	15.1	Severe Weather	Debris removal
6	Southeast	Lowndes	SR263	7.69	7.69	Severe Weather	Slope/slide repair
6	Southeast	Lowndes	SR263	8	10.5	Tropical Storm / Hurricane	Slope/slide repair
7	Southeast	Lowndes	SR8	110.1	110.1	Severe Weather	Slope/slide repair
7	Southeast	Lowndes	SR8	110.7	110.7	Severe Weather	Slope/slide repair
8	Southeast	Covington	CR70			Severe Weather	Emergency repairs
8	Southeast	Covington	CR70			Tropical Storm / Hurricane	Emergency repairs
9	Southeast	Dale	SR51	21.5		Severe Weather	Slope/slide repair
9	Southeast	Dale	SR5	21.476	21.58	Severe Weather	Slope/slide repair
10	Southeast	Geneva	SR87	0.02	0.3	Severe Weather	Slope/slide repair
10	Southeast	Geneva	SR87	0	0.02	Severe Weather	Slope/slide repair

Location Code	Region	County Name	Route ID	Beg. Mile Post	End Mile Post	Event_Code	Issue_Code
10	Southeast	Geneva	SR87	0.03		Severe Weather	Slope/slide repair
11	Southeast	Houston	SR52	82.81		Severe Weather	Bridge scour
11	Southeast	Houston	SR52	82.66		Severe Weather	Slope/slide repair
12	Southeast	Houston	SR210	10.02		Severe Weather	Slope/slide repair
12	Southeast	Houston	SR210	9.967	9.967	Severe Weather	Slope/slide repair
13	Southeast	Houston	SR210	12.7		Severe Weather	Emergency repairs
13	Southeast	Houston	SR210	12.7	12.7	Severe Weather	Slope/slide repair
14	Southeast	Pike	SR53	77.312	77.35	Severe Weather	Slope/slide repair
14	Southeast	Pike	SR53	77.38		Severe Weather	Slope/slide repair
15	Southwest	Choctaw	SR12	15		Severe Weather	Slope/slide repair
15	Southwest	Choctaw	SR12	15.5	15.7	Severe Weather	Slope/slide repair
16	Southwest	Choctaw	SR17	109		Severe Weather	Slope/slide repair
16	Southwest	Choctaw	SR17	109.25	109.25	Severe Weather	Slope/slide repair
17	Southwest	Clarke	SR5	0.5		Severe Weather	Slope/slide repair
17	Southwest	Clarke	SR5	0.7	0.7	Severe Weather	Slope/slide repair
17	Southwest	Clarke	SR5	0.7		Severe Weather	Slope/slide repair
18	Southwest	Clarke	SR13	80.48		Severe Weather	Slope/slide repair
18	Southwest	Clarke	SR13	80.5	80.52	Severe Weather	Slope/slide repair
18	Southwest	Clarke	SR13	80.423	80.423	Tropical Storm / Hurricane	Slope/slide repair
19	Southwest	Clarke	SR69	25.75	25.75	Severe Weather	Slope/slide repair
19	Southwest	Clarke	SR69	25.809	25.809	Tropical Storm / Hurricane	Slope/slide repair
20	Southwest	Marengo	SR8	31.1		Severe Weather	Slope/slide repair
20	Southwest	Marengo	SR8	31.35	31.45	Tropical Storm / Hurricane	Slope/slide repair
21	Southwest	Conecuh	SR12	119.356		Severe Weather	Slope/slide repair

Location Code	Region	County Name	Route ID	Beg. Mile Post	End Mile Post	Event_Code	Issue_Code
21	Southwest	Covington	SR12	119.8	119.8	Severe Weather	Stream bank failure
22	Southwest	Escambia		62.790	64.360	Severe Weather	Emergency repairs
22	Southwest	Escambia		62.790	64.360	Tropical Storm / Hurricane	Emergency repairs
23	Southwest	Baldwin	I10	37.07		Severe Weather	Culvert repair
23	Southwest	Baldwin	I10			Tropical Storm / Hurricane	Culvert repair
24	Southwest	Mobile	Schillinger Road	Airport Blvd.	Cottage Hill Road	Severe Weather	Emergency repairs
24	Southwest	Mobile	Schillinger Road	Airport Blvd.	Cottage Hill Road	Tropical Storm / Hurricane	Emergency repairs
25	Southwest	Mobile	University Blvd.	Zeigler Blvd	Moffett Blvd	Severe Weather	Emergency repairs
25	Southwest	Mobile	University Blvd.	Zeigler Blvd	Moffett Blvd	Tropical Storm / Hurricane	Emergency repairs
26	Southwest	Mobile	IN10	17.56		Severe Weather	Slope/slide repair
26	Southwest	Mobile	IN10	17.12		Severe Weather	Slope/slide repair
27	Southwest	Mobile	Bienville Blvd			Tropical Storm / Hurricane	Emergency repairs
27	Southwest	Mobile	Bienville Blvd	Non-Specific	Non-Specific	Tropical Storm / Hurricane	Emergency repairs
27	Southwest	Mobile	Bienville Blvd	Non-Specific	Non-Specific	Tropical Storm / Hurricane	Emergency repairs
28	Southwest	Mobile	Non-Specific	Non-Specific	Non-Specific	Tropical Storm / Hurricane	Emergency repairs
28	Southwest	Mobile	Non-Specific	Non-Specific	Non-Specific	Tropical Storm / Hurricane	Emergency repairs
29	Southwest	Mobile	SR193			Tropical Storm / Hurricane	Emergency repairs
29	Southwest	Mobile	AL193	3.967	6.000	Tropical Storm / Hurricane	Extend seawall
30	Southwest	Mobile	SR163			Tropical Storm / Hurricane	Emergency repairs

Location Code	Region	County Name	Route ID	Beg. Mile Post	End Mile Post	Event_Code	Issue_Code
30	Southwest	Mobile	AL163	2.700	2.800	Tropical Storm / Hurricane	Emergency repairs
31	Southwest	Mobile	SR158	0.01		Severe Weather	Slope/slide repair
31	Southwest	Mobile	SR158	0.306	0.306	Tropical Storm / Hurricane	Slope/slide repair
32	Southwest	Mobile	SR188	3.8	5.2	Severe Weather	Cross drain failures
32	Southwest	Mobile	AL16	3.900	3.900	Tropical Storm / Hurricane	Emergency repairs
33	Southwest	Mobile	AL16	31.792	36.103	Tropical Storm / Hurricane	Bridge repairs
33	Southwest	Mobile	AL16	31.792	36.103	Tropical Storm / Hurricane	Emergency repairs
33	Southwest	Mobile	AL16	31.926	32.556	Tropical Storm / Hurricane	Emergency repairs
34	Southwest	Mobile	IN10	27.662	27.662	Tropical Storm / Hurricane	Emergency repairs
35	Southeast	Montgomery	SR126	5.4		Severe Weather	Slope/slide repair
35	Southeast	Montgomery	SR126	5.4	5.4	Severe Weather	Slope/slide repair
36	Southeast	Montgomery	SR6	170.1	170.5	Severe Weather	Slope/slide repair
36	Southeast	Montgomery	SR6	170.7	170.7	Severe Weather	Slope/slide repair

Appendix G: Alabama Department of Transportation Pavement Preservation Policy

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Pavement Preservation is the planned strategy of cost-effective treatments to an existing roadway system that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system without significantly increasing the structural capacity of the pavement. The purpose of the Pavement Preservation Policy is to define the eligibility of two preservation strategies: Preventative Maintenance (PM) and Minor Rehabilitation (MR). The decision-making process is documented on the attached matrix.

Eligible Funding Categories for Pavement Preservation Projects:

The following funding sources should be considered for pavement preservation projects. The Maintenance Bureau will publish each year the amount of funds available by Region/Area in the first three categories.

- Federal Aid Resurfacing Program funds (FM)
- State Maintenance Resurfacing Program funds (99 or ST)
- State Special Maintenance funds (99)
- Interstate Maintenance Program funds (IM)
- State Construction funds (ST)

Project Scoping Team for Pavement Preservation Projects (PM & MR):

A scope of work inspection shall be conducted on each resurfacing project by the Region/Area. An on-site review shall be conducted by a scope team of the entire project limits. The scope team shall consist of appropriate personnel as determined by the Region/Area.

For interstate routes, the scope team is required to include the Interstate Maintenance Review Committee.

Pavement Condition Data:

Field data collection for all pavement preservation projects is to follow ALDOT Materials and Tests Bureau Procedure 392.

Non-Pavement Related Items of Work:

A major goal of this policy is to max1m1ze available funding for pavement management. Therefore, on Interstate Maintenance (IM) projects, other than eligible safety items, non- pavement related items shall not be included unless identified in the IM Review Committee's letter or specifically approved by the Maintenance Bureau. On Federal-Aid Maintenance Program (FM), State Maintenance Resurfacing Program (99 or ST), State Special Maintenance (99), and State Construction (ST) resurfacing projects, other than eligible safety items, non- pavement items of work shall not be included unless approved by the Maintenance Bureau. Non- pavement items may be included by split funding from alternate funding sources or shall be addressed in a separate project as funding is available.

Safety (General)

Safety items that are defined in the Pavement Preservation Policy Matrix are a systematic approach to upgrading existing safety hardware that should be addressed. Other site-specific safety items, based on crash history, that are not defined by the matrix but are identified by a Scoping Team may be included as part of the preservation maintenance project. Funding for these safety items will be through Highway Safety Improvement Program (HSIP) funds when eligible, through the appropriate allowable funding percentage by Pavement Preservation Category as outlined below in this document or alternative funding.

On an Interstate MR project, a Design Safety Scoping Team will be assembled which will include the appropriate Region personnel, personnel from the Design Bureau, and the respective FHWA Area Engineer.

In general, if safety item upgrades exceed available funding, it is desirable to address the below items in the following priority ranking. However, the judgment of the Scoping Team viewing actual site conditions and crash history is superior to this general priority list:

1. Guardrail to bridge rail transitions where the approach shoulder widths require narrowing of the bridge end guardrail at narrow bridges.
2. Guardrail end anchors
3. Low guardrail

Pavement Preservation - Preventative Maintenance (PM)

Intent:

Preventative maintenance projects extend the functional adequacy of pavements. This may include work on roadway surfaces in advance of various levels of observable deterioration.
This policy subdivides preventative maintenance into two categories: Preventative Maintenance 1 (PM1) and Preventative Maintenance 2 (PM2). See the Pavement Preservation Policy Matrix for the specific requirements associated with each category.

Preventative maintenance treatments should be considered for structurally sound pavements to extend and maintain their functional adequacy until the rehabilitation cycle is reached.

Note: Selected preventative maintenance treatments must be compatible with the existing traffic volumes, roadway design speeds, and in-place pavement structure. Preventative maintenance treatments are not appropriate when significant rutting, significant cracking, and/or significant faulting is present.

Pavement Preservation - Minor Rehabilitation (MR)

Intent:

Minor rehabilitation projects extend the useful life of pavements through treatments that are more involved than those used for preventative maintenance. See the Pavement Preservation Policy Matrix for the specific requirements associated with a MR project.

Pavement Preservation Policy Matrix

Note 1: These safety items may be eligible for HSIP or other alternative funding. Subject to the availability of alternative funding sources, these safety items identified within the matrix may be funded by the Pavement Preservation Project as initial deductions to the allowable safety funding for each category (0% on PM1, 5% on PM2, 10% on **MR).**

Note 2: Use ALDOT approved Manual for Assessing Safety Hardware 2016 (MASH) safety devices. If no MASH item is available, consult the Design Bureau for a recommendation for the site-specific application.

Note 3: Should the replacement or repair costs of damaged devices, combined with other improvement costs (guardrail, end anchors and bridge connection rails), exceed the allowable safety funds for each category (0% on PM1, 5% on PM2, 10% on MR) then seek alternative funds.

Pavement Preservation Policy Matrix

	Preventative Maintenance 1 (PM 1)	**Preventative Maintenance 2 (PM 2)**	**Minor Rehabilitation (MR)**
Americans with Disabilities Act	Install curb cuts and curb ramps along existing curb- and -gutter sections where sidewalks are present except when the following treatments are selected: • Crack Filling and Sealing • Surface Sealing • Chip Seals • Slurry Seals • Fog Seals • Scrub Seals • Joint Crack Seals • Joint Repairs • High Friction Treatments (Spot locations) • Diamond Grinding • Concrete Grooving • Pavement Patching	Install curb cuts and curb ramps along existing curb- and -gutter sections where sidewalks are present.	Install curb cuts and curb ramps along existing curb-and-gutter sections where sidewalks are present.

Pavement Preservation Policy Matrix (continued)

	Preventative Maintenance 1 (PM 1)	Preventative Maintenance 2 (PM 2)	Minor Rehabilitation (MR)
Safety	Safety items are not a required consideration - outside the purview of preventative maintenance unless specified within the PM 1 matrix.	Eligible safety items identified within the PM 2 matrix may be included in and funded by the preservation project up to five percent (5%) of the total pavement preventative maintenance cost. Safety items exceeding the 5% or that are not identified by the policy's PM 2 matrix shall be addressed by funding sources other than pavement preservation funding and addressed in a separate funding category in the construction project.	Eligible safety items identified within the MR matrix may be included in and funded by the preservation project up to ten percent (10%) of the total pavement rehabilitation cost. Safety items exceeding the 10% or that are not identified by the policy's MR matrix shall be addressed by funding sources other than pavement preservation funding and addressed in a separate funding category in the construction project.
Superelevation & Cross-Slope	Not a required consideration - outside the purview of preventative maintenance.	Not a required consideration - outside the purview of preventative maintenance.	ALDOT shall correct cross slope and super elevation on all route types. The Chief Engineer may approve justifications to match existing non-compliant cross slope based on an approved risk-based analysis considering cost, ROW considerations, etc. Where adjustment is warranted, provide correction Information within the project.
Clear Zone	Not a required consideration - outside the purview of preventative maintenance.	Not a required consideration - outside the purview of preventative maintenance.	Not a required consideration - outside the purview of preventative maintenance.

Pavement Preservation Policy Matrix (continued)

	Preventative Maintenance 1 (PM 1)	Preventative Maintenance 2 (PM 2)	Minor Rehabilitation (MR)
Pavement Width	Not a required consideration - outside the purview of preventative maintenance.	Not a required consideration - outside the purview of preventative maintenance.	All efforts shall be made to facilitate a 28-ft. roadway width when physically possible. (See Note 1}
Other Roadway Geometries	Not a required consideration - outside the purview of preventative maintenance.	Not a required consideration - outside the purview of preventative maintenance.	Not a required consideration - outside the purview of preventative maintenance.
Bridge Rails and Guardrail to Bridge Rail Connections	Not a required consideration - outside the purview of preventative maintenance.	On Interstate routes, guardrail to bridge rail connections that are not present or are not compliant with NCHRP 350 shall be replaced or installed with MASH 2016 compliant connections. (See Note 2) On non-Interstate NHS routes, guardrail to bridge rail connections that are not present or are not compliant with NCHRP 350 shall be replaced or installed with MASH 2016 compliant connections and funded by alternative sources. Should alternative funding sources not be available it is permissible to utilize the pavement preservation safety funding. (See Note 1 and 2) Bridge rail improvements are not a required consideration - outside the purview of preventative maintenance.	On all route types, guardrail to bridge rail connections that are not present or are not compliant with NCHRP 350 shall be replaced or installed with MASH 2016 compliant connections. (See Note 2) Bridge rails on NHS routes that are not compliant with NCHRP 350 shall be retrofitted to MASH 2016 compliance except where retrofitting is technically infeasible (e.g., widening of the bridge). (See Note 2)

Pavement Preservation Policy Matrix (continued)

	Preventative Maintenance 1 (PM 1)	Preventative Maintenance 2 (PM 2)	Minor Rehabilitation (MR)
Guardrail End Treatments	Safety items are not a required consideration outside the purview of preventative maintenance with the following exceptions: On all route types, undamaged guardrail approach end treatments that are not compliant with NCHRP 350 should be replaced by MASH 2016 compliant devices. (See Note 1 & 2) On all route types, MASH 2016 replacement of damaged NCHRP 350 compliant guardrail approach end treatments should be addressed by appropriate alternative funding other than HSIP or Pavement Preservation Project funding. (See Note 2 and 3)	On all route types, undamaged guardrail approach end treatments that are not compliant with NCHRP 350 should be replaced by MASH 2016 compliant devices. (See Note 1 and 2) On all route types, replacement or repairs to damaged NCHRP 350 compliant guardrail approach end treatments should be addressed by the Pavement Preservation Project funding or other appropriate alternative funding. On Interstate preservation projects, Pavement Preservation Project funding for the replacements or repairs must be prescribed by the IM Scope Review Letter. (See Note 2 and 3)	On all route types, undamaged guardrail approach end treatments that are not compliant with NCHRP 350 should be replaced by MASH 2016 compliant devices. (See Note 1 and 2) On all route types, replacement or repairs to damaged NCHRP 350 compliant guardrail approach end treatments should be addressed by the Pavement Preservation Project funding or other appropriate alternative funding. On Interstate preservation projects, Pavement Preservation Project funding for the replacements or repairs must be prescribed by the IM Scope Review Letter. (See Note 2 and 3)

Pavement Preservation Policy Matrix (continued)

	Preventative Maintenance 1 (PM 1)	Preventative Maintenance 2 (PM 2)	Minor Rehabilitation (MR)
Guardrail	Not a required consideration - outside the purview of preventative maintenance with the following exception: On all route types, guardrail that contains steel blackouts and/or does not meet the height requirement of the latest ALDOT adopted Roadside Design Guide edition should be replaced or reset. (See Note 1)	Not a required consideration - outside the purview of preventative maintenance with the following exception: On all route types, guardrail that contains steel blackouts and/or does not meet the height requirement of the latest ALDOT adopted Roadside Design Guide edition should be replaced or reset. (See Note 1)	Undamaged guardrail, on any route type, that meets latest adopted Roadside Design Guide height requirement, and no steel block outs are present, may be retained without adjustment and are considered outside the purview of preventative maintenance. On all route types, guardrail that contains steel blackouts and/or does not meet the height requirement of the latest ALDOT adopted Roadside Design Guide edition should be replaced or reset. (See Note 1) On non-Interstate routes, repair to damaged guardrail that is compliant with the latest adopted Roadside Design Guide height requirement and contains no steel block outs should be included in the Pavement Preservation Project. On Interstate projects, repairs to damaged guardrail must be prescribed by the IM Scope Review Letter. (See note 3)

Pavement Preservation Policy Matrix (continued)

	Preventative Maintenance 1 (PM 1)	Preventative Maintenance 2 (PM 2)	Minor Rehabilitation (MR)
Flexible Pavement Selection of Treatments	• Crack Filling and Sealing • Fog Seal • Scrub Seal • Chip Seal • Double Surface Treatment • Triple Surface Treatment • Slurry Seal • Micro-surfacing • Surface Sealing • High Friction Surface Treatment • Thin lift Asphalt Concrete Layer (not to exceed 110 lbs./sy.) • Safety Layer • Cape Seals	• PM 1 eligible treatments • Asphalt Concrete pavement should not exceed 2.0" in total thickness (excluding any safety layer).	• PM 1 and PM 2 eligible treatments • Adjustment layer (as needed for cross-slope and/or superelevation correction) • The combination of Asphalt Concrete binder and wearing surface layers should not exceed 5 inches in total thickness (excluding any safety layer or adjustment layers).
Flexible Pavement Milling	Single layer of any existing safety surface may be milled. Micro milling is required for milling depths of 1.0" or less. Milling of the safety layer may extend into the wearing layer between 0.25" and 0.50" (maximum) to scarify the surface and to ensure that no remnant "scabsn remain. If **a safety** layer is not present a milling depth of 1.0" or less is acceptable to remove the oxidized surface and/or existing traffic striping or markings that could create conflicts with selected treatments.	Establish a depth of milling that is sufficient to remove the oxidized and deteriorated wearing surface layer. Typical milling depths will be determined based on crack depth and other pavement condition data and should not exceed 2.0" in depth (excluding any safety layer).	Establish a depth of milling that is sufficient to remove the oxidized and deteriorated layer(s) of pavement. Typical milling depths will be determined based on crack depth and other pavement condition data and should not exceed 5.0" in depth (including any safety layer).

Pavement Preservation Policy Matrix (continued)

	Preventative Maintenance 1 (PM 1)	Preventative Maintenance 2 (PM 2)	Minor Rehabilitation (MR)
Rigid Pavement Selection of Treatments	• Diamond Grinding • Diamond Grooving • Crack Sealing or Filling • Joint Repair (Clean and Sealing Joints) • Pavement Patching limited to the repair of minor pavement surface defects. • Spall Repair- limited to the following: o Repair of minor pavement edge breaks, o Minor corner breaks that will not involve the repair of the pavement joint, o Minor breaks along the pavement joint. • Surface Sealing • High Friction Surface Treatment • Safety Layer **Note:** Spall Repair may be performed with partial width and length repairs.	• PM 1 eligible treatments • Slab Undersealing, Stabilization or Lifting. • Partial Slab Replacement (full width/full depth/partial length) • < 1% Full Slab Replacement of the high traffic lane	• PM 1 and PM 2 eligible treatments • < 5% of Full Slab Replacement of the high traffic lane • Asphalt Concrete Pavement
Rigid Pavement Grinding/Grooving	For the restoration of frictional properties or ride characteristics of the pavement surface.	For the restoration of frictional properties or ride characteristics of the pavement surface.	For the restoration of frictional properties or ride characteristics of the pavement surface.
Rigid Pavement Overlays	• Safety layer	• Safety layer	• Safety layer • Asphalt Concrete Pavement

Appendix H: B Codes

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B-Code	Description	Work Types
B1	Deck Cleaning	Preservation
B2	Curb/Rail Fence Repair	Maintenance
B3	Joint Seal Installation /Repair	Preservation
B4	Joint Structurl Repair	Preservation
B5	Minor Deck Repair - Steel	Preservation
B6	Minor Deck Repair - Concrete	Preservation
B7	Minor Deck Repair - Timber	Preservation
B8	Major Deck Repair - Steel	Preservation
B9	Major Deck Repair - Concrete	Preservation
B10	Major Deck Repair - Timber	Preservation
B11	Minor Superstructure Member Repair - Steel	Preservation
B12	Minor Superstructure Member Repair - Concrete	Preservation
B13	Minor Superstructure Member Repair - Timber	Preservation
B14	Major Superstructure Member Repair - Steel	Preservation
B15	Major Superstructure Member Repair - Concrete	Preservation
B16	Major Superstructure Member Repair - Timber	Preservation
B17	Minor Substructure Member Repair - Steel	Preservation
B18	Minor Substructure Member Repair - Concrete	Preservation
B19	Minor Substructure Member Repair - Timber	Preservation
B20	Major Substructure Repair - Steel	Preservation
B21	Major Substructure Repair - Concrete	Preservation
B22	Major Substructure Repair - Timber	Preservation
B23	Bridge Painting - Spot	Preservation
B24	Bridge Painting - Partial	Preservation
B25	Bridge Painting - Complete	Preservation
B26	Bridge Culvert Cleaning	Preservation
B27	Bridge Culvert Repair	Preservation
B28	Light & Navigation - Light Repair	Maintenance
B29	Drift Removal	Preservation
B30	Slope & Shore Protection Repair	Preservation
B32	Vandalism Repair	Maintenance
B33	Moveable Span Maintenance	Preservation
B34	Moveable Span Operations	Maintenance
B35	Tunnel Maintenance	Preservation
B36	Tunnel Operations	Maintenance
B37	Bridge Inspection	Preservation
B38	Other Structure Maintenance	Maintenance
B41	Drain/Joint Cleaning	Preservation
B42	Bent Cap. Beams, & Beam Seats	Preservation
B43	Bearing Devices & Assem. - Instal., Maint, Repair	Preservation
B46	Vegetation Control	Preservation
B47	Beaver Control	Preservation
B99	Bridge Maintenance Overhead	Maintenance

References

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[i] These targets relate to ALDOT's Pavement Condition Rating (PCR) metric and are different from the targets ALDOT will adopt using the metrics specified in 23 CFR Part 490: National Performance Management Measures; Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program.
[ii] The shortfall is the difference between the goal-specific investment scenarios and current funding levels for pavement and bridge. This is based on the "Target" scenario for pavement and "Manage at 3%" scenario for bridges.
[iii] 23 U.S.C. 101(a)(2)
[iv] Federal legislation: Moving Ahead for Progress in the 21st Century (July 6, 2012).
[v] http://www.dot.state.al.us/adweb/MissionStatement.htm
[vi] *Highway Performance Field Manual*, FHWA, December 2016.
[vii] For the purposes of the pavement investment scenarios, a slightly updated dataset (from December 2017) was used because it became available. The numbers are very similar. The lane-mile total for the December dataset includes 29,404, which is 890 more lane-miles than the data from 2016, most of which are on Interstate roads.
[viii] Federal Highway Administration. (2015). National Performance Measures: Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program. Retrieved from: https://www.federalregister.gov/articles/2015/01/05/2014-30085/national-performance-management-measures-assessing-pavement-condition-for-the-national-highway#h-59
[ix] According to the FHWA, a bridge is "structurally deficient" if the load-carrying elements are in diminished condition due to deterioration and/or damage. A bridge may also be structurally deficient if the waterway opening is "extremely insufficient" and causes "intolerable traffic interruption." Structurally deficient bridges are not unsafe but could require traffic limitations.
[x] http://nationalbridges.com/nbiDesc.html
[xi] http://www.regulations.gov/#!documentDetail;D=FHWA-2013-0052-0002
[xii] http://www.fhwa.dot.gov/map21/guidance/guideeldnhsb.cfm
[xiii] http://www.dot.state.al.us/csweb/CPMSCEMS.htm
[xiv] Dye Management Group. (2013). Best Practices for Highway Asset Management.
[xv] CitiTech Systems Inc. (2014). User Spotlight/ Case Study: Alabama Department of Transportation.
[xvi] http://www.fhwa.dot.gov/asset/faq.cfm#Implement
[xvii] http://www.fhwa.dot.gov/asset/faq.cfm#Implement
[xviii] http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_545.pdf
[xix] Fillastre, Chris, PMS Life-Cycle Cost, LADOTD, Baton Rouge, LA, 2012
[xx] FHWA, Pavement Management Systems - The Washington State Experience, Transportation Asset Management Case Studies, FHWA, Washington, DC, 2008.
[xxi] http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_551.pdf
[xxii] https://www.federalregister.gov/articles/2015/02/20/2015-03167/asset-management-plan
[xxiii] FHWA. 2013. "Risk-Based Transportation Asset Management: Building Resilience into Transportation Assets."
[xxiv] FHWA. 2012. FHWA International Practices for Program Development and Project Delivery.
[xxv] http://international.fhwa.dot.gov/scan/12029/12029_report.pdf
[xxvi] Implementation of AASHTO's Bridge Management System (BrM) version 5.2.3 (scheduled for 2016) should help address the risk for bridges.
[xxvii] Resurfacing is usually found within the Routine Maintenance budget items. It is separated within this exhibit to identify the federal/state funding split.
[xxviii] Source: (2012). FHWA. A Guide to Federal-Aid Programs and Projects. http://www.fhwa.dot.gov/federalaid/projects.pdf
[xxix] Source: (2009-2013). Table VM-3, Highway Statistics Series Publication, FHWA, Office of Highway Policy Information (OHPI).
[xxx] Source: (2015). ALDOT Bureau of Finance & Audits.
[xxxi] Source: (2009-2013). FHWA, Office of Highway Policy Information (OHPI). Highway Statistics Series Publication, Table VM-3.

[xxxii] Source: (No date). Alabama Department of Transportation. “State of Alabama Transportation Infrastructure Funding” presentation.
[xxxiii] Source: (2014). Public Affairs Research Council of Alabama. “Alabama Gasoline Tax Revenue Continues to Decline.”
[xxxiv] http://www.al.com/news/mobile/index.ssf/2015/11/alabama_gov_robert_bentley_pus.html, http://www.bizjournals.com/birmingham/news/2016/06/20/after-i-22-focus-turns-to-funding-for-alabama.html, http://www.al.com/news/index.ssf/2017/04/gas_tax_is_dead_house_pulls_bi.html
[xxxv] Source: (April 30, 2015). ASCE Blog. “Majority of Americans Say Yes to Gas Tax Increase to Fund Transportation.” http://www.infrastructurereportcard.org/asce-news/majority-of-americans-say-yes-to-gas-tax-increase-to-fund-transportation/
[xxxvi] InflationData.com. Cumulative Inflation Calculator. https://inflationdata.com/Inflation/Inflation_Calculators/Cumulative_Inflation_Calculator.aspx
[xxxvii] https://www.transportation.gov/fastact/
[xxxviii] The FAST Act will provide every state a 5.1 percent increase in formula funds in FY 2016. This is followed by annual increases ranging from 2.1 percent in FY 2017 to 2.4 percent in FY2020. http://www.artba.org/wp-content/uploads/2014/03/FASTAct_Publication.pdf
[xxxix] ALDOT’s pavement condition ratings are described in greater detail in Chapter 2, ALDOT Asset Inventory and Condition.
[xl] "PCR Prediction Exercise," Bureau of Materials & Tests, Pavement Management Section, Alabama Department of Transportation, February 13, 2015
[xli] Pavement costs averaged from historical resurfacing projects from years 2012-2017.
[xlii] All NHS routes will be collected and maintained by ALDOT in the future, so the use of HPMS should only be necessary for this TAMP.
[xliii] These targets relate to ALDOT’s Pavement Condition Rating (PCR) metric and are different from the targets ALDOT will adopt using the metrics specified in 23 CFR Part 490: National Performance Management Measures; Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program.
[xliv] The shortfall is the difference between the goal-specific investment scenarios and current funding levels for pavement and bridge. This is based on the “Target” scenario for pavement and “Manage at 3%” scenario for bridges.