Office of the Auditor General
Performance Audit Report

Measurement of State Highway Pavement Conditions

Michigan Department of Transportation

May 2017

State of Michigan Auditor General
Doug A. Ringler, CPA, CIA

591-0300-16

The auditor general shall conduct post audits of financial transactions and accounts of the state and of all branches, departments, offices, boards, commissions, agencies, authorities and institutions of the state established by this constitution or by law, and performance post audits thereof.

Article IV, Section 53 of the Michigan Constitution

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Report Summary

Performance Audit
Measurement of State Highway Pavement Conditions
Michigan Department of Transportation (MDOT)

Report Number:
591-0300-16

Released:
May 2017

Pavement condition data is necessary to help determine the State's preventive maintenance, rehabilitation, and reconstruction needs and costs for Michigan's highway system; to project future pavement conditions; and to identify the impacts of treatments. The pavement condition of Michigan's 122,310 miles of public roads is measured by MDOT and the Transportation Asset Management Council (TAMC). MDOT's responsibility is for the 9,668-mile State trunkline system, as well as sample segments requested by the Federal Highway Administration. TAMC oversees a comprehensive unified data collection of pavement condition at the State, county, and city levels.

Audit Objective	Conclusion
Objective: To assess the effectiveness of MDOT's and TAMC's coordinated efforts to measure State highway pavement conditions.	Effective

Findings Related to This Audit Objective	Material Condition	Reportable Condition	Agency Preliminary Response
None reported.	Not applicable.		

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May 9, 2017

Mr. Todd Wyett, Chair
State Transportation Commission
and
Kirk T. Steudle, PE, Director
Michigan Department of Transportation
Murray D. Van Wagoner Building
Lansing, Michigan

Dear Mr. Wyett and Mr. Steudle:

I am pleased to provide this performance audit report on the Measurement of State Highway Pavement Conditions, Michigan Department of Transportation.

As you are aware, when our initial review does not identify sufficient risk to warrant completing the audit, we issue a Preliminary Survey Summary. For this project, we went forward with the audit because of the public's interest in road conditions, because of recent changes to the funding mechanisms for roads, and to reflect the status of findings we reported in our prior audit from March 2012.

We appreciate the courtesy and cooperation extended to us during this audit.

Sincerely,

Doug Ringler

Doug Ringler
Auditor General

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AUDIT OBJECTIVES, CONCLUSIONS, FINDINGS, AND OBSERVATIONS

COORDINATED EFFORTS TO MEASURE STATE HIGHWAY PAVEMENT CONDITIONS

BACKGROUND

The pavement condition of Michigan's 122,310 miles of public roads is measured by the Michigan Department of Transportation (MDOT) and the Transportation Asset Management Council (TAMC). MDOT's responsibility is for the 9,668-mile State trunkline system* as well as sample segments requested by the Highway Performance Monitoring System (HPMS) within the Federal Highway Administration (FHWA). MDOT submits pavement condition data to HPMS annually.

TAMC oversees a comprehensive unified data collection of pavement condition at the State, county, and city levels for both federal-aid eligible highways* and nonfederal-aid eligible roads. TAMC annually reports to the State Transportation Commission (STC) and the Legislature the condition of Michigan's roads. TAMC also reports pavement conditions through dashboards on its interactive Web site.

Michigan's pavement condition is measured using two different methods:

1. MDOT contracts with a vendor to collect pavement data, using various lasers, sensors, and cameras mounted on a vehicle that take measurements and photographs as the vehicle travels the roads. Items that are measured include: International Roughness Index* (IRI), rutting*, faulting*, cracking*, longitudinal grade,* transverse grade,* and roadway/pavement imagery. Also, the vendor records the GPS coordinates of the measurements and images collected.

2. TAMC uses Pavement Surface Evaluation and Rating* (PASER), which is a windshield survey performed by specially trained individuals who visually inspect and rate the pavement condition on a scale from 1 to 10, with 1 being poor and 10 being good. PASER measures rutting, faulting, and cracking.

The road condition data provided by the vendor and PASER data, to a lesser degree, are both used in design and decision-making processes regarding transportation projects, pavement warranties, development of transportation programs, and fulfillment of federal and State reporting requirements. The key road performance measure used by MDOT for the State trunkline system is remaining service life* (RSL). RSL is an estimate of the number of years until it is no longer cost effective to perform pavement preventive maintenance* on a pavement section. MDOT classifies pavement RSL into six different categories. For example, category I pavements have

** See glossary at end of report for definition.*

RSL values of 0 - 2 years, which MDOT identifies as poor. The performance measure of RSL and condition measures, such as PASER, IRI, rutting, and joint or crack faulting, are used collectively to help MDOT manage the State highway network.

AUDIT OBJECTIVE

To assess the effectiveness* of MDOT's and TAMC's coordinated efforts to measure State highway pavement conditions.

CONCLUSION

Effective.

FACTORS IMPACTING CONCLUSION

- MDOT had sufficient quality assurance* and quality control* procedures to ensure that pavement data collected by the vendor and TAMC provided complete, reliable, and timely measurement.
- MDOT's quality assurance and quality control procedures used for pavement measurement are those recommended by FHWA.
- MDOT ensured that 99% of State trunkline highways were measured every two years as required during fiscal years 2013 through 2016.
- Changes to RSL estimates from calendar year 2014 to 2015 in our random sample of road segments for each of MDOT's seven regions appeared reasonable.
- The RSL estimates are verified by region engineers who possess the greatest knowledge of the road conditions within their regions (see Exhibit #1).
- TAMC, using MDOT support staff, ensured that 97% of PASER raters that we tested obtained the required training before collecting pavement data.
- Our random sample of fiscal year 2014 through 2016 PASER-related time and expense reimbursements noted no significant discrepancies.
- Our testing of the MDOT vendor's key contract deliverables, vehicle calibration, and payments noted no exceptions.

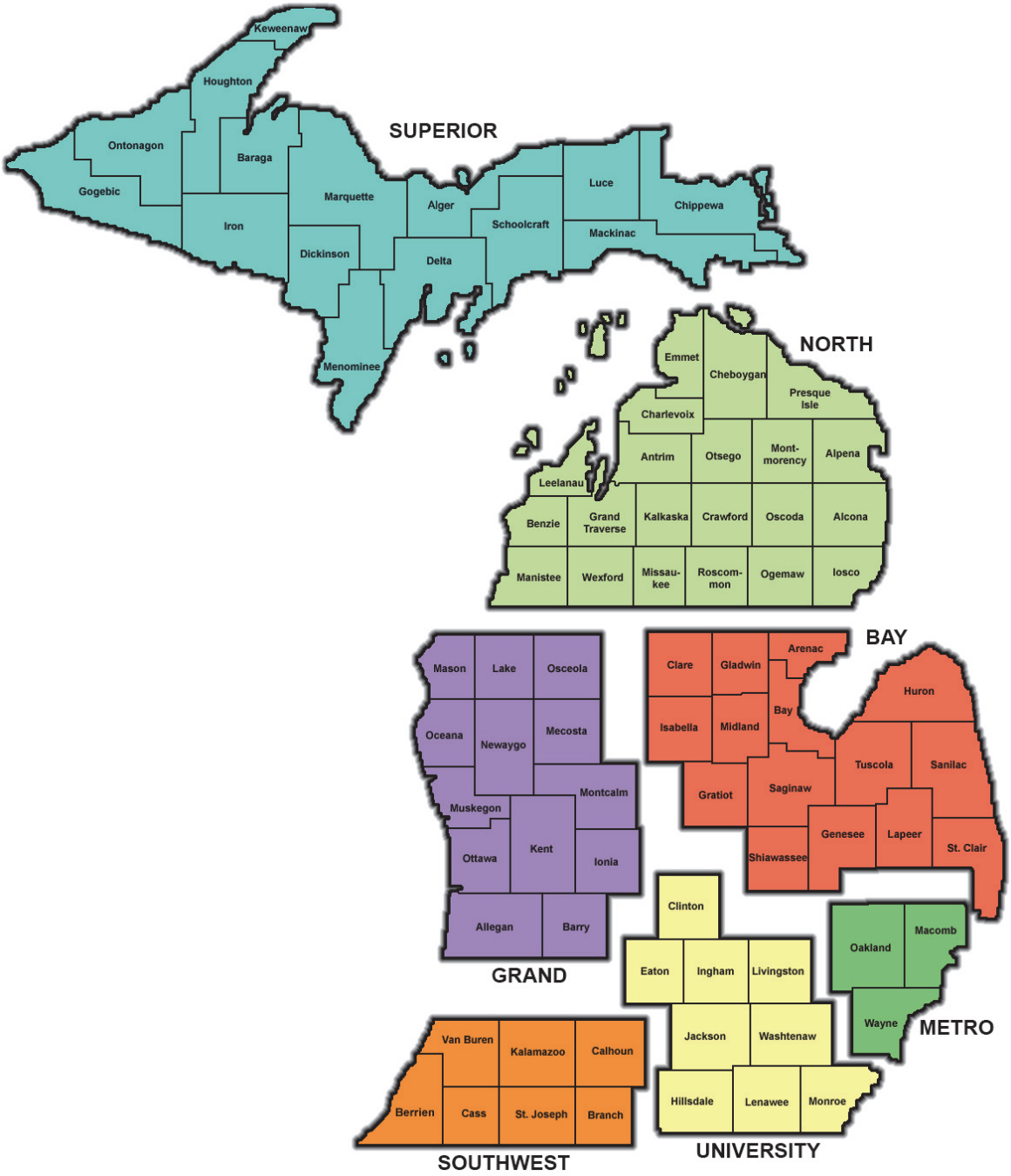
** See glossary at end of report for definition.*

SUPPLEMENTAL INFORMATION

UNAUDITED
Exhibit #1

MEASUREMENT OF STATE HIGHWAY PAVEMENT CONDITIONS
Michigan Department of Transportation

Map of MDOT Regions

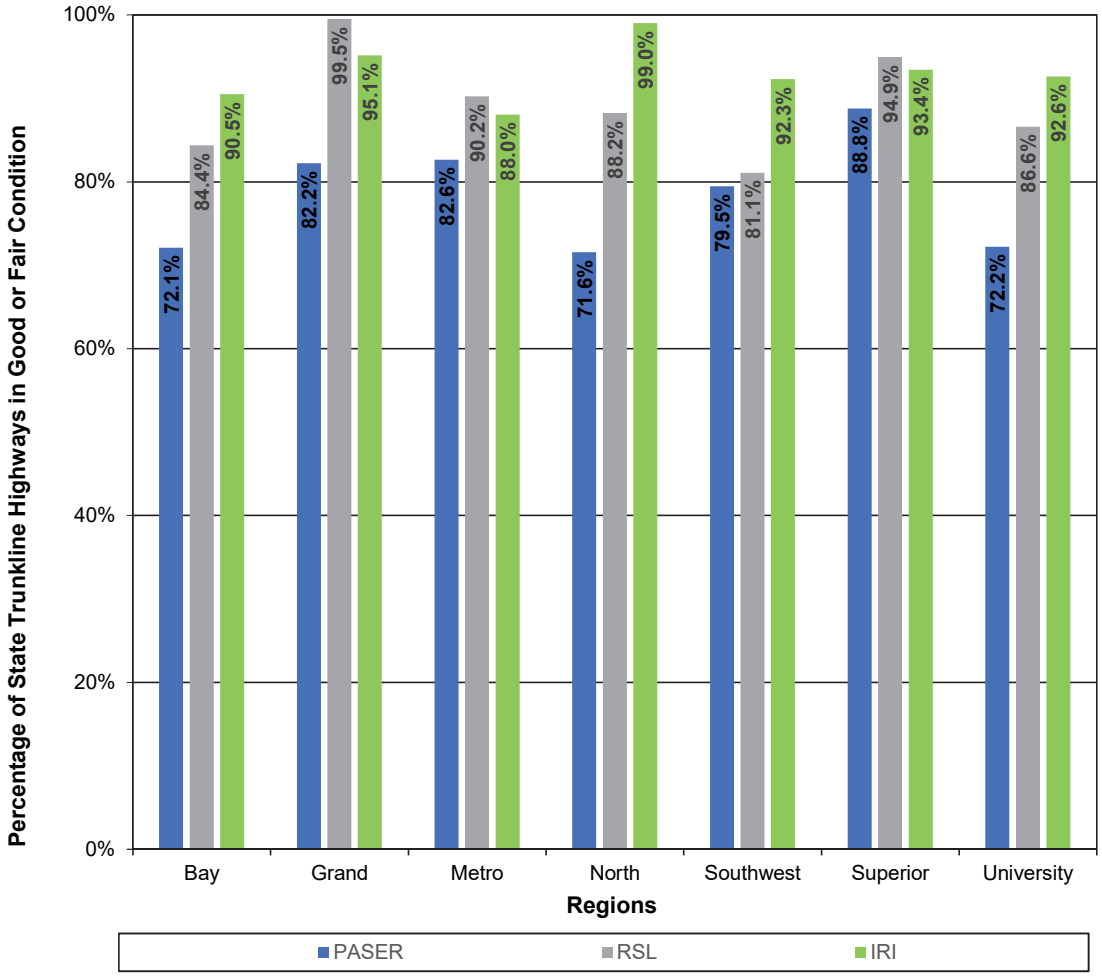


Source: The OAG created this map using MDOT information.

UNAUDITED
Exhibit #2

MEASUREMENT OF STATE HIGHWAY PAVEMENT CONDITIONS
Michigan Department of Transportation

Percentage of State Trunkline Highways Rated in Good or Fair Condition by
Comparison of Pavement Measurements
For Calendar Year 2015



This graph is a comparison of State trunkline highways by region, using three different pavement measurements, of the percentage of the State trunkline system pavements with good or fair ratings in calendar year 2015. The percentages characterize State trunkline highways, which are identified as Interstate, U.S.-numbered, and M-numbered highways. In most cases, the IRI measurement has the highest percentage of roads in good or fair condition, whereas the PASER rating typically shows the lowest percentage.

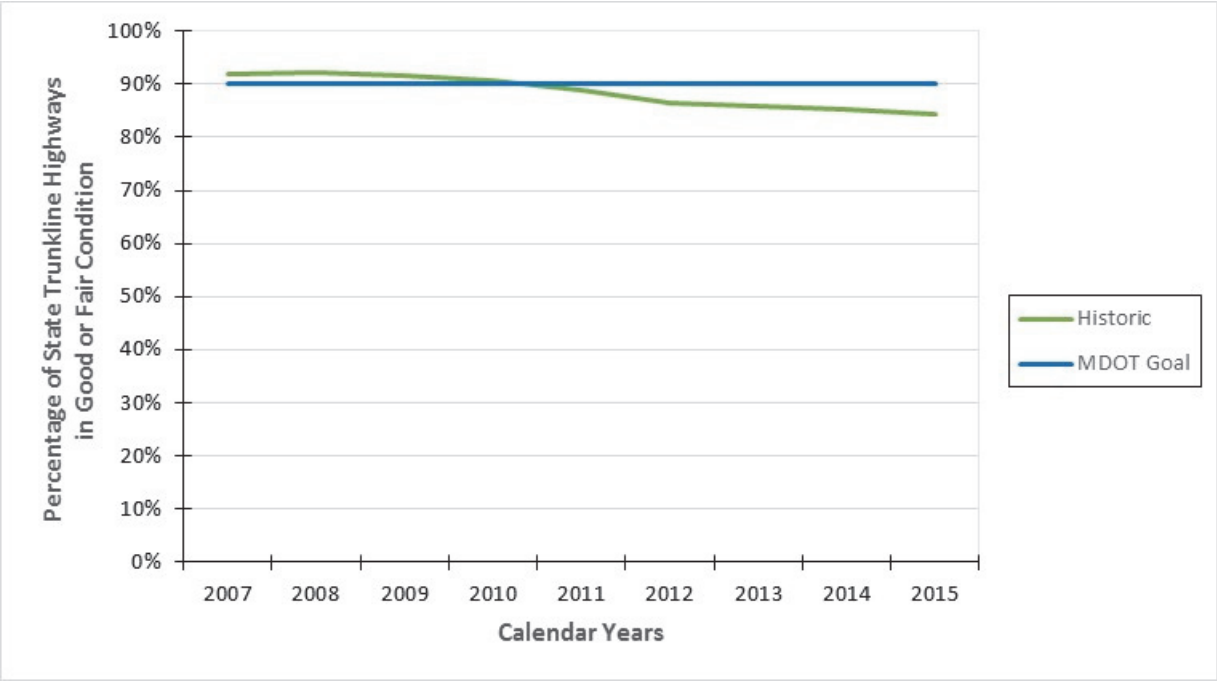
It is important to note that each of the three measurements uses a different range to signify "good" or "fair." For PASER, a rating between 5 and 10 means the road is in good or fair condition. RSL estimates between 3 and 7 years are categorized as roads in fair condition, whereas estimates greater than 7 years are categorized as good condition. IRI values from 0 to 94 inches per mile are categorized as good condition, whereas values from 95 to 170 inches per mile are categorized as fair condition.

Source: The OAG prepared this exhibit using data obtained from MDOT.

MEASUREMENT OF STATE HIGHWAY PAVEMENT CONDITIONS

Michigan Department of Transportation

Percentage of State Trunkline Highways in Good or Fair Condition by RSL Value
For Calendar Years 2007 Through 2015



This graph represents the percentage of State trunkline highways that are in good or fair condition using RSL values from 2007 through 2015. A road with an estimated poor RSL condition requires pavement rehabilitation* and reconstruction. A road with an estimated good or fair RSL condition requires preventive maintenance, which is a more cost-effective fix than rehabilitation or reconstruction.

Source: The OAG prepared this exhibit using data obtained from MDOT.

** See glossary at end of report for definition.*

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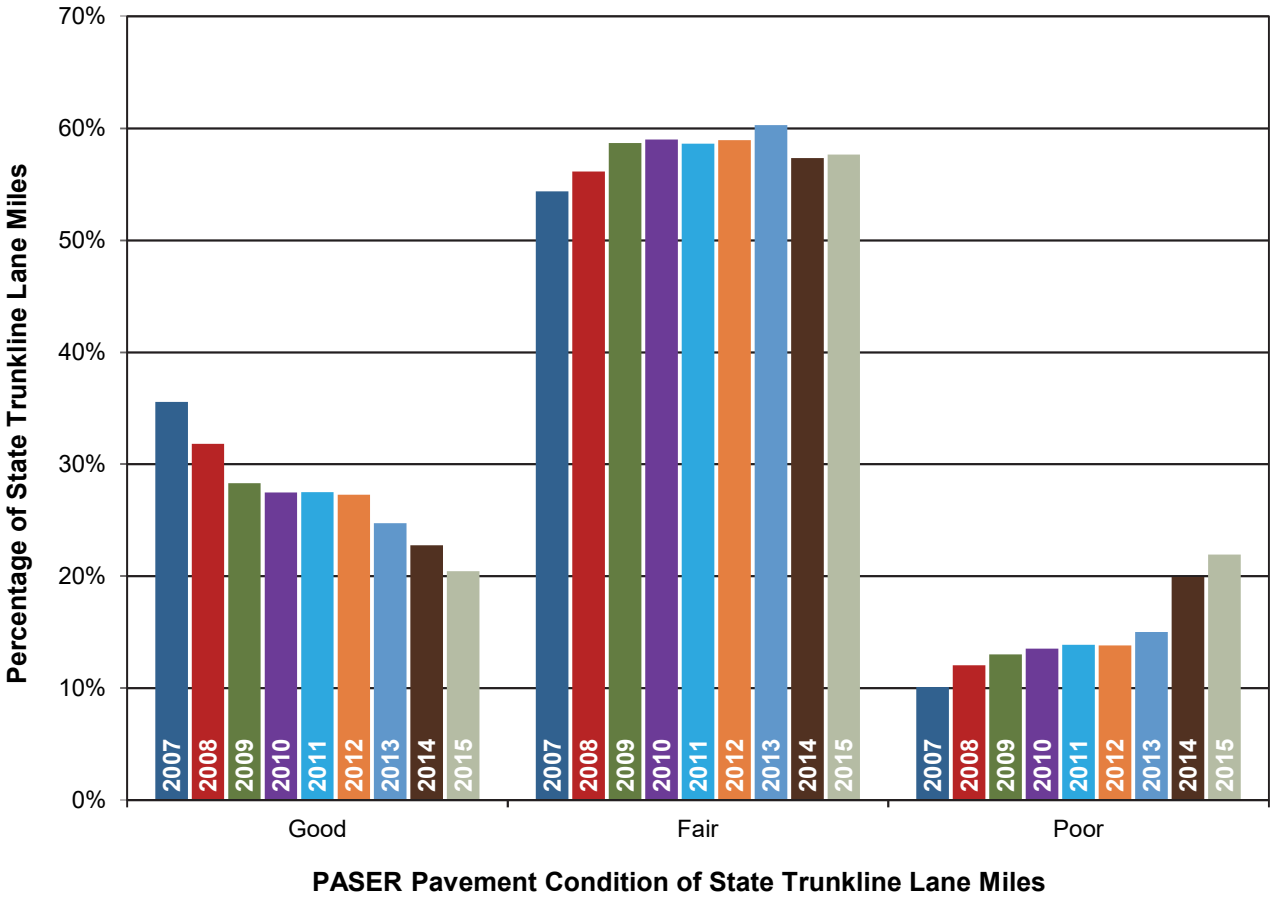
Exhibit #4

MEASUREMENT OF STATE HIGHWAY PAVEMENT CONDITIONS
Michigan Department of Transportation

PASER Pavement Condition of State Trunkline Lane Miles
For Calendar Years 2007 Through 2015



Since 2007, the number of State trunkline lane miles in good condition has steadily decreased.

Source: The OAG prepared this exhibit using PASER data obtained from TAMC's Michigan Transportation Reporting Portal Web site.

AGENCY DESCRIPTION

MDOT was organized under Public Act 380 of 1965 (Sections 16.450 - 16.458 of the *Michigan Compiled Laws*). MDOT is governed by the STC, which is made up of six members who are appointed by the Governor with the advice and consent of the Senate.

Public Act 51 of 1951 declared MDOT responsible for maintaining the State highway system, commonly known as the State trunkline system, and for allocating and distributing federal aid to local road agencies. MDOT has direct jurisdiction over Michigan's 9,668-mile State trunkline system, which is composed of all Interstate, U.S.-numbered, and M-numbered highways. Although the State trunkline system accounts for 8% of Michigan's 122,310-mile road network, it carries over 53% of all traffic and 66% of commercial truck traffic.

MDOT is responsible for measuring the pavement conditions of the State trunkline system and annually furnishing FHWA with highway system performance data of requested sample segments for all roads open to the public, regardless of ownership. Measurement of the State trunkline system is necessary to help determine pavement preventive maintenance, rehabilitation*, and reconstruction needs and costs; to project future pavement conditions; and to identify the impacts of treatments. Also, such data is used to help identify the most cost-effective and optimum maintenance and rehabilitation treatments for the State trunkline system.

Public Act 499 of 2002 (Section 247.659a of the *Michigan Compiled Laws*) established TAMC within the STC as a 10-member body charged with advising the STC on a Statewide asset management strategy and implementing a pavement management system for each mile of roadway on the State's federal-aid eligible highway system. This pavement management system shall attempt to ensure that a disproportionate share of pavement shall not become due for replacement or major repair at the same time. MDOT is responsible for providing administrative and technical assistance to TAMC.

MDOT administers pavement measurement operations through the Bureau of Transportation Planning, 7 region offices, and 25 transportation service centers located throughout Michigan. The Bureau's total expenditures in fiscal year 2016 were $22.4 million, which included pavement measurement costs of $1.2 million. TAMC expenditures for administrative costs in fiscal year 2016 were $1.5 million. The 2016 MDOT Annual Report documents the value of roads as $11.8 billion.

** See glossary at end of report for definition.*

AUDIT SCOPE, METHODOLOGY, AND OTHER INFORMATION

AUDIT SCOPE

To examine the activities and records related to Michigan's highway pavement condition measurement performed and administered by MDOT. We conducted this performance audit* in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our conclusion based on our audit objective. We believe that the evidence obtained provides a reasonable basis for our conclusion based on our audit objective.

PERIOD

Our audit procedures, which included a preliminary survey, audit fieldwork, report preparation, and quality assurance, generally covered October 1, 2013 through September 30, 2016.

METHODOLOGY

We conducted a preliminary survey to gain an understanding of MDOT's role in highway pavement condition measurement operations and activities to establish our audit objective and methodology. As part of our preliminary survey, we:

- Interviewed MDOT staff and analyzed applicable information to obtain an understanding of the pavement condition measurement methods used by MDOT and TAMC.
- Reviewed policies and procedures for measuring pavement conditions, including relevant State and federal laws.
- Analyzed PASER data for fiscal years 2014 and 2015 to assess consistency of the ratings and to determine that the quality control process was in place.
- Analyzed MDOT's vendor-collected data for fiscal years 2014, 2015, and 2016.
- Reviewed MDOT's contract with the vendor to determine expectations and deliverables.
- Reviewed two judgmentally selected vendor weekly verification reports of vehicle calibration for road surface testing. Because we judgmentally selected the two reports, we could not project our results to the entire population.

** See glossary at end of report for definition.*

OBJECTIVE

To assess the effectiveness of MDOT's and TAMC's coordinated efforts to measure State highway pavement conditions.

To accomplish this objective, we:

- Tested a judgmental selection of MDOT's quality assurance procedures for pavement condition data and observed quality assurance checks to determine if controls were in place and operating effectively.
- Compared calendar year 2015 RSL estimates for road segments with 2014 estimates for reasonableness.
- Reviewed a random sample of 10 invoices for PASER time and expense reimbursements to determine the propriety of the billings.
- Reviewed PASER rater training records for 79 judgmentally selected fiscal year 2014 and 2015 raters to ensure that the raters received the required training prior to commencing pavement condition data collection.
- Reviewed judgmentally selected contract deliverables for MDOT's vendor for compliance with the terms and agreements of the contract.
- Verified that the amount paid to the vendor was in compliance with the contract.
- Applied analytical procedures to the vendor's measurement data completed during fiscal years 2013 through 2016 to assess whether the frequency of pavement condition measurement complied with FHWA.

We selected our random samples to enable us to project the results to the respective populations. We could not project our judgmental selections to the respective populations.

CONCLUSIONS

We base our conclusions on our audit efforts and any resulting material conditions* or reportable conditions*.

When selecting activities or programs for audit, we direct our efforts based on risk and opportunities to improve State government operations. Consequently, we prepare our performance audit reports on an exception basis.

AGENCY RESPONSES

Not applicable.

** See glossary at end of report for definition.*

PRIOR AUDIT FOLLOW-UP

Following is the status of the reported findings from our March 2012 performance audit of the Measurement of State Highway Pavement Conditions, Michigan Department of Transportation (591-0300-11):

Prior Audit Finding Number	Topic Area	Current Status	Current Finding Number
1	Quality Control and Quality Assurance of PASER Data Collection	Complied	Not applicable
2	PASER Raters and Reimbursements	Complied	Not applicable
3	Remaining Service Life (RSL)	Complied	Not applicable
4	Coordination of Data Collection Methods	Complied	Not applicable

SUPPLEMENTAL INFORMATION

Our audit report includes supplemental information that relates to our audit objectives. Our audit was not directed toward expressing an opinion on this information.

GLOSSARY OF ABBREVIATIONS AND TERMS

cracking	A fracture in the pavement surface not necessarily extending through the entire thickness of the pavement. Cracks generally develop after initial construction of the pavement and may be caused by thermal effects; excess loadings; or excess deflections, which are movements in or under the pavement.
effectiveness	Success in achieving mission and goals.
faulting	Differential vertical displacement of a slab or other member adjacent to a joint or crack. Faulting commonly occurs at transverse joints of concrete pavements that do not have adequate load transfer.
federal-aid eligible highway	Those highways defined by federal regulations as eligible for federal assistance.
FHWA	Federal Highway Administration.
GPS	Global Positioning System.
HPMS	Highway Performance Monitoring System.
International Roughness Index (IRI)	A standardized mathematical function of a pavement section's longitudinal profile that is used to summarize surface roughness in relation to overall ride quality.
longitudinal grade (profile)	A line representing elevations of the pavement surface along or parallel to the centerline.
material condition	A matter that, in the auditor's judgment, is more severe than a reportable condition and could impair the ability of management to operate a program in an effective and efficient manner and/or could adversely affect the judgment of an interested person concerning the effectiveness and efficiency of the program.
MDOT	Michigan Department of Transportation.
OAG	Office of the Auditor General.
pavement preventive maintenance	Planned strategy of cost-effective treatments to an existing roadway system to extend the life of the pavement, slow future

	deterioration, and maintain or improve the functional condition of the system without increasing the structural capacity.
pavement rehabilitation	Structural enhancements that extend the service life of an existing pavement and/or improve its load carrying capability. Techniques include restoration treatments and structural overlays.
Pavement Surface Evaluation and Rating (PASER)	A manual visual survey of the condition of the surface of the road developed by the University of Wisconsin and performed by people directly involved in the observation that rates the condition of various types of pavement distresses on a scale of 1 to 10 without the benefit of automated equipment.
performance audit	An audit that provides findings or conclusions based on an evaluation of sufficient, appropriate evidence against criteria. Performance audits provide objective analysis to assist management and those charged with governance and oversight in using the information to improve program performance and operations, reduce costs, facilitate decision-making by parties with responsibility to oversee or initiate corrective action, and contribute to public accountability.
quality assurance	Actions necessary to verify that pavement data meets quality requirements before it is accepted and used to support pavement management decisions.
quality control	Actions necessary to control the quality of pavement data collection activities.
remaining service life (RSL)	An estimate of the remaining time, in years, until a pavement's most cost-effective treatment is either major rehabilitation or reconstruction.
reportable condition	A matter that, in the auditor's judgment, is less severe than a material condition and falls within any of the following categories: an opportunity for improvement within the context of the audit objectives; a deficiency in internal control that is significant within the context of the audit objectives; all instances of fraud; illegal acts unless they are inconsequential within the context of the audit objectives; significant violations of provisions of contracts or grant agreements; and significant abuse that has occurred or is likely to have occurred.

rutting	Longitudinal surface depressions in the wheel path of a hot mix asphalt pavement, caused by plastic movement of the hot mix asphalt, inadequate compaction, or abrasion from studded tires.
State trunkline system	Michigan's State highway system, which is composed of all Interstate, U.S.-numbered, and M-numbered highways.
STC	State Transportation Commission.
TAMC	Transportation Asset Management Council.
transverse grade (cross section)	A line perpendicular to a road's centerline representing elevations of the pavement surface.

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