MDOT

MICHIGAN DEPARTMENT OF TRANSPORTATION

State Long-Range Transportation Plan 2005-2030

Conditions and Performance Technical Report

Prepared by
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With assistance from

ENGINEERS PLANNERS ECONOMISTS
Wilbur Smith Associates

MI Transportation
MICHIGAN LONG RANGE TRANSPORTATION PLAN

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Executive Summary

To identify issues and needs facing Michigan's transportation system within the context of *MI Transportation Plan*, this *Conditions and Performance Technical Report* presents performance trends and indicators based on the specific information in the other technical reports and other available data. Our multi-modal transportation system is crucial to our state economy and to our competitive position. While MDOT does not own all of these assets, it has direct jurisdiction over some of the assets and provides funding to other government agencies, which have assets under their own jurisdictions. MDOT relies on its federal, local, and private sector partners to monitor changes it cannot directly control. This report draws heavily on the basic structure and language of the national *Conditions and Performance Technical Report*. The objectives of the report are:

(1) Define the roles of different components of Michigan's transportation system in ways consistent with the *Integration Technical Report* of *MI Transportation Plan*.

(2) Bring together information from other technical reports and sources regarding the existing and emerging conditions on Michigan's overall transportation system for which MDOT has jurisdiction over, provides funding for, or regulates.

(3) Offer an assessment of the current and expected operational and safety performance of highway, transit, and non-motorized components of Michigan's transportation system at today's funding levels.

(4) Provide a clear, quantitative assessment of existing and emerging deficiencies on the system that may be addressed through the *Revenue Gap and Investment Packages Report* of *MI Transportation Plan.*

The role of highways in Michigan is to support both personal mobility and freight movement. The freedom accorded by autos and highways as a primary mode of transportation to most activities accounts in large part for the popularity of automobile travel in Michigan. However, Michigan's roadways also provide personal mobility by providing the underlying infrastructure to support transit and intercity bus routes, as well as access to cargo and passenger airports, freight rail depots, passenger rail stations, park-and- ride lots, transit, and intercity bus facilities. Highways are also a key conduit for truck freight movement in Michigan, accounting for 70 percent of total freight transport by weight (and 86 percent by value) in 2005.

Transit also plays a vital role in enhancing productivity and the quality of life in Michigan. It provides basic mobility and expanded opportunities to people without the use of a car; it provides broader transportation choices to people with cars and has the potential to reduce pressures on roadway capacity, reducing travel times and road congestion in major transportation corridors. Transit also facilitates economic growth and development and supports environmentally sustainable, safe communities.

Other modes such as aviation, intercity passenger services, and non-motorized services also play important roles in the safety, mobility, choices, and quality of life supported by Michigan's transportation system.

The National Functional Classification system is useful for understanding the conditions and performance of roadway facilities. The overarching principle of functional classification is interconnectedness of the system. Each segment of road, other than the lowest classification (local), should connect at both ends only to another segment functionally classified at an equal or higher level. The National Functional Classification system organizes Michigan's roadways into arterials, collectors, and local roads. The table below shows the distribution of Michigan's trunkline system by different National Functional Classifications.

Trunkline System	*National Functional Classification (NFC)*	*Route Miles*	*% of Total*	*Pavement Miles*	*% of Total*	*Lane Miles*	*% of Total*
Urban	Principal Arterial-Interstate	634.4	6.5%	1,268.9	10.5%	3,444.6	12.5%
	Principal Arterial-Other Freeways	327.8	3.4%	655.0	5.4%	1,464.9	5.3%
	Principal Arterial-Others	1,115.6	11.5%	1,421.5	11.8%	4,457.3	16.2%
	Minor Arterial	516.7	5.3%	538.1	4.5%	1,344.0	4.9%
	Collector	9.4	0.1%	10.6	0.1%	21.1	0.1%
	Local	2.9	0.0%	2.9	0.0%	5.7	0.0%
Rural	Principal Arterial-Interstate	608.7	6.3%	1,217.4	10.1%	2,589.9	9.4%
	Principal Arterial-Others	2,584.4	26.7%	3,011.8	25.0%	6,236.6	22.6%
	Minor Arterial	3,430.5	35.4%	3,463.9	28.7%	7,047.9	25.6%
	Major Collector	454.0	4.7%	454.7	3.8%	924.0	3.4%
	Minor Collector	0.5	0.0%	0.5	0.0%	0.9	0.0%
	Local	10.2	0.1%	10.2	0.1%	20.4	0.1%
Statewide Trunkline		9,695.1	100.0%	12,055.3	100.0%	27,557.4	100.0%

Source: 2005 Highway Performance Monitoring System (HPMS)

Bridges are another critical element of Michigan's transportation system. They provide connections across natural barriers, bodies of water, and land features; they support freeway interchanges, the safe overpass or underpass between Michigan's roadways, and rail or other facilities; they also often provide important links in non-motorized and transit routes. As a peninsula state, separated from Canada by bodies of water, Michigan's bridges are especially important for both domestic and international transportation. The following table gives an inventory of Michigan's trunkline bridges, as well as non-trunkline bridge structures from *MI Transportation Plan Highway and Bridge Technical Report*.

Owner	*Number of Highway Structures*	*Square Footage in Millions*	*Percent of Total Square Footage*
MDOT Freeway	3,198	41.2	63%
MDOT Non-Freeway	1,215	7.9	12%
Local – County	5,608	11.5	18%
Local – Cities and Villages	790	4.7	7%
Total Highway	10,811	65.3	100%
Highway Bridges on Major Freeways			
I-75	568	10.3	15.7%
I-94	482	6.6	10.2%
I-96	363	4.7	7.2%
I-69	300	3.1	4.7%

Source: *MI Transportation Plan Highway and Bridge Technical Report*

System Conditions:

Maintaining the condition of Michigan's highways and bridges is critical to ensure responsible stewardship of the state's transportation assets and support system performance in the long-term. The table below shows the lane miles where today's pavement condition must be improved to meet Michigan's pavement goals of 85 percent good for non-freeway facilities and 95 percent good for freeway facilities.

	Reconstruction Lane Miles		*Total Backlog Reconstruction Lane Miles*	*Total System Lane Miles by Region*	*Regions as a Percentage of Statewide Need*
Estimated Backlog Reconstruction Needs 2005	*Freeway*	*Non-Freeway*	*Lane Miles*	*Lane Miles*	*Reconstruction*
MDOT Bay Region	145	42	188	4,272	23.2%
MDOT Grand Region	69	8	77	2,771	9.6%
MDOT Metro Region	161	116	276	4,436	34.2%
MDOT North Region	32	19	51	4,572	6.3%
MDOT Southwest Region	64	22	85	3,433	10.6%
MDOT Superior Region	11	47	57	3,960	7.1%
MDOT University Region	62	11	73	4,052	9.1%
Statewide Total	543	264	807	27,496	100.0%

Source: Michigan Department of Transportation Suffiency Data, 2005

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

In order to maintain Michigan's pavement condition goals to the year 2030, additional investment will be required. The table below shows the expected accruing needs for pavement resurfacing and preventative maintenance in Michigan by MDOT region to the year 2030.

Estimated Accruing Reconstruction Needs to 2030	*Reconstruction Lane Miles*		*Total Accruing Reconstruction Lane Miles*	*Total System Lane Miles by Region*	*Regions as a Percentage of Statewide Need*
	Freeway	*Non-Freeway*	*Lane Miles*	*Lane Miles*	*Reconstruction*
MDOT Bay Region	917	353	1,270	4,272	14.8%
MDOT Grand Region	656	205	861	2,771	10.0%
MDOT Metro Region	1,708	577	2,285	4,436	26.6%
MDOT North Region	342	465	807	4,572	9.4%
MDOT Southwest Region	920	274	1,195	3,433	13.9%
MDOT Superior Region	183	467	650	3,960	7.6%
MDOT University Region	1,238	279	1,517	4,052	17.7%
Statewide Total	5,964	2,620	8,584	27,496	100.0%

Source: Michigan Department of Transportation Suffiency Data, 2005

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

Like highways, Michigan's bridges require ongoing rehabilitation, replacement, and maintenance to maintain desired conditions and support system performance. MDOT estimates that 410 freeway and 54 non-freeway bridges need rehabilitation or replacement today. These bridges represent MDOT's backlog in bridge replacement/rehabilitation and preventative maintenance needs. This backlog is summarized by MDOT region in the following table.

Estimated Backlog Bridge Needs 2005	*Bridge Replacements*		*Bridges Requiring Preventative Maintenance*		*Total Bridges with Existing Needs in 2005*	
	Freeway	*Non-Freeway*	*Freeway*	*Non-Freeway*	***Replacement*	*Maintenance*
MDOT Bay Region	103	32	67	3	135	70
MDOT Grand Region	6	0	54	3	6	57
MDOT Metro Region	192	14	83	2	206	85
MDOT North Region	0	0	11	2	0	13
MDOT Southwest Region	39	0	39	3	39	42
MDOT Superior Region	0	0	2	3	0	5
MDOT University Region	70	8	57	2	78	59
Statewide Total	410	54	313	18	464	331

Source: Michigan Department of Transportation

**Replacement includes Replacement and Rehabilitation

In addition to the backlog in bridge replacement and maintenance needs, to achieve MDOT's bridge goals will require additional bridge replacement/rehabilitation and maintenance activities to the year 2030. The table below summarizes the expected accruing bridge replacement and maintenance activities needed to consistently achieve MDOT's bridge condition goals to the year 2030. In the time horizon of *MI Transportation Plan*, approximately 2,290 of Michigan's trunkline bridges will need replacement or rehabilitation and 2,335 will require preventive maintenance projects.

Estimated Accruing Bridge Needs to 2030	*Bridge Replacements*		*Bridges Requiring Preventive Maintenance*		*Total Bridges with Accruing Needs to 2030*	
	Freeway	*Non-Freeway*	*Freeway*	*Non-Freeway*	***Replacement*	*Maintenance*
MDOT Bay Region	269	85	282	78	354	360
MDOT Grand Region	262	54	275	50	316	325
MDOT Metro Region	581	66	610	61	647	671
MDOT North Region	99	70	104	65	169	169
MDOT Southwest Region	196	61	205	56	257	261
MDOT Superior Region	19	119	20	109	138	129
MDOT University Region	340	69	357	63	409	420
Statewide Total	1,766	524	1,853	482	2,290	2,335

Source: Michigan Department of Transportation

**Replacement includes Replacement and Rehabilitation

Michigan's non-pavement highway system assets include carpool lots, rest areas, drainage structures, and noise walls. Their condition is important both for the integration of the system and for the performance of Michigan's roadways. Non-motorized system conditions are measured primarily by the prevalence of four-foot-wide shoulders on Michigan's non-freeway trunklines. Four-foot-wide shoulders have increased from 2,337 route miles of Michigan's system in 2001, to 2,561 in 2005.

The condition of the public transportation fleet statewide, as measured in the National Transit Database (NTD) by the average age of the vehicles and usage rates, has remained largely steady between 1996 and 2004. As shown in the table below the average age of buses shows a modest improvement in the age of the vehicles between 1996 and 2004. In 1996, the average age of the fleet was 9.1 years, decreasing to 6.4 in 2001 (suggesting some new vehicles entering the fleet), and increasing again in 2004 to 7.9. Also shown in the table below, the age of the demand-response vehicle fleet is virtually unchanged between the design years with 4.2 years in 1996 and 4.3 years in 2004.

	Fleet Size				*Average Age of Fleet in Yrs*	
	Bus	*Demand-Response*	*Light Rail*	*Total*	*Bus*	*Demand-Response*
1996	1,461	458		1,919	9.1	4.2
2001	1,738	863	12	2,613	6.4	3.6
2004	1,586	910	12	2,508	7.9	4.3

Source: Federal Transit Administration National Transit Database

Note: Includes Michigan transit agencies reporting to NTD at year shown only.

Usage indicators such as peak-to-base ratio of transit vehicles needed for regular service and the percentage of spare vehicles available to operators suggest modest improvements in the period between 1996 and 2004. The average peak-to-base ratio in 1996 was 1.6; 2004 shows an improvement to 1.4 (see the table below). In 1996, on average, Michigan operators had 26 percent spares; this increased to 30 percent in 2004, exceeding the FTA recommended industry guideline of 20 percent. Michigan's percent spare ratios reflect Michigan's smaller systems, where spare ratios tend to be higher, as well as overall effective management of bus and demand-response fleet. The percent of spares for the demand-response fleet shows similar patterns; operators had a spare rate of approximately 27 percent in 1996 and 2004.

	Average Peak-to-Base Ratio		*Average Percent Spares*	
	Bus	*Demand-Response*	*Bus*	*Demand-Response*
1996	1.6	n/a	26.5	26.9
2001	1.4	n/a	19.8	22.3
2004	1.4	n/a	30.3	27.3

Source: Federal Transit Administration National Transit Database

Note: Includes Michigan transit agencies reporting to NTD at year shown only. Does not include light rail vehicles.

System Operational Performance:

The operational performance of the system pertains to the mobility provided by the system in all of its components to connect users with activities. The mobility available on the highway and transit components of Michigan's transportation system are two key aspects of operational performance that lend themselves to analysis in this report.

If MDOT were to remedy today's congestion by adding lane miles to the trunkline system, it would require adding 722 lane miles of trunkline freeway and 1,387 miles of trunkline non-freeway to the statewide system. It would increase the overall size of the trunkline system by more than seven percent. The table below shows the number of lane miles that would need to be added to Michigan's trunkline system to remedy today's congestion by adding lanes to the trunkline system.

Estimated Backlog	*Expansion Lane Miles for Congested Facilities in 2005*		*Total Backlog for Expansion Lane Miles*	*Total System Lane Miles by Region in 2005*	*Regional Shares of Overall Statewide Increases In Lane Miles*
Expansion Needs in 2005	*Freeway*	*Non-Freeway*	*Lane Miles Added*	*Lane Miles*	*% of Statewide Lane Miles Added*
MDOT Bay Region	41	130	171	4,272	8.1%
MDOT Grand Region	62	201	262	2,771	12.4%
MDOT Metro Region	417	285	702	4,436	33.3%
MDOT North Region	3	270	273	4,572	13.0%
MDOT Southwest Region	29	204	233	3,433	11.1%
MDOT Superior Region	0	43	43	3,960	2.1%
MDOT University Region	170	254	423	4,052	20.1%
Statewide Total	722	1,387	2,109	27,496	100.0%

Source: Michigan Department of Transportation Suffiency Data, 2005

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

Improvements in transit, non-motorized facilities, and carpool lots and changes in land use may all be leveraged to improve mobility on the integrated system. The *Integration Technical Report* of *MI Transportation Plan* addresses possible sources of leverage to use improvements on different components to moderate the needs for costly expansion projects. MDOT's leverage in delivering an integrated system is important both because of users' need for an integrated system based on the *2030 Preferred Public Vision* of *MI Transportation Plan*, and because of the costs of adding lanes to MDOT's trunkline system. The following table shows the number of new lane miles that would have to be added to the trunkline system to provide uncongested operational performance, if roadways alone must be improved to carry increases in traffic to the year 2030 (this is in addition to the lane miles needed to address the expansion backlog shown in the previous table).

Estimated Accruing Expansion Needs to 2030	*Expansion Lane Miles for Congested Facilities to 2030*		*Total Backlog for Expansion Lane Miles*	*Total System Lane Miles by Region in 2005*	*Regional Shares of Overall Statewide Increases In Lane Miles*
	Freeway	*Non-Freeway*	*Lane Miles Added*	*Lane Miles*	*% of Statewide Lane Miles*
MDOT Bay Region	1	174	175	4,272	7.9%
MDOT Grand Region	60	235	295	2,771	13.4%
MDOT Metro Region	349	403	751	4,436	34.0%
MDOT North Region	0	209	209	4,572	9.5%
MDOT Southwest Region	3	185	188	3,433	8.5%
MDOT Superior Region	0	28	28	3,960	1.2%
MDOT University Region	230	332	562	4,052	25.5%
Statewide Total	642	1,564	2,207	27,496	100.0%

Source: Michigan Department of Transportation Suffiency Data, 2005

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

If lane miles are added to address congestion on state roadways to the year 2030, the addition of 2,207 new lane miles would increase Michigan's lane miles by an additional eight percent (which would combine with the 7.5-percent increase in lane miles for today's congestion for an overall 2030 system with 15 percent more lane miles than exist today). More than one-third of these new lane miles would have to be added in the Metro Region, with the least additional lane miles added in the less densely populated North and Superior regions.

To broadly measure trends in transit systems performance, the study team examined changes in key indicators typically used in the public transportation industry. The data include performance measures as reported in the NTD, including agencies that reported to the NTD only.

Fixed-Route Bus Service:

As shown in the following two tables, for fixed-route bus services in the state of Michigan, indicators of service efficiency and cost-effectiveness increased between 1996 and 2004, likely reflecting a combination of inflation as well as some real increases in both operating and capital expenses. It is also noteworthy that two of the key costs driving transit operating expenses increased significantly during this time period: insurance and fuel. The numbers are rounded.

	Vehicle Revenue Mile	*Average Annual Percent Change*	*Vehicle Revenue Hour*	*Average Annual Percent Change*	*Passenger Mile*	*Average Annual Percent Change*	*Unlinked Passenger Trip*
1996	$4.23		$56.98		$0.77		$2.99
2001	$4.88	3.1%	$64.72	2.7%	$0.95	4.5%	$3.73
2004	$5.56	4.7%	$74.45	5.0%	$1.20	9.0%	$4.60

Source: Federal Transit Administration National Transit Database

Note: Includes Michigan transit agencies reporting to NTD at year shown only.

Does not include light rail vehicles.

	Vehicle Revenue Mile	*Average Annual Percent Change*	*Vehicle Revenue Hour*	*Average Annual Percent Change*
1996	$1.54		$20.39	
2001	$1.63	1.3%	$20.69	0.3%
2004	$1.58	-1.1%	$20.15	-0.9%

Source: Federal Transit Administration National Transit Database

Note: Includes Michigan transit agencies reporting to NTD at year shown only. Does not include light rail vehicles.

The first of the above tables shows that corresponding indicators relating to unlinked passenger trips shows increases in costs between 1996 and 2001, followed by decreases in vehicle revenue miles and revenue hours. This data suggests that after 2001 service effectiveness improved with more passengers served per mile and hour. Statewide unlinked passenger trips per vehicle revenue hour were marginally lower in 2004 ($20.15) than in 1996 ($20.39).

Demand-Response:

Similar to the performance indicators for fixed-route service, the demand-response data also suggests increasing operating cost ratios between 1996 and 2004. Indicators of service effectiveness, however, suggest improvement between 1996 and 2004; both unlinked passenger trips per vehicle revenue mile and per vehicle revenue hour were lower in 2004 than in 1996, suggesting improved service effectiveness. This data is shown in the following two tables. Numbers are rounded.

	Vehicle Revenue Mile	*Average Annual Percent Change*	*Vehicle Revenue Hour*	*Average Annual Percent Change*	*Passenger Mile*	*Average Annual Percent Change*	*Unlinked Passenger Trip*
1996	$2.57		$34.65		$2.23		$13.53
2001	$3.54	7.6%	$45.61	6.3%	$3.20	8.7%	$17.79
2004	$3.98	4.2%	$55.58	7.3%	$3.54	3.5%	$20.56

Source: Federal Transit Administration National Transit Database

Note: Includes Michigan transit agencies reporting to NTD at year shown only.

	Vehicle Revenue Mile	*Average Annual Percent Change*	*Vehicle Revenue Hour*	*Average Annual Percent Change*
1996	$0.23		$3.05	
2001	$0.22	-2.4%	$2.94	-3.6%
2004	$0.21	-4.0%	$2.98	1.4%

Source: Federal Transit Administration National Transit

Note: Includes Michigan transit agencies reporting to NTD at year shown only.

System Safety Performance:

The *Safety Technical Report* of *MI Transportation Plan* explores safety performance in depth. Overall, crashes and fatalities in Michigan have decreased in the 10-year period from 1994 to 2004, even as vehicle registrations, population, and vehicle miles traveled have increased. Improvements in Michigan's safety performance are supported by education, enforcement, and engineering solutions, which include but are not limited to the reconstruction of trunkline roadways, where appropriate.

The long-term condition and performance of Michigan's transportation system depends on the strategic investment of resources into the state's highway and bridge, transit, non-motorized, and other assets. This report explores the issues accounting for existing and accruing needs in six major funding categories:

- Roadway Preservation;
- Roadway Reconstruction;
- Roadway Expansion;
- Bridge Preservation;
- Bridge Rehabilitation and Reconstruction; and
- Transit

For roadway categories, the lane miles of existing and accruing improvements needed are summarized in the table below. The costing of these needs, in addition to transit and other needs, form the basis for the baseline improvement needs for each system component as introduced in the *Investment and Revenue Gap and Investment Packages Report* of *MI Transportation Plan*.

	Backlog (2005)		*Accruing (2006 to 2030)*	
	State Total (Lane Miles) or Number of Bridges		*State Total (Lane Miles) or Number of Bridges*	
Improvement Type	*Freeway*	*Non-Freeway*	*Freeway*	*Non-Freeway*
Preservation				
Resurfacing	820	1,324	3,696	9,428
Preventative Maintenance	850	2,975	18,462	32,866
Modernization				
Reconstruction	543	264	5,964	2,620
Expansion				
Capacity Improvement (Adding Lanes)	722	1,387	642	1,564
Bridge Work (Number of Bridges)				
Rehabilitation or Replacement	410	54	1,765	523
Preventative Maintenance	313	18	1,852	481
Big Bridge (Rehab, Replacement, PM)	1	1	70	36

Source: Michigan Department of Transportation

Note: Roadway needs and needs for non-roadway components are represented by costs in the *Revenue Gap and Investment Packages Report* of *MI Transportation Plan.*

In the investment and gap analysis, funding needs and potential sources of financial or performance leverage to be gained will be considered for the integrated system. This will include needs beyond deficiencies and requirements explicitly identified in this report. System components with needs addressed in the *Revenue Gap and Investment Packages Report*, beyond the deficiencies explicitly addressed in this report, include:

- Intercity Passenger :
- Aviation ;
- Ferries;
- Non-motorized (not covered by roadway categories);
- Ports;
- Intercity Passenger Transportation; and
- Non-Pavement Highway Infrastructure including:
    - Carpool Lots
    - Rest Areas
    - Drainage Structures
    - Noise Abatement Barriers

- Freeway Lighting
- Pump Houses

While some of these categories do not lend themselves to an assessment of conditions and performance within the scope of this report, the *Intercity Passenger Technical Report, Aviation Technical Report, Freight Profile Technical Report,* and *Non-motorized Technical Report* provide context for the costing of needs of these components. The full costing of needs (for all categories) is provided in the *Revenue Gap and Investment Packages Report* of *MI Transportation Plan*. The *Integration Technical Report* identifies linkages between components and offers decision principles for leveraging available resources in ways that will support the long-term conditions and performance of the components explicitly addressed in this *Conditions and Performance Technical Report*.

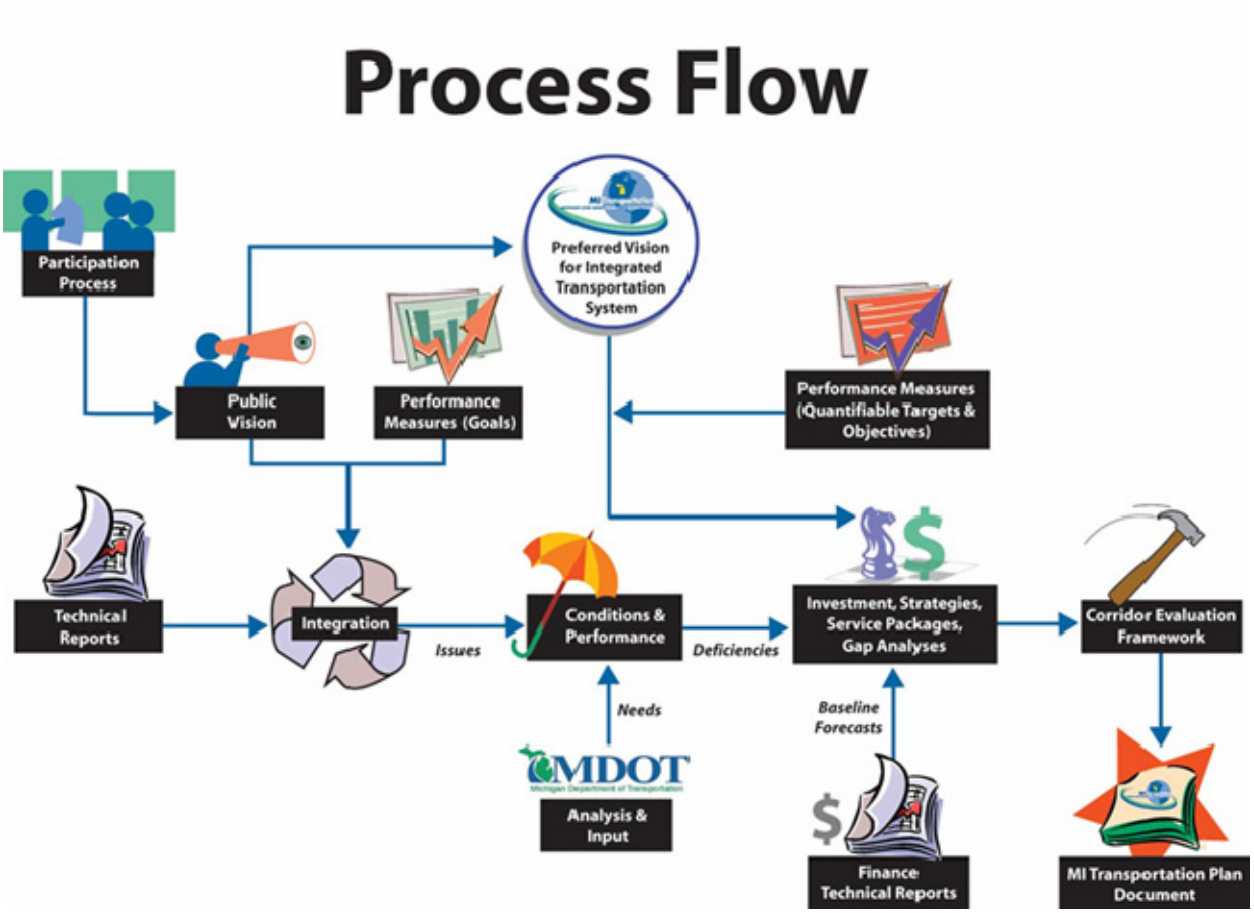
Chapter 1. Introduction

The *Conditions and Performance Technical Report* is one of 17 technical reports developed to support *MI Transportation Plan*. Each report serves: (1) as a resource for information about its substantive focus area and (2) as a component of the integrated transportation plan.

The technical reports can be grouped into four different categories based on the aspect of Michigan's transportation markets and policy environment addressed by each. The technical reports include: (1) reports describing the nature of transportation demand and markets in Michigan, (2) reports pertaining to Michigan's supply of transportation services and infrastructure, (3) reports addressing externalities bearing on Michigan's transportation system and (4) synthesis reports addressing the implications of potential transportation improvement actions and strategies. The *Conditions and Performance Technical Report* is the second of the synthesis reports, drawing on the principles and issues of the *Integration Technical Report*, and providing input into the investment and gap analysis of *MI Transportation Plan*.

Figure 1 illustrates how the *Conditions and Performance Technical Report* links the other technical reports of *MI Transportation Plan* to the statewide strategies and priorities ultimately resulting from the plan itself.

Figure 1*: MI Transportation Plan* **Process Flow**



Source: Michigan Department of Transportation

Chapter 2. Objective and Scope

The Federal Highway Administration (FHWA) offers a national *Conditions and Performance Technical Report* on the status of the nation's transportation infrastructure, addressing the role of system components such as highways and transit, system conditions, operational performance, safety performance and finance. To identify issues and needs facing Michigan's transportation system within the context of *MI Transportation Plan*, this *Conditions and Performance Technical Report* has been compiled for the state of Michigan based on the specific information in the other technical reports and other available data. This report draws heavily on the basic structure and language of the national *Conditions and Performance Technical Report*. The objectives of the report are:

(1) Define the roles of different components of Michigan's transportation system in ways consistent with the *Integration Technical Report* of *MI Transportation Plan*.

(2) Bring together information from other technical reports and sources regarding the existing and emerging conditions on Michigan's overall transportation system for which MDOT has jurisdiction over, provides funding for, or regulates.

(3) Offer an assessment of the current and expected operational and safety performance of highway, transit, and non-motorized components of Michigan's transportation system at today's funding levels.

(4) Provide a clear, quantitative assessment of existing and emerging deficiencies on the system that may be addressed through the *Revenue Gap and Investment Packages Report* of *MI Transportation Plan*.

This *Conditions and Performance Technical Report*, together with the decision principles of the *Integration Technical Report* provide the basis for the costing of transportation needs and investment requirements in the *Revenue Gap and Investment Packages Report* of *MI Transportation Plan*.

Chapter 3. Data and Sources

The *Conditions and Performance Technical Report* is based on the findings of other technical reports in *MI Transportation Plan* and addresses the conditions and performance of Michigan's highway, bridge, transit, and non-motorized components. Relevant linkages to intercity services, aviation, and freight are also explored. Excerpts and tables drawn from these technical reports are included within sections of this *Conditions and Performance Technical Report* where they are directly applicable to a holistic view of the statewide system. Additional information from MDOT's Transportation Management Systems and the Michigan Statewide Travel Demand Model are reported to examine emerging needs to the year 2030, time horizon of *MI Transportation Plan*. For additional context, and for consistency with the national *Conditions and Performance Technical Report*, language from the national *Conditions and Performance Technical Report* is also used, as are federal highway and transit statistics on the National Functional Classification system (NFC) provided by the US Department of Transportation.

Chapter 4. The Role of System Components

Michigan's transportation system is the essential element facilitating the movement of goods and people within Michigan, throughout the United States, and between the United States and Canada. It forms the backbone of Michigan's local, regional, national, and international trade, making most economic activity critically dependent upon this resource. The *Integration Technical Report* of *MI Transportation Plan* explores ways in which Michigan's transportation system components must work together to support economic vitality for the state.

The *Integration Technical Report* points out how users often depend on multiple components of the transportation system to support their economic activities and needs. The use of the

transportation system is often complex, with the same user depending on multiple components and modes to support the same activity. The *Integration Technical Report* suggests that the value of the system for users depends on the condition, performance, and arrangement of system components to support user access to activities. In order for components to be arranged into an integrated system, it is critical that the condition of each system component is appropriate to meet user needs, and that each component is sufficient to perform its function within the larger system. For example, if bus transit service is offered in an urban area but the buses travel on congested and deficient roadways, the quality of both the transit service and the roadway can be diminished for many users. The condition and performance of each system element is essential to support the overall system in Michigan's economy.

This report focuses on the role of infrastructure quality and operating characteristics of key transportation system elements, addressed in the technical reports of *MI Transportation Plan*. The report draws on the findings of the other technical reports, covering the following areas:

- Highway;
- Bridge;
- Transit;
- Intercity Passenger Service;
- Non-motorized;
- Aviation; and
- Freight.

While the largest emphasis is on the highway, bridge, non-motorized, and transit components, their relevance to freight, intercity passenger, and aviation systems are described where the conditions and performance of highways, bridges, non-motorized, and transit systems affect these other modes in the integrated system.

4.1 Role of Highways

Highways form the backbone of Michigan's transportation system, connecting Michigan to the world. Moving people and goods across this network is critical to meeting the everyday needs of Michigan's people and businesses.

Michigan's highways are highly versatile, engineered to allow for a wide array of users and vehicles simultaneously. A given stretch of urban interstate freeway might be shared by large commercial trucks and vacationers passing through the area, local workers commuting to jobs in buses, carpools, residents running errands or shopping in private autos, delivery trucks bringing merchandise to shops or homes, and business people and contractors driving from one customer to another.

Highway transportation depends on both public and private inputs and investment. In Michigan, most vehicles used on highways are owned and operated by private individuals and firms, while highway infrastructure is funded and maintained by the public sector. This stands

in contrast to freight railroads, where both vehicles and infrastructure are owned by private firms, and to mass transit, which is generally provided by public agencies, either directly or through contracted private operators. Understanding this dual nature of highway travel is important in understanding how public policy affects the efficient use of the highway network.

Another key feature of highways, experienced by millions each day, is that they are subject to conditions that create performance barriers for system users. Barriers such as congestion, crash risk, insufficient pavements and bridges, and the adverse environmental impacts of highways can interfere with users of Michigan's overall transportation system.

High traffic volumes relative to highway capacity (experienced especially during peak travel periods) can lead to reduced travel speeds and stop-and-go traffic conditions, even on freeways (which have controlled access and no traffic signals). Crashes, adverse weather conditions, and construction delay can also temporarily and, unpredictably, reduce capacity, causing additional travel delay. While these congested periods are generally associated with morning and evening weekday commuting flows, they may also coincide with weekend shopping, recreational travel, and traffic incidents.

Highway transportation in Michigan plays a significant role in two major areas: providing personal mobility to/from households and facilitating freight movement.

Personal Mobility: The use of private automobiles on Michigan's highway network provides users with a high degree of personal mobility. Automobile transportation allows people to travel where they want, when they want, and with whom they want. The freedom accorded by autos and highways accounts in large part for the enormous popularity of automobile travel, leading to the high rates of automobile ownership and use found in Michigan. However, Michigan's roadways also provide personal mobility by providing the underlying infrastructure to support transit and intercity bus routes, as well as access to airports, rail, park-and-ride, transit, and intercity bus facilities.

Freight Movement: Highways are a key conduit for freight movement in Michigan, accounting for 70 percent of total freight transport by weight (and 86 percent by value) in 2003. Highways can be used for hauls of virtually any length, including coast-to-coast shipments passing through Michigan, international flows between the US, Mexico, and Canada, and short mail and parcel delivery trips. While technological and legal limits on truck size make other modes (such as railroads and barges) more suitable for long-distance movements of bulk commodities, highways are important for drayage movements between terminal facilities (such as ports and railheads).

4.2 Role of Transit

Transit plays a vital role in enhancing productivity and the quality of life in Michigan. It provides basic mobility and expanded opportunities to people without the use of a car; it provides broader transportation choices to people with cars and has the potential to reduce pressures on roadway capacity, reducing travel times and road congestion in major

transportation corridors. Transit also facilitates economic growth and development and supports environmentally sustainable, safe communities.

Basic Mobility and Expanded Opportunities: Transit provides basic mobility to people with limited incomes or without cars. The 2001 National Household Travel Survey (NHTS) found that 43 percent of nationwide transit riders live in households with incomes of less than $20,000 and that 44 percent come from households without cars. The *Travel Characteristics Technical Report* of *MI Transportation Plan* also shows higher rates of transit use among those in low-income households. **Figure 26** of the *Travel Characteristics Technical Report* indicates that more than 10 percent of travel from households with annual incomes less than $10,000 is made by transit, and more than five percent of travel from households with annual incomes between $10,000 and $20,000 are made by transit. Transit helps people without cars take advantage of a wider range of job and educational opportunities and to obtain the health care they may require. It also enables them to be active members of their communities and to build and maintain social relationships with family and friends.

Broader Transportation Choices: Many of the people who use transit are choice riders. These people come from households with incomes sufficient to own a car but use transit because it offers them a more convenient, reliable, and less expensive transportation alternative. Some live in a densely-developed area with highly accessible, frequent transit service or in a suburb with access to a transit system that offers a cheaper, more comfortable, or more convenient way of traveling to and from a downtown city center.

4.3 Role of Non-motorized Facilities

Non-motorized transportation facilities include bicycle trails and routes, sidewalks, pedestrian and bicycle crossings of roadways, and other bicycle and pedestrian infrastructure. They often provide access and connectivity between parking lots where roadway users begin and end private vehicle trips, and where they connect with different passenger modes, such as transit, roadways, and airports. While non-motorized infrastructure is often maintained by local and county units of government, it has a critical role in connecting users to Michigan's roadway, transit, aviation, and intercity infrastructure and services. Non-motorized facilities also support healthier lifestyles and improved quality of life for Michigan's people and visitors.

The safety of non-motorized facilities providing access, crossing, or otherwise interfacing with Michigan's other transportation modes is an important consideration in statewide planning.

Non-motorized transportation plays a key role in Michigan's transportation system in the following ways:

Personal Mobility: The use of non-motorized facilities provides users with access to Michigan's roadway, transit, intercity, rail, and aviation systems. For example, crosswalks that connect transit stops to major centers of activity can be vital to ensuring transit performance translates into the integrated system performance. Walkways connecting parking facilities, and transit stops at airports, to terminals are another pertinent example of the role of non-motorized facilities in supporting the conditions and performance of other system components.

Beyond their role in connecting the integrated system, non-motorized facilities also provide direct mobility for users to access activities. The *Travel Characteristics Technical Report* of *MI Transportation Plan* finds that walking is next only to private auto travel in its frequency as a mode of transportation in Michigan, accounting for four percent of all trips in the state, and 12 percent of work trips. Walking is especially important in zero-auto households, where nearly 23 percent of all trips are made by walking.

Safety: Non-motorized facilities play a critical role in safely accommodating cyclists and pedestrians where walk and bicycle trips interface with other modes. Pedestrian signals, crosswalks, sidewalks, and wide shoulders are often important features to protect both the safety of the roadway user and the safety of pedestrians.

Health and Quality of Life: Non-motorized facilities can often provide amenities enhancing the value of Michigan's communities and the health and quality of life for Michigan's residents and visitors. The value that individuals place on the opportunity to walk or jog to an activity goes far beyond the money they may save on gas, parking, or transit fare. Walking and cycling are activities known to support a healthy lifestyle; regular walkers, joggers, and cyclists, nationally show lower levels of heart disease, obesity, and other health problems.

4.4 Role of Aviation

Michigan's airports and aviation systems play a vital role in the mobility of people, goods, and capital in the state. The aviation system makes national and global workers and services personally available to support Michigan's businesses and makes Michigan's professional service workers available to global and national markets. The system also supports Michigan's quality of life by making family and recreational activities around the world available to Michigan residents. Air cargo operations support global industries operating supply chains with high-value and time-sensitive activities in Michigan. Air cargo also makes products from around the world rapidly available in Michigan's consumer markets and opens national and global markets for Michigan's products.

Aviation plays the following key roles in Michigan's transportation system:

Access to Global Labor Markets: Michigan's aviation system makes it possible for firms to operate in Michigan while benefiting from labor and expertise from throughout the world. For example, a hospital in Michigan may be able to offer a highly skilled procedure in Detroit only if the global expert in that procedure can gain access to Michigan through the aviation system (and when the aviation system is supported by local transportation from the airport to the hospital). In a similar way, a world-renowned mechanical engineering firm in Michigan may provide greater value in the marketplace (and create more wealth in Michigan) when engineers from the Michigan firm can travel to Tokyo or London to spend a week performing work for international clients, with earnings accruing in Michigan. Michigan's aviation system plays a critical role in providing this type of access to global labor markets for both the import and export of services to support Michigan's economy.

Quality of Life: Access to tourist and recreational destinations as well as distant family members is a key consideration for workers and managers considering locating in Michigan. Michigan's aviation system provides this important linkage to people, places, and activities of interest throughout the state, making Michigan an easier and more attractive place to live and do business.

Support for Time-Sensitive Freight Shipments: Advanced supply chain management technologies and the globalization of industries, like transportation equipment manufacturing, make rapid access to certain commodities very important for manufacturers. The role of Michigan's aviation system in providing timely and reliable air cargo shipments for manufacturers is a key success factor for the state's economy. Other time-sensitive shipments, such as mail and contract deliveries, medical supplies, or perishable agricultural product items are of strategic importance to Michigan's emerging service industries as well.

4.5 Balanced Transportation

The components of Michigan's transportation system function together to serve a public comprised of distinct and overlapping markets. The *Integration Technical Report* of *MI Transportation Plan* examines the segmentation of these markets with respect to user needs as well as the potential to leverage improvements in related system components to connect users with activities.

Transit may serve the basic mobility needs of riders for whom car ownership is not a viable option while highways and autos may best meet the needs of residents and firms whose trip patterns are not readily met by transit. However, in many cases, roadway and non-motorized improvements are essential to ensure the safety, accessibility, and mobility of transit routes. Transit and non-motorized improvements support the performance of roadways both directly and indirectly. For example, a non-motorized improvement may reduce the likelihood of a pedestrian auto crash, directly improving the safety of the roadway system. In another example, an urban transit service may reduce the number of vehicle miles on a congested roadway, indirectly improving the flow of traffic. Strategic investment of resources and implementation of improvements on different system components can improve the performance of the system as a whole.

Chapter 5. System and Use Characteristics

An in-depth examination of the system and use characteristics of Michigan's roadways, transit, and non-motorized infrastructure provides a useful checkup on the state's transportation plan for understanding the condition and performance of these components.

5.1 Highway System and Use

Highways are typically classified by either ownership or purpose. Ownership can be determined by which jurisdiction has primary responsibility over a particular portion of the infrastructure, while purpose is identified by the roadway's function. This section presents highway miles by jurisdiction as well as system and use characteristics by functional classification.

5.1.1 Highway Ownership

Ownership is largely split among the federal, state, and local governments. Roads owned by these governments are considered public. This report focuses primarily on the conditions and performance of state facilities.

The state of Michigan owns approximately eight percent of Michigan's public road route mileage (11 percent of the lane mileage). Counties own nearly 74 percent with cities and villages accounting for the remaining 18 percent. In addition to these miles, the federal government has control over some facilities, primarily in national parks and forests, on Indian reservations, and on military bases. **Table 1** demonstrates the different levels of ownership for Michigan's roadways.

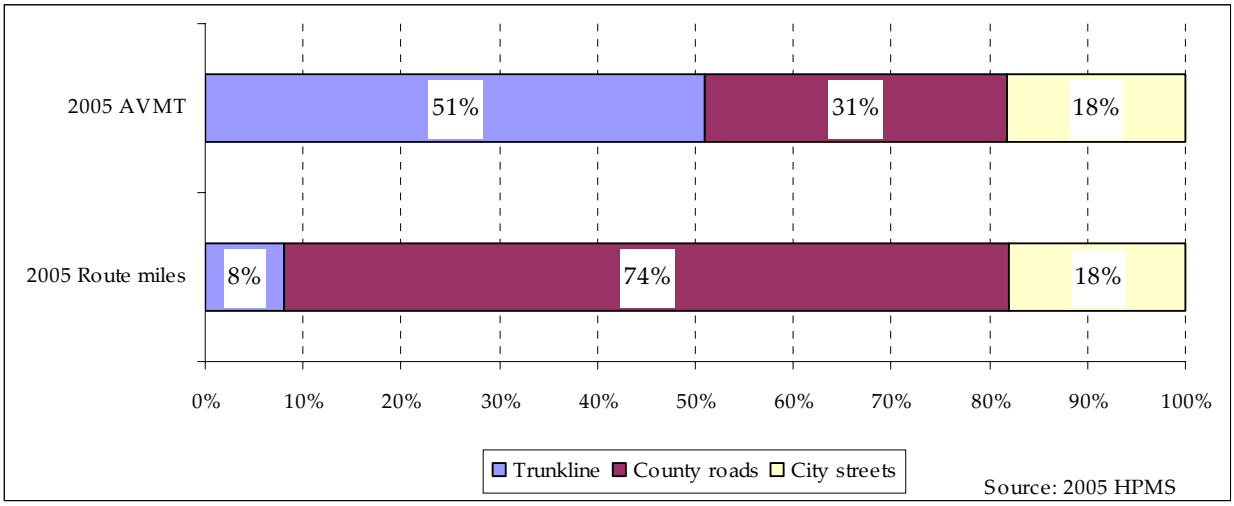
Table 1: Michigan Highways by Ownership: 2005

	Route Miles	*% of Total*	*Pavement Miles*	*% of Total*	*Lane Miles*	*% of Total*
State Trunkline	9,695.1	8.1%	12,055.3	9.9%	27,557.4	11.0%
County Roads	88,960.3	74.4%	89,113.4	72.9%	180,040.7	71.6%
City/Village Streets	20,914.1	17.5%	21,012.0	17.2%	43,745.5	17.4%
Total	119,569.5	100.0%	122,180.7	100.0%	251,343.6	100.0%

Source: Highway Performance Monitoring System

While 90 percent of Michigan's roads are locally-owned, the state-owned facilities account for more than half (51%) of vehicle miles traveled (VMT) in the state. **Figure 2** demonstrates the shares of Michigan's VMT by government ownership.

Figure 2: Michigan VMT by System Ownership

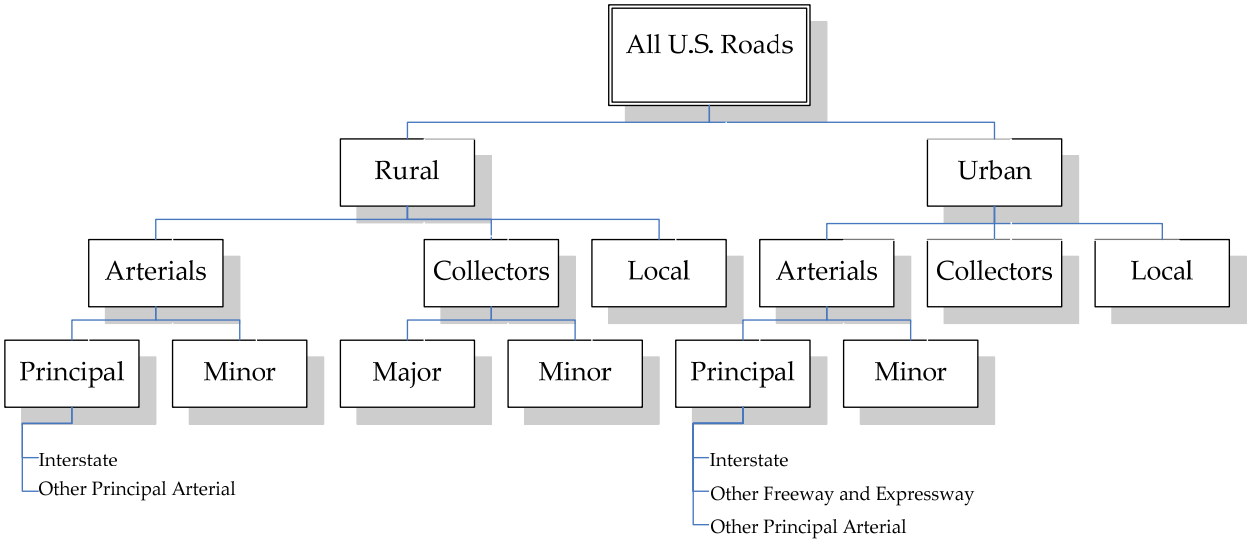


5.1.2 Highways by Purpose

Another way to categorize roads is by purpose, commonly called functional classification. The National Functional Classification System (NFC system) is the basic organization used for the national *Conditions and Performance Report*; it demonstrates system conditions and performance based on the ways roadways are used. **Figure 3** shows the hierarchy of the NFC pictorially.

The overarching principle of functional classification is interconnectedness of the system. Each segment of road, other than the lowest classification (local), should connect at both ends only to another segment functionally classified at an equal or higher level. Exceptions to this principle typically occur because of unusual geographic or traffic conditions (e.g., connections to international borders, coastal cities, seaports, and airports).

Figure 3: National Functional Classification Hierarchy



Source: *Conditions and Performance Technical Report*, FHWA, 2004

Roadways serve two important functions: land access and mobility. The more land access is available on a roadway, the less able the roadway is to support traffic flow and mobility. In the same way, local access is often difficult to accommodate on roads with greater speed and volume of traffic. Thus, routes on the Interstate Highway System will allow a driver to travel long distances in a relatively short time, but will not allow the driver to enter each farm field along the way. Contrarily, a subdivision street will allow a driver access to any address along its length, but will not allow the driver to travel at high speeds and will frequently be interrupted by intersections, often controlled by stop signs. The trade-off between mobility and land access exists in both rural and urban areas, but is often more observable where there is a high density of land development.

Arterials provide the highest level of mobility, at the highest speed, for long, uninterrupted travel. Arterials typically have higher design standards than other roads. They often include multiple lanes and have some degree of access control.

The rural arterial network provides interstate and intercounty service so that all developed areas are within a reasonable distance of an arterial highway. This network is broken down into principal and minor routes, of which principal roads are more significant. Rural principal arterial highways connect virtually all urbanized areas with more than 50,000 people, and most urban areas with more than 25,000 people. The rural principal arterial network is divided into two subgroups: interstate highways and other principal arterials.

Similarly, in urban areas the arterial system is divided into principal and minor arterials. The urban principal arterial system is the system accounting for the majority of MDOT's trunkline system and carrying the majority of traffic in Michigan; it includes (in descending order of expected mobility performance) interstate highways, other freeways and expressways, and other principal arterials. The urban principal arterial system serves major metropolitan centers, corridors with the highest traffic volume, and corridors with the longest trip lengths. It carries most trips entering and leaving metropolitan areas and provides continuity for rural arterials that cross urban boundaries. Urban minor arterial routes provide service for trips of moderate length at a lower level of mobility. They connect with the urban principal arterial system and other minor arterial routes.

Collectors provide a lower degree of mobility than arterials. They are designed for travel at lower speeds and for shorter distances. Generally, collectors are two-lane roads that collect travel from local roads and distribute it to the arterial system.

The rural collector system is stratified into two subsystems: major and minor collectors. Major collectors serve larger towns not accessed by higher order roads and important industrial or agricultural centers that generate significant traffic but are not served by arterials. Rural minor collectors are typically spaced at intervals consistent with population density to collect traffic from local roads and to ensure that a collector road serves all small urban areas.

In urban areas, the collector system provides traffic circulation within residential areas, commercial, and industrial areas. Unlike arterials, collector roads may penetrate residential communities, distributing traffic from the arterials to the ultimate destination for many

motorists. Urban collectors also channel traffic from local streets onto the arterial system. Unlike rural collectors, the urban collector system has no subclassification.

Local roads (including state and county roads) represent the largest element in Michigan's public road network in terms of mileage. All public road mileage below the collector system is considered local. Local roads provide basic access between residential and commercial properties, connecting with higher order highways.

Most of Michigan's trunkline system is classified as arterial or above, with the interstates, urban expressways, and arterials carrying the largest share of traffic on the trunkline system. **Table 2** shows the distribution of Michigan's trunkline highways by National Functional Classification.

Table 2: Michigan Trunkline System by National Functional Classification

Trunkline System	*National Functional Classification (NFC)*	*Route Miles*	*% of Total*	*Pavement Miles*	*% of Total*	*Lane Miles*	*% of Total*
Urban	Principal Arterial-Interstate	634.4	6.5%	1,268.9	10.5%	3,444.6	12.5%
	Principal Arterial-Other Freeways	327.8	3.4%	655.0	5.4%	1,464.9	5.3%
	Principal Arterial-Others	1,115.6	11.5%	1,421.5	11.8%	4,457.3	16.2%
	Minor Arterial	516.7	5.3%	538.1	4.5%	1,344.0	4.9%
	Collector	9.4	0.1%	10.6	0.1%	21.1	0.1%
	Local	2.9	0.0%	2.9	0.0%	5.7	0.0%
Rural	Principal Arterial-Interstate	608.7	6.3%	1,217.4	10.1%	2,589.9	9.4%
	Principal Arterial-Others	2,584.4	26.7%	3,011.8	25.0%	6,236.6	22.6%
	Minor Arterial	3,430.5	35.4%	3,463.9	28.7%	7,047.9	25.6%
	Major Collector	454.0	4.7%	454.7	3.8%	924.0	3.4%
	Minor Collector	0.5	0.0%	0.5	0.0%	0.9	0.0%
	Local	10.2	0.1%	10.2	0.1%	20.4	0.1%
Statewide Trunkline		9,695.1	100.0%	12,055.3	100.0%	27,557.4	100.0%

Source: 2005 Highway Performance Monitoring System (HPMS)

The density of traffic is lower in rural areas, where long distances between points are connected by miles of state roadway. Therefore, rural areas require more miles to carry the same number of trips as urban areas. In 2005, the rural interstate system accounted for about nine percent of total lane miles in Michigan, and carried 11 percent of Michigan's vehicle miles traveled (VMT). Michigan's rural principal and minor arterials account for approximately 23 and 26 percent of total lane miles in Michigan respectively, but carry only 14 and 10 percent of Michigan's trunkline vehicle miles traveled.

Urban roadways serve localities with a much higher density of traffic, carrying more, shorter trips to and from activities concentrated in urban areas. Michigan's urban interstates and freeways account for only 12 percent and five percent of Michigan's lane miles, respectively, but account for 31 percent and 11 percent of Michigan's trunkline VMT. Michigan's principal and minor arterials account for 16 and five percent of the state's lane miles, respectively carrying 18 percent and four percent of trunkline traffic. The share of trunkline miles and VMT is less on

minor arterials and collectors, as these facilities connect to county and local roadway systems, which carry a significant share of traffic in urban areas.

5.1.3 Bridges

Bridges are a critical element of Michigan's transportation system. They provide connections across natural barriers, bodies of water, and land features; they support freeway interchanges, the safe overpass or underpass between Michigan's roadways, rail, and other facilities, and often provide important links in non-motorized and transit routes. As a peninsula state, separated from Canada by bodies of water, Michigan's bridges are especially important for both domestic and international transportation. **Table 3** gives an inventory of Michigan's trunkline bridges as well as non-trunkline bridge structures from *MI Transportation Plan Highway and Bridge Technical Report*.

Table 3: Inventory of Bridges in Michigan

Owner	*Number of Highway Structures*	*Square Footage in Millions*	*Percent of Total Square Footage*
MDOT Freeway	3,198	41.2	63%
MDOT Non-Freeway	1,215	7.9	12%
Local – County	5,608	11.5	18%
Local – Cities and Villages	790	4.7	7%
Total Highway	10,811	65.3	100%
Highway Bridges on Major Freeways			
I-75	568	10.3	15.7%
I-94	482	6.6	10.2%
I-96	363	4.7	7.2%
I-69	300	3.1	4.7%

Source: *MI Transportation Plan Highway and Bridge Technical Report*

5.1.4 Highway Travel

This section describes highway infrastructure use, which is typically defined by VMT. During the 1990s, Americans traveled at record levels, a phenomenon prompted by the booming economy, population growth, and other socioeconomic factors. These changes were experienced on Michigan's overall VMT on both trunkline and non-trunkline roadways. To assess long-term (10-year) trends in the system, trends are analyzed for even-numbered years from 1994 to 2004. These 10-year trends provide background supporting the most current (2005) system as reported in the *Highway and Bridge Technical Report* of *MI Transportation Plan*.

As **Table 4** shows, overall trunkline VMT grew by an average annual rate of two percent between 1994 and 2004. By the end of that period, Michigan's trunkline system users were traveling almost 54 billion vehicle miles annually on the trunkline system. More than 34 billion vehicle miles were on urban highways and over 19 billion vehicle miles were on rural roads.

Table 4: Michigan VMT Trend by National Functional Classification

Area Type	National Functional Classification	1994 MVMT	1996 MVMT	1996 % Change	1998 MVMT	1998 % Change	2000 MVMT	2000 % Change	2002 MVMT	2002 % Change	2004 MVMT	2004 % Change	Average Annual Rate of Change
Rural	Principal Arterial - Interstate	6,210	6,390	3%	7,046	10%	7,311	4%	7,638	4%	5,897	-23%	-0.5%
	Principal Arterial - Other	7,151	7,557	6%	8,166	8%	8,464	4%	8,831	4%	7,431	-16%	0.4%
	Minor Arterial	5,212	5,429	4%	5,873	8%	5,876	0%	6,012	2%	5,394	-10%	0.3%
	Major Collector	890	682	-23%	710	4%	690	-3%	679	-2%	533	-21%	-4.0%
	Minor Collector and Below	4	4	5%	4	2%	4	-7%	4	-6%	3	-17%	-2.1%
	Rural Subtotal	19,467	20,063	3%	21,799	9%	22,345	3%	23,164	4%	19,258	-17%	-0.1%
Urban	Principal Arterial - Interstate	12,601	12,989	3%	13,865	7%	14,289	3%	14,478	1%	16,785	16%	3.3%
	Principal Arterial-Other Freeways & Expressways	3,868	4,036	4%	4,312	7%	4,402	2%	4,700	7%	5,818	24%	5.0%
	Principal Arterial - Other	7,921	8,255	4%	8,369	1%	8,898	6%	8,844	-1%	9,573	8%	2.1%
	Minor Arterial	1,541	1,484	-4%	1,589	7%	1,549	-2%	1,618	4%	2,170	34%	4.1%
	Collector and Below	43	38	-11%	66	74%	44	-33%	46	5%	119	157%	18.0%
	Urban Subtotal	25,974	26,801	3%	28,200	5%	29,182	3%	29,687	2%	34,466	16%	3.3%
	Total VMT on Trunkline System	45,441	46,863	3%	49,999	7%	51,527	3%	52,851	3%	53,724	2%	1.8%

Source: Michigan Department of Transportation Sufficiency File

The National Functional Classifications of some of Michigan's trunkline highways has changed from 1994 to 2004, as some areas with rural classifications have become urban and other facilities have been subject to turnbacks and other jurisdictional changes. For this reason, and to assess the changes in VMT by functional classification, it is helpful to examine changes in VMT by functional classification per lane mile. **Table 5** shows trends in Michigan's number of trunkline lane miles by National Functional Classification for the period from 1994 to 2004. **Table 6** shows trends in the VMT per lane mile on Michigan's trunklines by National Functional Classification.

Table 5: Trend in Michigan Number of Trunkline Lane Miles by National Functional Classification

Area Type	National Functional Classification	1994 Lane Miles	1996 Lane Miles	1996 % Change	1998 Lane Miles	1998 % Change	2000 Lane Miles	2000 % Change	2002 Lane Miles	2002 % Change	2004 Lane Miles	2004 % Change	Average Annual Rate of Change
Rural	Principal Arterial - Interstate	3,144	3,154	0%	3,198	1%	3,168	-1%	3,177	0%	2,584	-19%	-1.8%
	Principal Arterial - Other	6,594	6,664	1%	6,681	0%	6,732	1%	6,808	1%	6,214	-9%	-0.6%
	Minor Arterial	7,296	7,345	1%	7,503	2%	7,446	-1%	7,457	0%	7,033	-6%	-0.4%
	Major Collector	1,276	1,205	-6%	1,183	-2%	1,228	4%	1,190	-3%	1,027	-14%	-2.0%
	Minor Collector and Below	30	30	0%	29	-4%	27	-5%	28	4%	25	-12%	-1.7%
	Rural Subtotal	18,340	18,399	0%	18,594	1%	18,601	0%	18,661	0%	16,883	-10%	-0.8%
Urban	Principal Arterial - Interstate	2,788	2,799	0%	2,798	0%	2,810	0%	2,810	0%	3,417	22%	2.3%
	Principal Arterial-Other Freeways & Expressways	989	998	1%	1,009	1%	1,028	2%	1,029	0%	1,435	39%	4.5%
	Principal Arterial - Other	3,820	3,844	1%	3,896	1%	4,142	6%	3,982	-4%	4,375	10%	1.5%
	Minor Arterial	915	899	-2%	953	6%	930	-2%	932	0%	1,336	43%	4.6%
	Collector and Below	52	38	-27%	64	67%	44	-32%	43	0%	112	157%	11.3%
	Urban Subtotal	8,565	8,579	0%	8,720	2%	8,953	3%	8,796	-2%	10,674	21%	2.5%
	Total Lane Miles on Trunkline System	26,905	26,977	0%	27,314	1%	27,554	1%	27,457	0%	27,557	0%	0.2%

Source: Michigan Department of Transportation Suffiency Data, 2005

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

By comparing **Table 4** with **Table 5,** it becomes evident that VMT on the trunkline system has increased at a faster rate than the growth in available capacity (lane miles). **Table 5** shows that, while the overall lane miles on Michigan's trunkline system have changed very little in the 10-year period, significant mileages have shifted from rural to urban classifications. **Table 5** also shows the expansion of urban roadways accounting for the largest expansions in the trunkline system capacity in the period. In **Table 5,** it should be noted that for collectors and below, the

percentages should be interpreted with caution, as these systems are often subject to jurisdictional changes and account for a relatively small number of trunkline lane miles. Consequently, small shifts in state jurisdiction over collectors and other local roads can show a large percentage of change in overall lane miles.

Table 6: VMT-Per-Lane Mile; Michigan Trunkline System by National Functional Classification

Area Type	National Functional Classification	1994 MVMT Per Lane Mile	1996 MVMT Per Lane Mile	% Change	1998 MVMT Per Lane Mile	% Change	2000 MVMT Per Lane Mile	% Change	2002 MVMT Per Lane Mile	% Change	2004 MVMT Per Lane Mile	% Change	Average Annual Rate of Change
Rural	Principal Arterial - Interstate	1.98	2.03	3%	2.20	9%	2.31	5%	2.40	4%	2.28	-5%	1.6%
	Principal Arterial - Other	1.08	1.13	5%	1.22	8%	1.26	3%	1.30	3%	1.20	-8%	1.0%
	Minor Arterial	0.71	0.74	3%	0.78	6%	0.79	1%	0.81	2%	0.77	-5%	0.7%
	Major Collector	0.70	0.57	-19%	0.60	6%	0.56	-6%	0.57	2%	0.52	-9%	-2.5%
	Minor Collector and Below	0.13	0.14	5%	0.15	7%	0.14	-2%	0.13	-10%	0.12	-5%	-0.5%
	Rural Subtotal	5	5	0%	5	8%	5	2%	5	3%	5	-6%	0.6%
Urban	Principal Arterial - Interstate	4.52	4.64	3%	4.95	7%	5.08	3%	5.15	1%	4.91	-5%	0.9%
	Principal Arterial-Other Freeways & Expressways	3.91	4.05	3%	4.27	6%	4.28	0%	4.57	7%	4.05	-11%	0.4%
	Principal Arterial - Other	2.07	2.15	4%	2.15	0%	2.15	0%	2.22	3%	2.19	-1%	0.6%
	Minor Arterial	1.68	1.65	-2%	1.67	1%	1.67	0%	1.74	4%	1.63	-6%	-0.3%
	Collector and Below	0.81	0.99	21%	1.03	4%	1.01	-1%	1.07	6%	1.07	0%	3.2%
	Urban Subtotal	13	13	4%	14	4%	14	1%	15	4%	14	-6%	0.7%
	Trunkline Systemwide Average	1.69	1.74	3%	1.83	5%	1.87	2%	1.92	3%	1.95	1%	1.5%

Source: Michigan Department of Transportation Suffiency Data, 2005

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

When these changes are taken into account, the average annual increase in trunkline VMT from 1994 to 2004 across Michigan's entire trunkline system is approximately 1.8 percent, exceeding the 0.2-percent increase in overall lane miles. The relationship between changes in met demand (VMT) and changes in capacity (lane miles) can be quantified by examining the trend in VMT per lane mile. Trends in Michigan's millions of miles traveled (MVMT) per lane mile on the trunkline system are demonstrated on **Table 6.** A positive change in MVMT per lane mile indicates that growth in the demand for roadway travel is outpacing growth in the supply of roadway infrastructure.

Growth in VMT has outpaced growth in lane miles for both urban and rural areas. The average rates of growth in VMT per lane mile have been greatest for rural interstates and arterials, whereas the urban increases have been more on minor arterial and lower classified systems. This is due to both the increases in Michigan's urban freeway lane miles in the overall period since 1994, as well as the possibility that as urban freeways become congested, traffic diverts to lower classified systems, increasing the rates of traffic growth on urban arterials. Land use issues such as urban sprawl and urbanization of rural areas contributes to increases in MVMT.

5.1.5 Highway Vehicles

The types of vehicles using Michigan's highways have an important impact on the condition of the system and its performance. Heavier vehicles, such as commercial trucks and buses, create more wear and tear on the pavement infrastructure, accelerating pavement deterioration rates and preservation needs.

Vehicle types are also important because of the different operational, safety, and sustainability considerations associated with heavier or larger vehicles. For example, SUVs are known to be

more prone to rollover risk on facilities with steeper side slopes[1], buses and commercial trucks require wider turning radii, and motorcycle safety has special sensitivities to speed and visibility among other factors. Heavier vehicles and motorcycles also pose special air quality and noise concerns requiring mitigation when concentrated on corridors in dense urban areas. SUVs and light trucks are also known to have lower levels of fuel efficiency than standard automobiles.

For all of these reasons, changes in the vehicle mix can affect the conditions and performance of Michigan's roadways. **Table 7** and **Figure 4** show trends in Michigan's vehicle-mix over the 10-year period from 1994 to 2004. Overall, vehicle registrations in Michigan have increased by 10 percent in this period. However, the increase has been primarily in the trucks and buses (which include SUVs) and motorcycles categories. Passenger automobile registrations have declined, as SUVs (which are considered trucks in national highway statistics) have accounted for an increasing share of private passenger autos.

Table 7: Trends in Michigan Vehicle Registration 1994-2004

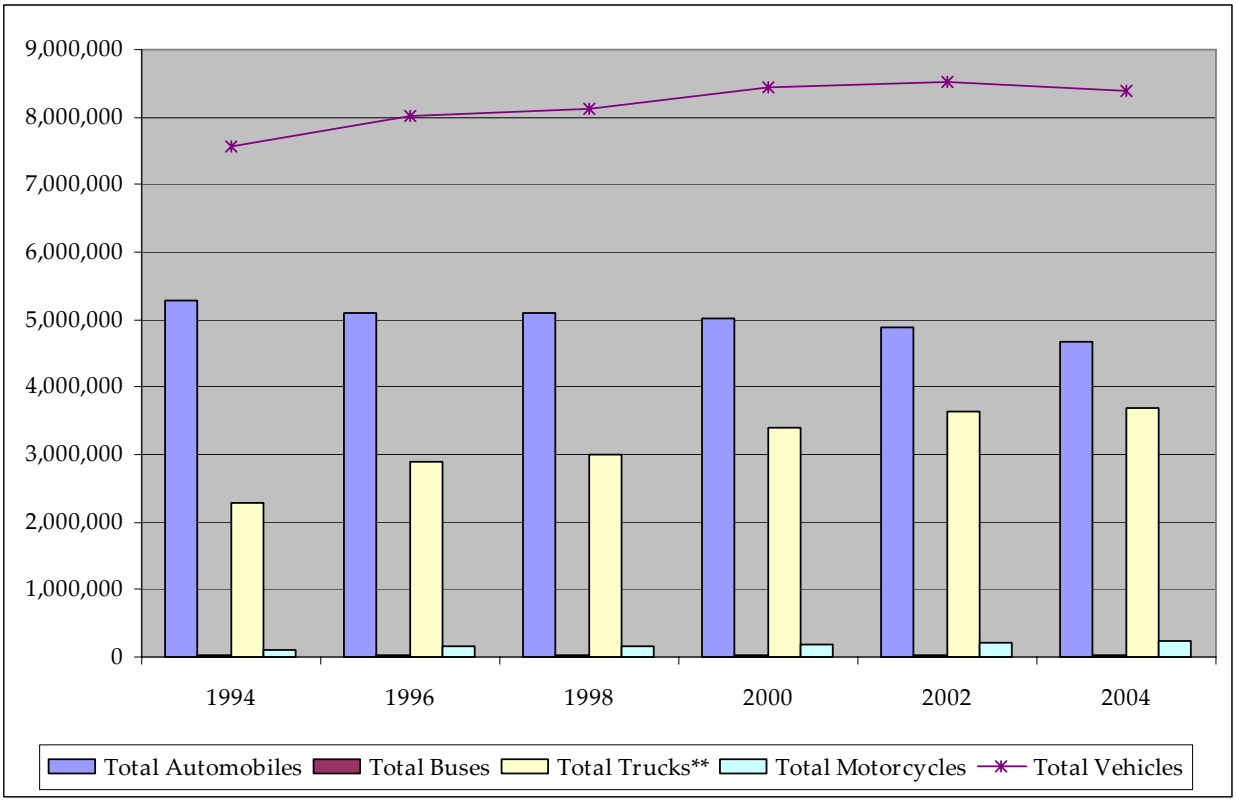
Vehicle Types	*Vehicles Registered By Type*	*Year*						*Average Annual Rate of Change*
		1994	*1996*	*1998*	*2000*	*2002*	*2004*	
Automobiles	Private and Commercial Automobiles	5,232,501	5,045,227	5,058,415	4,976,218	4,826,224	4,631,850	-1.1%
	Publicly-Owned Automobiles	44,452	45,507	46,366	47,203	48,091	48,879	1.0%
	Total Automobiles	5,276,953	5,090,734	5,104,781	5,023,421	4,874,315	4,680,729	-1.1%
Buses	Private and Commercial Buses	9,495	9,867	10,111	10,495	10,682	10,218	0.8%
	Publicly-Owned Buses	14,445	14,737	15,031	15,332	15,647	15,955	1.0%
	Total Buses	23,940	24,604	25,142	25,827	26,329	26,173	0.9%
Trucks and SUVs	Private and Commercial Trucks**	2,201,144	2,821,785	2,923,241	3,309,618	3,554,752	3,612,504	6.4%
	Publicly-Owned Trucks**	71,556	73,273	74,986	76,855	78,239	79,215	1.1%
	Total Trucks**	2,272,700	2,895,058	2,998,227	3,386,473	3,632,991	3,691,719	6.2%
Motorcycles	Private and Commercial Motorcycles	111,800	148,647	153,007	182,213	203,398	227,422	10.3%
	Publicly-Owned Motorcycles	1,298	1,324	1,351	1,379	1,407	1,434	1.1%
	Total Motorcycles	113,098	149,971	154,358	183,592	204,805	228,856	10.2%
Grand Totals	Total Private and Commercial Vehicles	7,443,140	7,876,879	7,991,767	8,296,331	8,391,658	8,254,572	1.1%
	Total Publicly-Owned Vehicles	130,453	133,517	136,383	139,390	141,977	144,049	1.0%
	Total Vehicles	7,573,593	8,010,396	8,128,150	8,435,721	8,533,635	8,398,621	1.1%

Source: Federal Highway Administration Statistics, 1994-2004

**SUVs Are Defined as Trucks

[1] Insurance Institute for Highway Safety 2004 Fatality Facts

Figure 4: Vehicle Registrations in Michigan



Source: Federal Highway Statistics
**Indicates trucks include commercial trucks, pickup trucks, and SUVs.

The implications of these changes are likely to entail more needs for roadway reconstruction and preservation in areas where these vehicle types are most concentrated, as designers may take into account the pavement deterioration, operational performance, and safety considerations associated with these vehicle types. In urban activity centers, increases in truck traffic may also lead to higher mitigation costs for certain projects.

5.1.6 Non-pavement Highway Infrastructure

Michigan's non-pavement infrastructure includes carpool lots, noise walls, drainage facilities, weigh stations, and rest areas. The inventory, performance, condition, and significance of these facilities are further discussed in **Chapter 6, System Conditions**.

5.1.7 Non-motorized Facilities on Highways

Non-motorized facilities on highways include wide paved shoulders, crosswalks, pedestrian signals, and other facilities supporting bicycle and pedestrian use of Michigan's roadways as well as the connectivity between modes in highway right of way. The extent and condition of Michigan's roadways for non-motorized uses is further examined in the next section of this report, as well as in the *Non-motorized Technical Report* of *MI Transportation Plan*.

5.2 Transit Systems and Use

Michigan is served by 79 local public transportation systems and 40 specialized transportation systems. One or both of these services serve all 83 Michigan counties. All 78 local public transportation systems have lift-equipped vehicles in their fleet, with a number of fleets being 100 percent lift-equipped. Public transit in Michigan also includes a state-managed commuter vanpool service and two public ferry operators; the state also funds intercity bus services and two intercity rail routes; however, information on these services is not included in this section of the report.

The assessment of transit systems and use provides an overview of key statistics for public transportation services in the state of Michigan in order to highlight key trends and changes. Data was drawn from two main sources: the Public Transportation Management System (PTMS) data provided by the state of Michigan and, in cases where this data was not available, the National Transit Database (NTD). The NTD includes only urban transit agencies in Michigan and, therefore, is not considered as accurate and representative as the PTMS sources. Trends are reported for 1990, 2000, and 2004 based on data available from the existing NTD.

Transit system coverage and capacity in Michigan increased between 1990 and 2004, with annual vehicle miles and fleet size increasing by 38 and 43 percent respectively. These increases are shown in **Tables 8** and **9**. Ridership growth, however, did not keep pace with increases in service. Statewide ridership decreased 15 percent, with the greater Detroit area experiencing a 30 percent decline between 1990 and 2004 (see **Table 10**).

While the tables show service levels have increased, available ridership data for this same period does not show commensurate ridership increases. Statewide ridership decreased 15 percent, with the greater Detroit area experiencing a 30-percent decline between 1990 and 2004. While the city of Detroit has experienced some service reductions during this time, MDOT believes a large portion of the decline represents a change in local counting procedures, such that 1990 figures were overstated. More recently, there have been steady ridership increases in portions of the greater Detroit area. The Suburban Mobility Authority for Regional Transportation, which services a large portion of the Detroit urbanized area has reported ridership increases every year since 2003, from 9.1 million in 2003 to 9.4 million in 2005.

Ridership in Michigan's other urbanized areas increased 36 percent between 1990 and 2004, and ridership in non-urban cities and townships increased 17 percent in this same timeframe. It should be noted that ridership data is collected and generated locally and reported to MDOT by each individual system.

Table 8: Public Transit Vehicle Miles (In Millions per Year)

	Greater Detroit	*Other Urban*	*City/ Township*	*County*	*Total*	*% Change*
1990	39	12.5	2.9	13.2	67.6	
2000	29.4	25.9	4.2	18.3	77.8	15.1%
2004	38.5	30	4.7	19.9	93.1	19.7%

Source: 1990 DDOT data from 10e(21) report to legislator
All other data from Public Transportation Monitoring System

Table 9: Local Public Transit Fleet

	Greater Detroit	*Other Urban*	*City/ Township*	*County*	*Total*	*% Change*
1990	819	700	134	445	2098	
2000	997	1026	202	688	2913	0.4
2004	969	969	245	816	2999	0.0

Source: 1990 DDOT data from 10e(21) report to legislator
All other data from Public Transportation Monitoring System

Table 10: Annual Passengers by Service Area Type (In Millions per Year)

	Greater Detroit	*Other Urban*	*City/ Township*	*County*	*Total*	*% Change*
1990	72.1	21	1.8	4.2	99.1	
2000	55	28	1.8	4.8	89.6	-9.6%
2004	49.3	29.3	2.1	4.4	85.1	-5.0%

Source: 1990 DDOT data from 10e(21) report to legislator
All other data from Public Transportation Monitoring System

Chapter 6. System Conditions

6.1 Highway System Conditions

Current highway system conditions indicate the current physical characteristics of Michigan's roadways relative to desired characteristics. Key characteristics include pavement condition, design, and the condition of non-pavement highway infrastructure, such as park-and-ride lots and drainage structures. System pavement and design conditions form the basis for estimating existing and accruing highway investment needs in *MI Transportation Plan*.

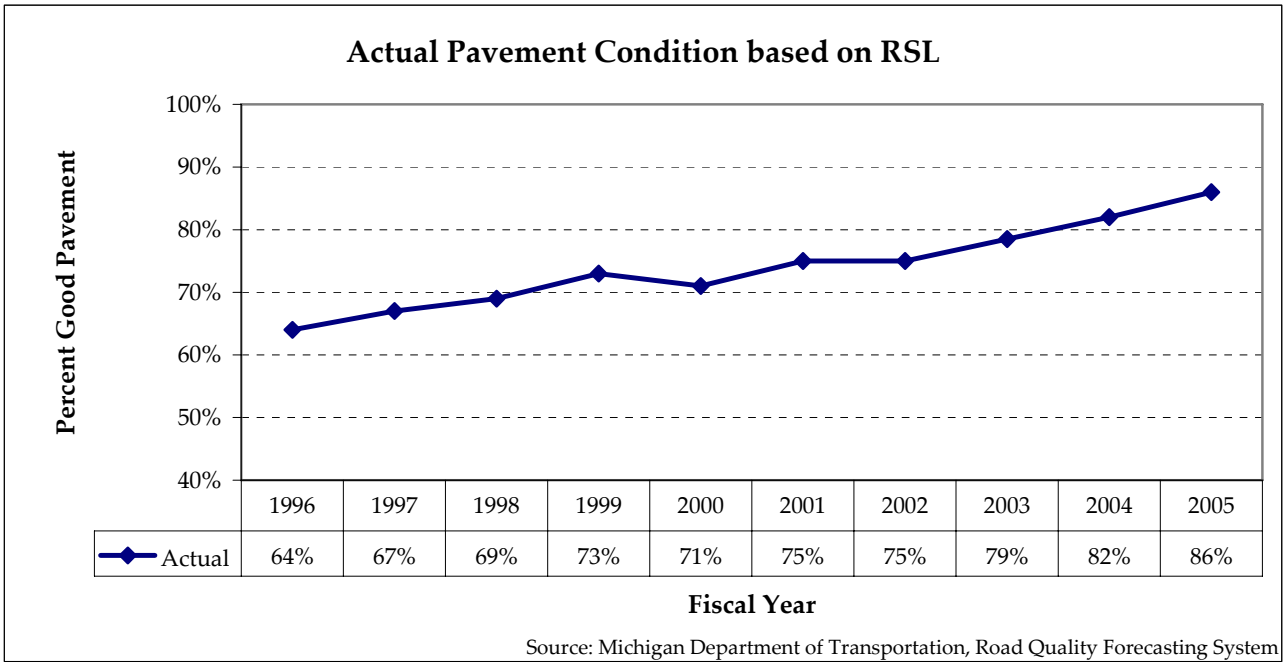
6.1.1 Pavement Terminology and Measurement

Pavement deterioration is cited in the *Integration Technical Report* of *MI Transportation Plan* as a key performance barrier not only for roadway performance, but also for the viability of freight, transit, and intercity services in Michigan. The key performance measure used by MDOT is called Remaining Service Life (RSL). It is defined as the estimated number of years until it is no longer cost-effective to perform preventive maintenance on, or reactively maintain, a pavement section. When a pavement section reaches a RSL of zero to two, it becomes more cost-effective to prepare rehabilitation or reconstruction work. RSL is a good performance measure for use in MDOT's forecasting software tool, Road Quality Forecasting System (RQFS), because it takes into consideration not only the current condition state, but incorporates data from previous years to predict future deterioration. Historical project and condition data are used to calculate the deterioration rate for specific segments and to determine the current RSL of each. By using several years of treatment type and distress data, MDOT is able to assess the rate of deterioration of a pavement segment.

MDOT has made substantial progress since the adoption of pavement condition goals in 1997. The preservation projects included in MDOT's Five-Year Program are prioritized based on approved asset management strategies, with a specific focus on reconstructing the worst roads and bridges, rehabilitating structures that still have some structural integrity, but are beyond preventive maintenance, and using cost-effective preventive maintenance treatments extending the life of roads and bridges to keep them in good condition. Our programs include a combination of long-term fixes (reconstruction), intermediate fixes (resurfacing/rehabilitation), an aggressive capital preventative maintenance (CPM) program, and routine maintenance of the system.

The RQFS analysis in *MI Transportation Plan Highway and Bridge Technical Report* shows 86 percent of statewide trunkline pavement is in good condition after the implementation of the Fiscal Year (FY) 2005 road program, as shown in **Figure 5**. It has been a significant accomplishment to improve the state trunkline condition from 64 percent good in 1996, to 86 percent (a 22-percent increase over the entire network) good in 2005.

Figure 5: Pavement Condition on Statewide Trunkline System

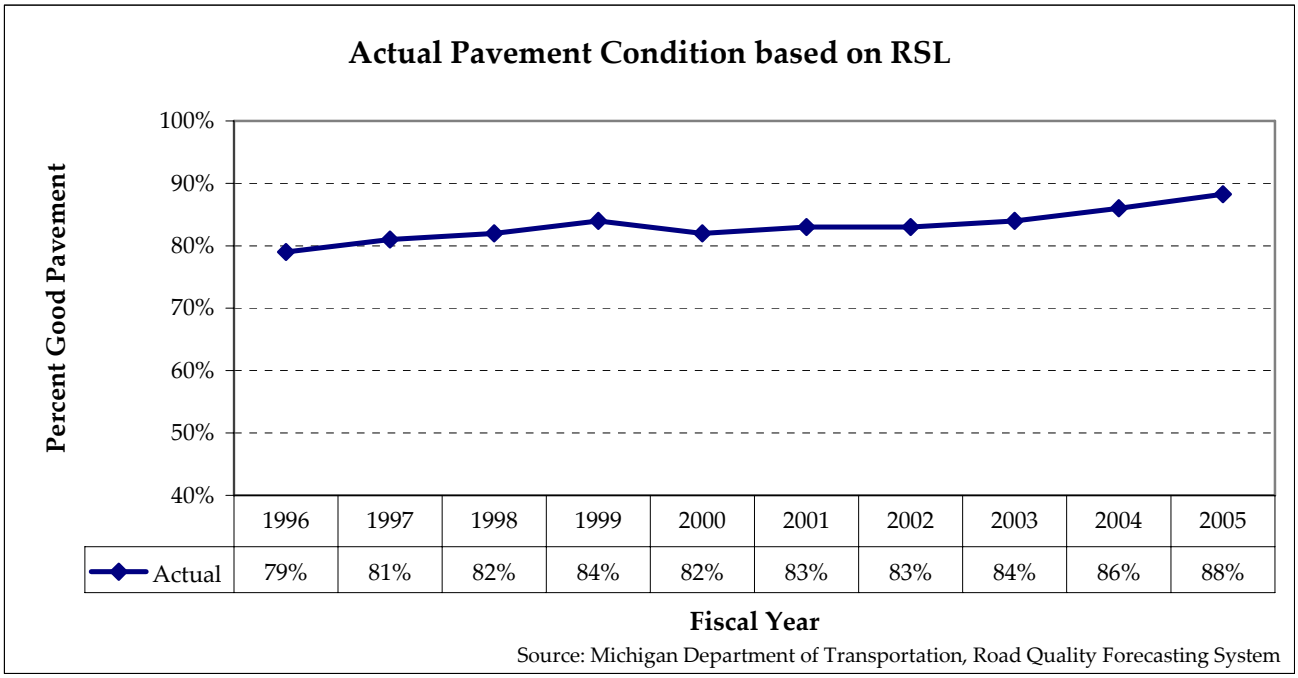


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Actual	64%	67%	69%	73%	71%	75%	75%	79%	82%	86%

Source: Michigan Department of Transportation, Road Quality Forecasting System

As shown in **Figure 6**, MDOT has continued to make good progress by increasing the percent of good pavements on the freeway network. At the end of FY 2005, 88 percent of MDOT's freeway system was in good condition.

Figure 6: Pavement Condition on Trunkline Freeway

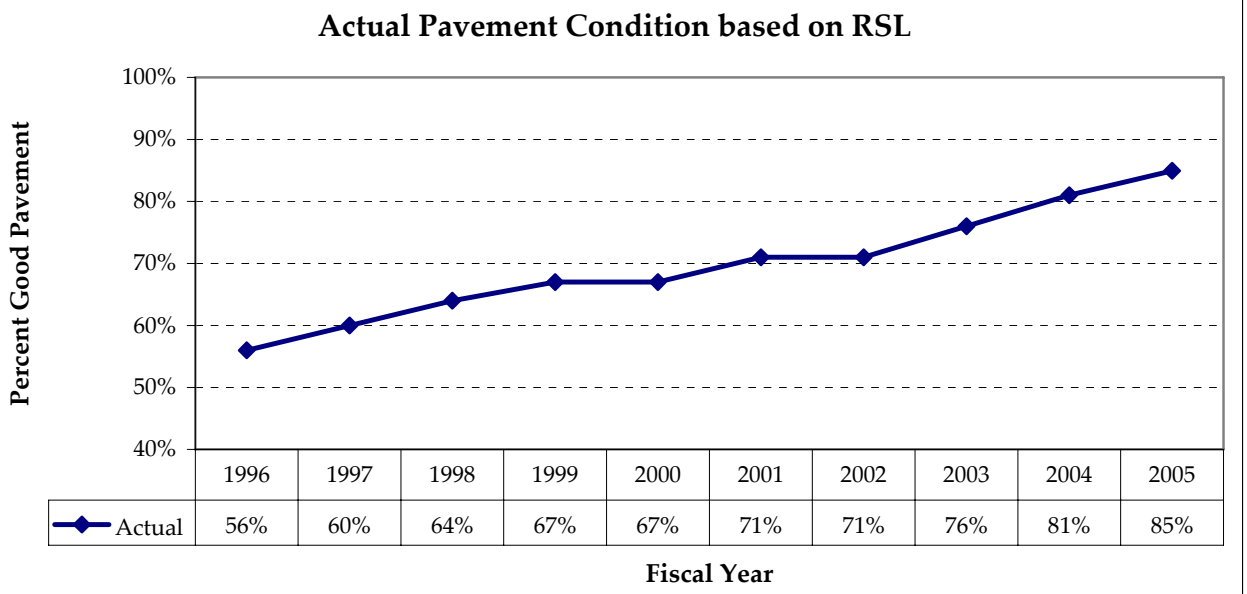


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Actual	79%	81%	82%	84%	82%	83%	83%	84%	86%	88%

Source: Michigan Department of Transportation, Road Quality Forecasting System

Progress also continues on the non-freeway system. At the end of FY 2005, 85 percent of MDOT's non-freeway system was in good condition, as shown in **Figure 7**. This is the first year the non-freeway system reached the department's goal of 85 percent good, two years earlier than the goal year of 2007.

Figure 7: Pavement Condition on Trunkline Non-Freeway



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Actual	56%	60%	64%	67%	67%	71%	71%	76%	81%	85%

Source: Michigan Department of Transportation, Road Quality Forecasting System

6.1.2 Pavement Condition by National Functional Classification

To more fully understand the requirements to preserve pavement on Michigan's trunkline system, it is helpful to examine pavement condition by lane mile, by National Functional Classification. Examining pavement condition by lane mile provides a basis for estimating how many lane miles of pavement need to be improved to maintain acceptable pavement conditions statewide. This is important because lane miles provide a cost allocation base for assessing the initial costs for Michigan's roadway preservation needs.

Understanding how pavement quality varies across urban and rural functional classifications provides insight regarding where on the freeway and non-freeway systems pavement conditions have improved and where conditions may be deteriorating. For example, differences between urban and rural principal and minor arterials may be significant; differences between rural interstates and urban interstates and expressways can be important for understanding pavement requirements.

The interstate, freeway, and principal arterial systems require the highest quality of pavement conditions to support their higher VMT and concentrations of heavy truck and bus traffic. For the same reasons, pavements in urban conditions with higher VMT and more bus and truck traffic can deteriorate at faster rates and may require more preservation effort. **Table 11** shows the percent good pavement condition for National Functional Classifications for the period from 1994 to 2004. As noted in the discussion of lane miles by National Functional Classifications, minor arterials, collectors and below represent relatively low number of lane miles on the trunkline system, therefore shifts in percentages for these classifications may disproportionately reflect improvements to only a few lane miles of roadway.

Table 11: Trend in Michigan Trunkline Pavement Condition by National Functional Classification

Area Type	*National Functional Classification*	*% Trunkline Lane Miles with Good Pavement*						*Average Annual Increase in % Good*
		1994	*1996*	*1998*	*2000*	*2002*	*2004*	
Rural	Principal Arterial - Interstate	76%	73%	78%	77%	77%	82%	0.8%
	Principal Arterial - Other	61%	62%	75%	78%	76%	82%	3.4%
	Minor Arterial	62%	65%	75%	83%	84%	83%	3.4%
	Major Collector	51%	52%	59%	58%	68%	70%	3.8%
	Minor Collector and Below	53%	53%	76%	75%	82%	91%	7.1%
	Rural Subtotal	63%	64%	74%	78%	79%	82%	2.9%
Urban	Principal Arterial - Interstate	84%	83%	87%	86%	80%	83%	-0.1%
	Principal Arterial-Other Freeways & Expressways	62%	58%	67%	76%	72%	76%	2.3%
	Principal Arterial - Other	56%	59%	69%	74%	75%	80%	4.3%
	Minor Arterial	57%	58%	63%	73%	75%	78%	3.8%
	Collector and Below	26%	35%	34%	65%	42%	64%	14.6%
	Urban Subtotal	66%	67%	74%	78%	76%	80%	2.2%
	Overall % Good on Trunkline	64%	65%	74%	78%	78%	81%	2.7%

Source: Michigan Department of Transportation Pavement Sufficiency Database

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

Figure 6 shows that overall, statewide trunklines have steadily improved from 1994 to 2004, reaching 86 percent good in 2004 (in terms of lane miles) as analyzed in the RQFS System, (and reported in the *Highway and Bridge Technical Report* of *MI Transportation Plan* as 88 percent good in 2005). However, the assessment of lane miles by functional classification (**Table 11**) shows that urban freeways, which are among the most costly to improve, lagged in condition significantly behind other trunkline freeways. Urban interstate trunkline lane miles have maintained pavement conditions over 80 percent good throughout the period, but have declined in some periods and have not consistently improved at rates comparable to improvements in rural interstates.

The most consistent improvements in the 10-year period have been in urban and rural non-freeway principal arterial systems, all of which have improved at an average annual rate exceeding two percent in the last 10 years.

6.1.3 Existing and Emerging Pavement Preservation Needs

Pavement deteriorates constantly due to the flow of vehicles over the trunkline system, weather conditions and the relative concentration of heavy trucks and other vehicles. The use of snowmobiles in the winter can add significantly to wear and tear on pavements and shoulders where snowmobiles are permitted and used. Pavements in good condition today will still require improvement to the year 2030 in order to maintain good condition. Pavements not in good condition today require not only improvements to attain good condition, but also additional support to maintain good condition to the year 2030. To maintain the target good percentages of 85 percent good on non-freeway, and 95 percent good on freeways to the year 2030, Michigan's pavements will require an ongoing commitment to preserving these pavements.

The preservation backlog represents the number of lane miles that MDOT would need to improve to bring current conditions to the state's pavement goals of 95 percent good for freeways and 85 percent good for non-freeway trunklines. **Table 12** shows Michigan's pavement condition resurfacing and preventative maintenance backlog in the year 2005.

Table 12: Lane Mile Improvements to Attain Pavement Goals in 2005 (Resurfacing and Maintenance Backlog)

Estimated Backlog Pavement Preservation Needs in 2005	*Resurfacing Lane Miles*		*Preventative Maintenance Lane Miles*		*Total Lane Miles with Backlog Preservation Needs*		*Totals by Preservation Activity*		*Total System Lane Miles by Region*	*Regions as a Percentage of Statewide Need*	
	Freeway	*Non-Freeway*	*Freeway*	*Non-Freeway*	*Freeway*	*Non-Freeway*	*Resurfacing*	*Maintenance*	*Lane Miles*	*Resurfacing*	*Maintenance*
MDOT Bay Region	301	240	144	847	445	1,086	541	990	4,272	25.2%	25.9%
MDOT Grand Region	30	66	66	246	95	312	95	312	2,771	4.4%	8.1%
MDOT Metro Region	247	116	298	162	544	277	362	459	4,436	16.9%	12.0%
MDOT North Region	73	261	91	391	164	651	333	482	4,572	15.6%	12.6%
MDOT Southwest Region	133	318	89	494	222	812	451	582	3,433	21.1%	15.2%
MDOT Superior Region	11	196	21	569	31	765	206	590	3,960	9.6%	15.4%
MDOT University Region	27	128	142	268	168	396	155	409	4,052	7.2%	10.7%
Statewide Total	820	1,324	850	2,975	1,670	4,299	2,144	3,825	27,496	100.0%	100.0%

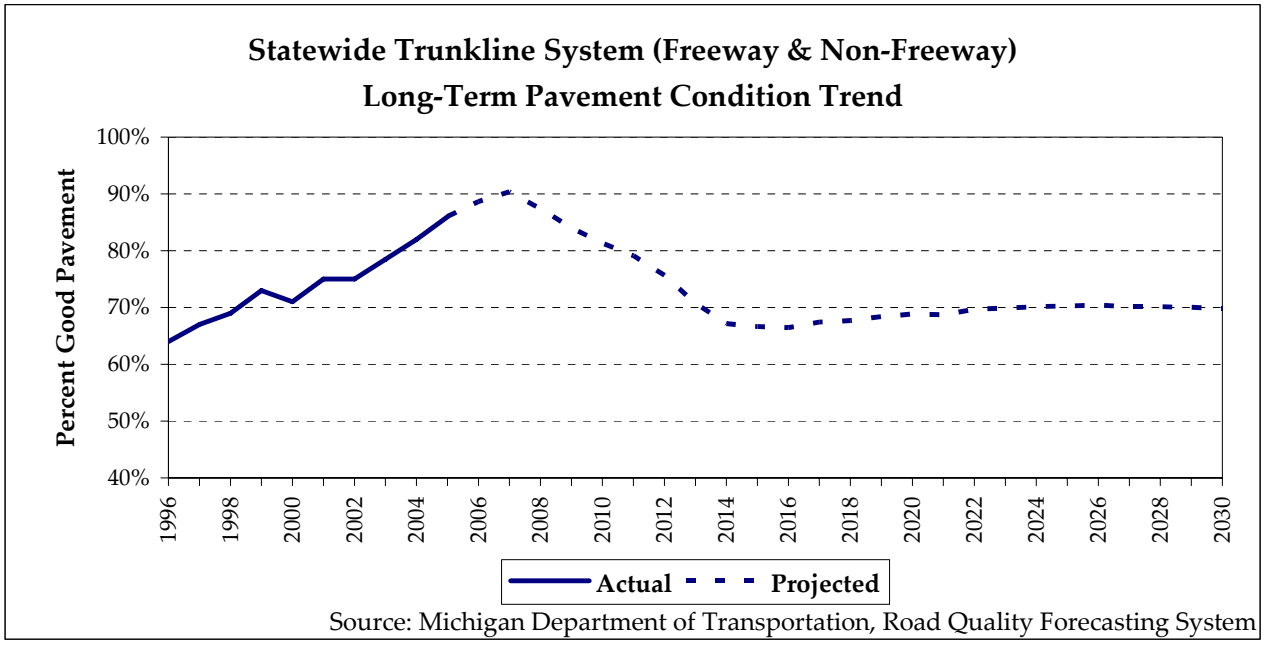
Source: Michigan Department of Transportation Pavement Sufficiency Database

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

Bringing Michigan's trunklines to today's desired levels entails resurfacing 2,144 lane miles of trunkline roadway and preventative maintenance projects on 3,825 lane miles. Michigan's largest preservation backlog is on non-freeway systems, with the greatest resurfacing needs in the Bay and Southwest regions, and the greatest preventative maintenance backlog in the Bay, Superior, and Southwest regions.

In addition to bringing trunkline roadways to these goals, maintaining desired levels of pavement condition to the year 2030 will require additional investment over the time horizon of *MI Transportation Plan*. **Figure 8** shows the forecasted deterioration of Michigan's trunkline pavements to the year 2030; **Table 13** shows the lane miles that will need to be improved to maintain Michigan's pavement goals to the year 2030, accounting for accruing preservation needs due to changing traffic conditions and pavement deterioration. The totals include resurfacing and preventative maintenance needs. Accruing resurfacing and preventative maintenance needs in lane miles are reported by MDOT region.

Figure 8: Long-Term Forecast: Pavement Condition on Statewide Trunkline System



Source: Michigan Department of Transportation, Road Quality Forecasting System

Table 13: Lane Mile Improvements to Maintain System Conditions to 2030 (Accruing Preservation Needs)

Estimated Accruing Pavement Preservation Needs to 2030	*Resurfacing Lane Miles*		*Preventative Maintenance Lane Miles*		*Total Lane Miles with Accruing Preservation Needs*		*Totals by Preservation Activity*		*Total System Lane Miles by Region*	*Regions as a Percentage of Statewide Need*	
	Freeway	*Non-Freeway*	*Freeway*	*Non-Freeway*	*Freeway*	*Non-Freeway*	*Resurfacing*	*Maintenance*	*Lane Miles*	*Resurfacing*	*Maintenance*
MDOT Bay Region	701	1,411	3,057	4,938	3,758	6,348	2,112	7,995	4,272	16.1%	15.6%
MDOT Grand Region	506	922	2,323	2,665	2,829	3,587	1,428	4,988	2,771	10.9%	9.7%
MDOT Metro Region	771	1,155	4,682	4,476	5,453	5,631	1,926	9,158	4,436	14.7%	17.8%
MDOT North Region	627	1,861	1,709	6,513	2,336	8,373	2,488	8,222	4,572	19.0%	16.0%
MDOT Southwest Region	508	1,097	2,539	3,838	3,047	4,935	1,605	6,377	3,433	12.2%	12.4%
MDOT Superior Region	52	1,866	392	6,531	445	8,397	1,918	6,923	3,960	14.6%	13.5%
MDOT University Region	531	1,116	3,759	3,906	4,289	5,022	1,647	7,664	4,052	12.5%	14.9%
Statewide Total	3,696	9,428	18,462	32,866	22,157	42,293	13,123	51,327	27,496	100.0%	100.0%

Source: Michigan Department of Transportation Pavement Sufficiency Database

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

Statewide, MDOT will need to complete resurfacing of approximately 13,123 lane miles of roadway and preventative maintenance on 51,327 lane miles to maintain pavement condition goals to the year 2030. This involves performing resurfacing on approximately 48 percent of Michigan's roadways and performing preventative maintenance on all of the trunkline system, with approximately 86 percent of the system expected to require more than one preventative maintenance treatment to preserve desired conditions to the year 2030.

Those regions with the largest mileages of trunkline roadway will naturally require the most preservation of lane miles to maintain desired conditions. The Metro and North regions will each account for approximately 17 percent of Michigan's accruing preservation needs to 2030, the Bay region will account for 16 percent, and the University and Superior regions each will

account for approximately 14 percent of lane miles with accruing preservation requirements. The Southwest and Grand regions will account for 10 and 12 percent respectively.

6.1.4 Lane Width

Lane width affects both capacity and safety. Narrow lanes prevent a road from operating at capacity and can increase the likelihood of lateral conflicts between vehicles, or between vehicles and fixed objects. As with roadway alignment, lane width is more crucial on those functional classifications with higher travel volumes. Facilities with narrow lanes (10-feet or less) may require reconstruction projects as volumes increase, or vehicle and driver characteristics change necessitating wider lanes to secure safety and operational performance.

Currently, freeway type facilities (e.g., interstates) are expected to have 12-foot lanes. The percentage of miles with 12-foot-plus lane widths is lower on non-freeway type facilities that carry less traffic. Lanes that are less than ten feet wide are mainly concentrated on the collector roads. **Table 14** shows MDOT sufficiency data demonstrating the concentration of narrow lane facilities on Michigan's urban collectors and minor arterials.

Table 14: Miles by Lane Width

Area Type	*National Functional System*	*Route Miles Less than 10-Foot Wide*		*Route Miles Less than 12-Foot Wide*		*Total Route Miles*
		Miles	*Percent*	*Miles*	*Percent*	*Miles*
Rural	Rural Interstate	0	0%	0	0%	613
	Rural Other Principal Arterial	0	0%	476	18%	2,573
	Rural Minor Arterial	0	0%	1,604	47%	3,428
	Rural Collector and Below	30	6%	397	78%	513
	Rural Subtotal	30	0%	2,478	35%	7,126
Urban	Urban Interstate	0	0%	1	0%	630
	Urban Freeways and Expressways	0	0%	8	3%	320
	Urban Other Principal Arterial	0	0%	332	30%	1,095
	Urban Minor Arterial	0	0%	184	36%	508
	Urban Collector	0	0%	23	54%	43
	Urban Subtotal	0	0%	548	21%	2,596
	System Totals	30	0%	3,026	31%	9,723

Source: Michigan Department of Transportation Sufficiency File

6.1.5 Existing and Emerging Reconstruction Needs

In addition to deficient lane width, factors such as changes in traffic rates, vehicle mix, land development, population, and other system components can cause existing designs to become antiquated or insufficient for safety and operational performance on the integrated system. Often, reconstruction of roadways may be necessary to achieve better integration with non-motorized, transit, or aviation systems to connect users with activities. At this time, 807 lane miles of Michigan's trunkline roadways are in need of reconstruction to support safety and operational performance needs in 2005. **Table 15** shows Michigan's current trunkline roadway reconstruction for operational and safety performance backlog by MDOT region.

Table 15: Backlog Lane Mile Reconstruction Needs for Operational and Safety Performance

	Reconstruction Lane Miles		*Total Backlog Reconstruction Lane Miles*	*Total System Lane Miles by Region*	*Regions as a Percentage of Statewide Need*
Estimated Backlog Reconstruction Needs 2005	*Freeway*	*Non-Freeway*	*Lane Miles*	*Lane Miles*	*Reconstruction*
MDOT Bay Region	145	42	188	4,272	23.2%
MDOT Grand Region	69	8	77	2,771	9.6%
MDOT Metro Region	161	116	276	4,436	34.2%
MDOT North Region	32	19	51	4,572	6.3%
MDOT Southwest Region	64	22	85	3,433	10.6%
MDOT Superior Region	11	47	57	3,960	7.1%
MDOT University Region	62	11	73	4,052	9.1%
Statewide Total	543	264	807	27,496	100.0%

Source: Michigan Department of Transportation Suffiency Data, 2005

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

As demands on Michigan's integrated system respond to changes in traffic volumes, development patterns, system user characteristics, and vehicle mix, designs that are sufficient today will require reconstruction to accommodate changing conditions. For example, roadways today classified as rural in the future may become urban. Roadways today classified as minor arterials in the future may require upgrades to principal arterials. For this reason, Michigan's roadways will require further reconstruction in the time horizon of *MI Transportation Plan*. **Table 16** shows the anticipated accruing needs for roadway reconstruction by MDOT region; it shows the number of lane miles that are expected to need reconstruction from 2006 to 2030, as well as the percentage of overall miles within each region expected to require reconstruction.

Table 16: Accruing Lane Mile Reconstruction Needs for Operational and Safety Performance to 2030

Estimated Accruing Reconstruction Needs to 2030	*Reconstruction Lane Miles*		*Total Accruing Reconstruction Lane Miles*	*Total System Lane Miles by Region*	*Regions as a Percentage of Statewide Need*
	Freeway	*Non-Freeway*	*Lane Miles*	*Lane Miles*	*Reconstruction*
MDOT Bay Region	917	353	1,270	4,272	14.8%
MDOT Grand Region	656	205	861	2,771	10.0%
MDOT Metro Region	1,708	577	2,285	4,436	26.6%
MDOT North Region	342	465	807	4,572	9.4%
MDOT Southwest Region	920	274	1,195	3,433	13.9%
MDOT Superior Region	183	467	650	3,960	7.6%
MDOT University Region	1,238	279	1,517	4,052	17.7%
Statewide Total	5,964	2,620	8,584	27,496	100.0%

Source: Michigan Department of Transportation Suffiency Data, 2005

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

Approximately 30 percent of Michigan's trunkline lane miles will require reconstruction in the period from 2006 to 2030. The Metro region accounts for more than 25 percent of accruing reconstruction needs to the year 2030. More than half of the trunkline lane miles in the Metro region requiring reconstruction occur during this period. The University and Southwest regions have high concentrations of reconstruction needs as well, with each of these regions requiring a reconstruction of more than one-third of trunkline lane miles to the year 2030. The Metro, University, and Southwest regions collectively account for more than half of the expected accruing reconstruction needs on Michigan's trunkline system, accounting for just less than half (43 percent) of the total overall system lane mileage today.

6.1.6 Bridge System Conditions

6.1.6.1 Bridge Conditions

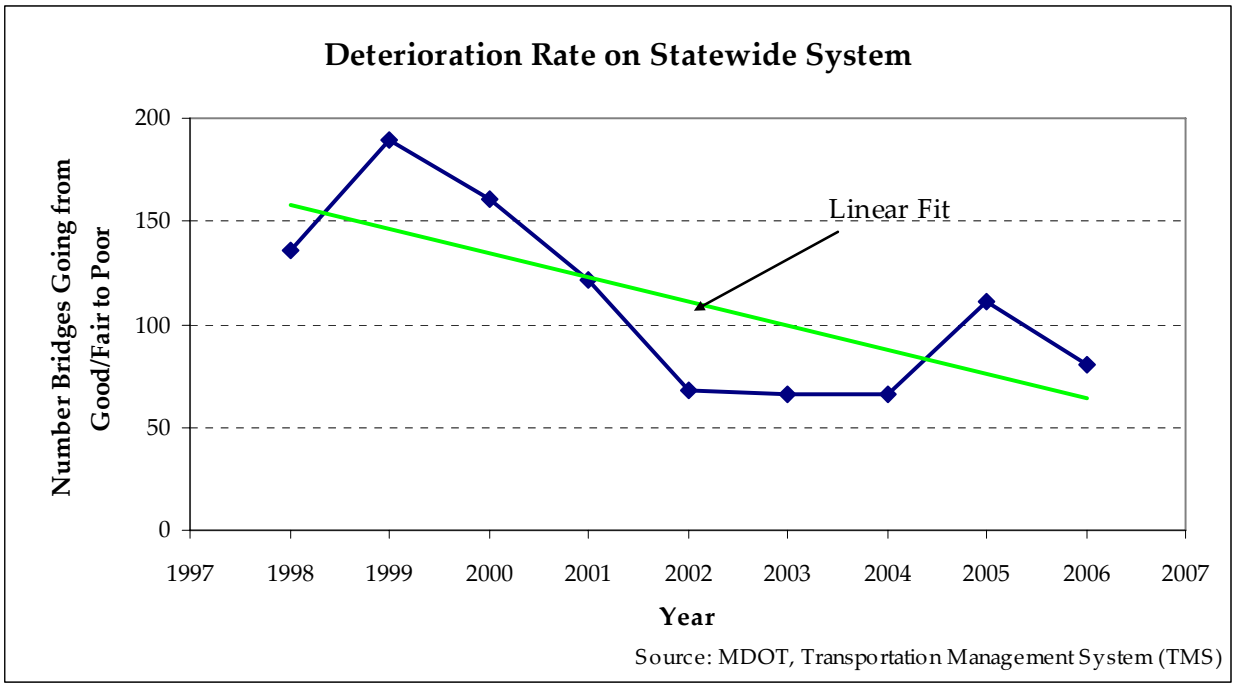
MDOT's Bridge Management System (BMS) is an important part of the department's overall asset management process. BMS is a strategic approach to linking data, strategies, programs, and projects into a systematic process to ensure achievement of desired results.

An important BMS tool used by MDOT to develop preservation policies is the Bridge Condition Forecasting System (BCFS). Using the National Bridge Inventory (NBI) condition ratings, bridge deterioration rate, project cost, expected inflation, and fix strategies, BCFS estimates the future condition of the state trunkline bridge system. BCFS can compare a mix of fixes by modeling different percentages of preventative maintenance, rehabilitation, and replacement projects. Strategies can be modeled on the statewide trunkline network or by region.

Strategies developed using BCFS have proven to be very helpful in managing the trunkline bridge network. By undertaking a balanced mixture of preventative maintenance, rehabilitation, and replacement, MDOT has dramatically increased the number of bridges

improved each year. In 1997, MDOT had fewer than 60 bridge projects, while in 2004 and 2005, MDOT had over 300 bridge projects each year. At this rate, MDOT will work on each bridge in the network every 15 years. The department has also dramatically decreased the number of bridges falling into the poor category as shown in **Figure 9**.

Figure 9: Number of Bridges Going from Good or Fair to Poor



MDOT manages large and unique bridges separately. The complexity, large cost, and strategic importance of these bridges require specialized expertise to inspect and manage them. A centralized unit is dedicated to administration and strategic planning for these important structures.

6.1.6.2 Highway Bridge Condition Goal

In 1998, MDOT developed the *Strategic Investment Plan for Trunkline Bridges*. This plan has served as the framework for MDOT's Bridge Management System (BMS) and it made a commitment to long-range strategic planning and investment in the trunkline bridge network. The strategic plan, along with MDOT's Call for Projects process, provides an integrated network management strategy that is necessary to achieve the network condition goals in a cost-effective manner.

The goal of MDOT's *Strategic Investment Plan for Trunkline Bridges* is to preserve the trunkline bridge network to ensure safety and serviceability, while optimizing all available resources. Specifically, the network condition goals are:

1. As a priority on the network, immediately address the needs of 100 percent of the structures of critical concern. The critical structures are those bridge needs that must be addressed immediately to preserve the safety of the public.
2. To improve the overall condition of the freeway bridge network so that 95 percent of the structures on that network are rated good or fair.
3. To improve the overall condition of the non-freeway bridge network so that 85 percent of the structures on that network are rated good or fair.

Goal number one is the department's ongoing commitment to always keep MDOT's bridges safe. Goal numbers two and three provide set targets for condition levels for the trunkline freeway and non-freeway systems. In 2004, MDOT achieved the non-freeway goal (goal number three) of 85 percent non-freeway bridges in good or fair condition. The department's strategy now is to maintain that condition, while making steady progress towards the freeway bridge goal, which the following **Section, 6.1.6.3, Projected Trend in Bridge Conditions**, and the *Revenue Gap and Investment Packages Report* will discuss further.

6.1.6.3 Projected Trend in Bridge Conditions

Figure 10 shows the forecasted condition of trunkline bridges given current funding levels. It can be seen that given the current bridge strategy and funding, the department will continue to be able to improve the condition of the trunkline bridge network, but inflation will gradually erode the ability to make progress and, after 2019, the condition of the trunkline bridges will begin to decline.

A review of the freeway bridge forecast, **Figure 11**, shows that MDOT is not on track to meet the freeway bridge goal of 95 percent in good or fair condition. At this funding level, conditions will peak at approximately 90 percent of freeway bridges in good or fair condition in 2018 and thereafter freeway bridge conditions will once again decrease. **Figure 12** shows that, with current funding, MDOT will be able to exceed the non-freeway bridge goal until 2014; then it, too, will begin to decline, with non-freeway bridge conditions falling below 85 percent rated good or fair by 2024.

Figure 10: Long-Term Forecast: Bridge Condition on Statewide System (Combined Freeway and Non-Freeway)

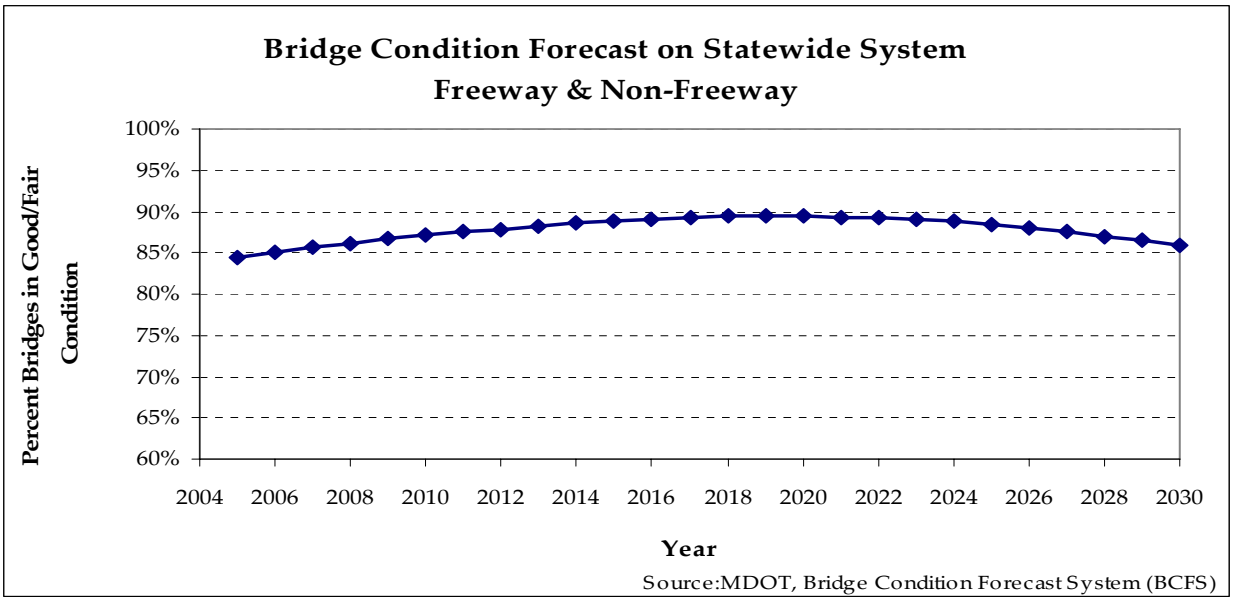


Figure 11: Long-Term Forecast: Bridge Condition on Freeway Network

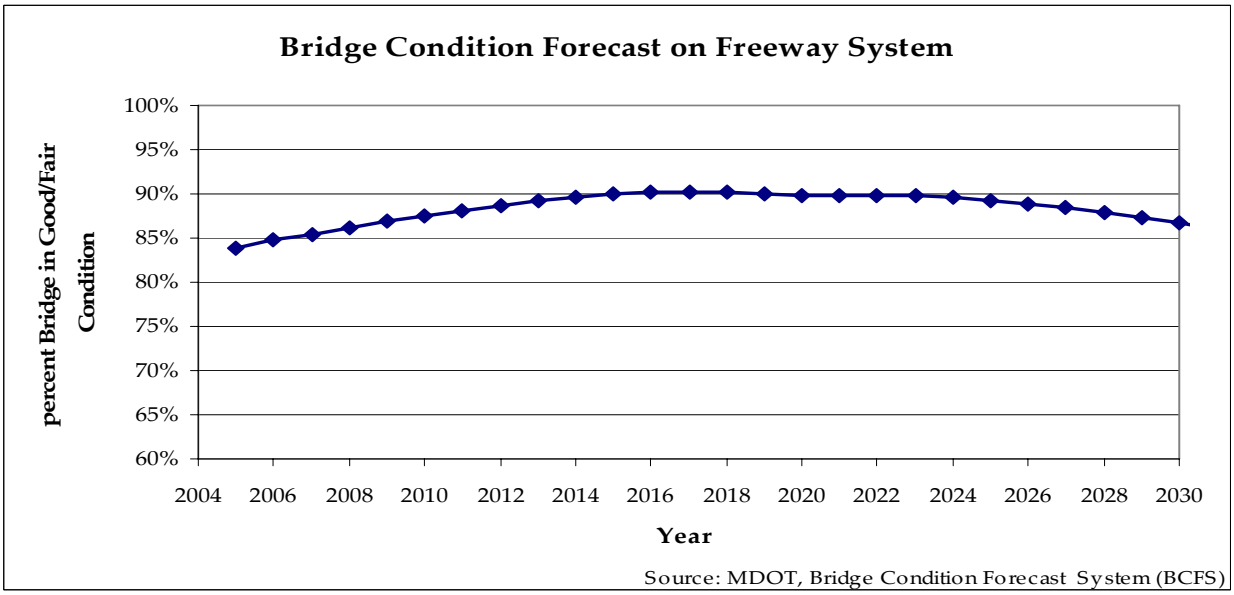
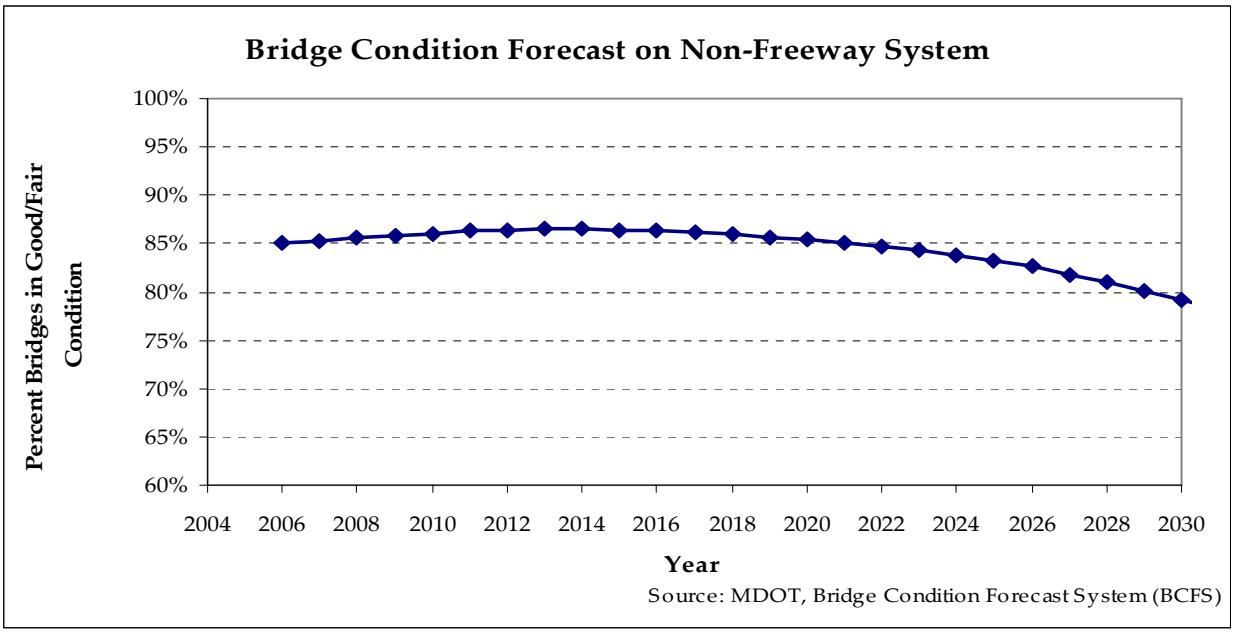


Figure 12: Long-Term Forecast: Bridge Condition on Non-Freeway Network



6.1.7 Existing and Accruing Bridge Needs

Based on these analyses, MDOT estimates that 410 freeway and 54 non-freeway bridges need rehabilitation or replacement today. These bridges represent MDOT's backlog in bridge replacement/rehabilitation and preventative maintenance needs. MDOT's backlog in bridge needs is summarized by MDOT region in **Table 17**.

Table 17: Backlog of Bridge Needs for Michigan Trunkline Bridges 2005

Estimated Backlog Bridge Needs 2005	*Bridge Replacements*		*Bridges Requiring Preventative Maintenance*		*Total Bridges with Existing Needs in 2005*	
	Freeway	*Non-Freeway*	*Freeway*	*Non-Freeway*	***Replacement*	*Maintenance*
MDOT Bay Region	103	32	67	3	135	70
MDOT Grand Region	6	0	54	3	6	57
MDOT Metro Region	192	14	83	2	206	85
MDOT North Region	0	0	11	2	0	13
MDOT Southwest Region	39	0	39	3	39	42
MDOT Superior Region	0	0	2	3	0	5
MDOT University Region	70	8	57	2	78	59
Statewide Total	410	54	313	18	464	331

Source: Michigan Department of Transportation

**Replacement includes Replacement and Rehabilitation

In addition to the backlog in bridge replacement and maintenance needs, to achieve MDOT's bridge goals will require additional bridge replacement/rehabilitation and maintenance activities to the year 2030. **Table 18** summarizes the expected accruing bridge replacement and maintenance activities needed to consistently achieve MDOT's bridge condition goals to the year 2030. In the time horizon of *MI Transportation Plan*, approximately 2,290 of Michigan's trunkline bridges will need replacement or rehabilitation, and 2,335 will require preventative maintenance projects.

Table 18: Accruing Bridge Needs for Michigan Trunkline Bridges 2006 to 2030

Estimated Accruing Bridge Needs to 2030	*Bridge Replacements*		*Bridges Requiring Preventive Maintenance*		*Total Bridges with Accruing Needs to 2030*	
	Freeway	*Non-Freeway*	*Freeway*	*Non-Freeway*	***Replacement*	*Maintenance*
MDOT Bay Region	269	85	282	78	354	360
MDOT Grand Region	262	54	275	50	316	325
MDOT Metro Region	581	66	610	61	647	671
MDOT North Region	99	70	104	65	169	169
MDOT Southwest Region	196	61	205	56	257	261
MDOT Superior Region	19	119	20	109	138	129
MDOT University Region	340	69	357	63	409	420
Statewide Total	1,766	524	1,853	482	2,290	2,335

Source: Michigan Department of Transportation

**Replacement includes Replacement and Rehabilitation

6.1.8 Non-pavement System Conditions

Michigan's non-pavement highway system assets include carpool lots, rest areas, drainage structures, noise walls, freeway lighting and pump houses. Their condition is important both for the integration of the system and for the performance of Michigan's roadways.

6.1.8.1 Carpool Lots

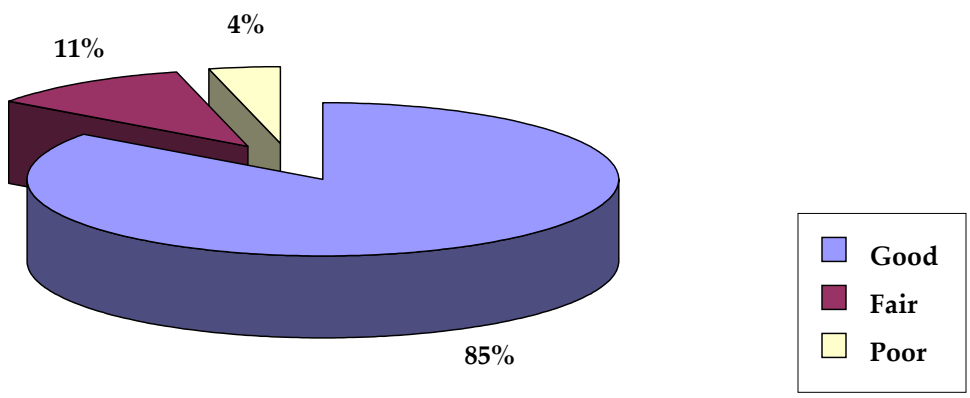
Carpool Parking Lots (CPLs) are used as rendezvous points for parties traveling or commuting together and as parking lots where those travelers and commuters can park unneeded vehicles until their return. MDOT manages more than 200 carpool parking lots, of which 182 (84 percent) are located within MDOT right-of-way (ROW). The rest are owned by local units of government or leased from private property owners. As of 2005, the system had 217 CPLs spread across the state. Approximately 75 percent of CPLs are paved and 25 percent are gravel.

CPLs are evaluated using the Pavement Surface Evaluation and Ratings (PASER) system, a 1 to 10 scale measuring the condition of road surfaces. The following categories are used for CPLs:

- Good – PASER rating of 6-10;
- Fair – PASER rating of 4-5; and
- Poor – PASER rating of 1-3

As shown in **Figure 13**, at the end of 2005, 85 percent of the CPL system was in good condition (PASER rating between 6 and 10); 96 percent of the system was in fair or good condition (PASER rating of 4 or greater). The overall average PASER rating for the CPL system was 7.2 out of 10. CPL inspections are usually performed during the summer months and, thus, 2005 is the last year for which data is available.

Figure 13: 2005 Carpool Parking Lot Conditions



Source: Michigan Department of Transportation, Transportation Management System (TMS)

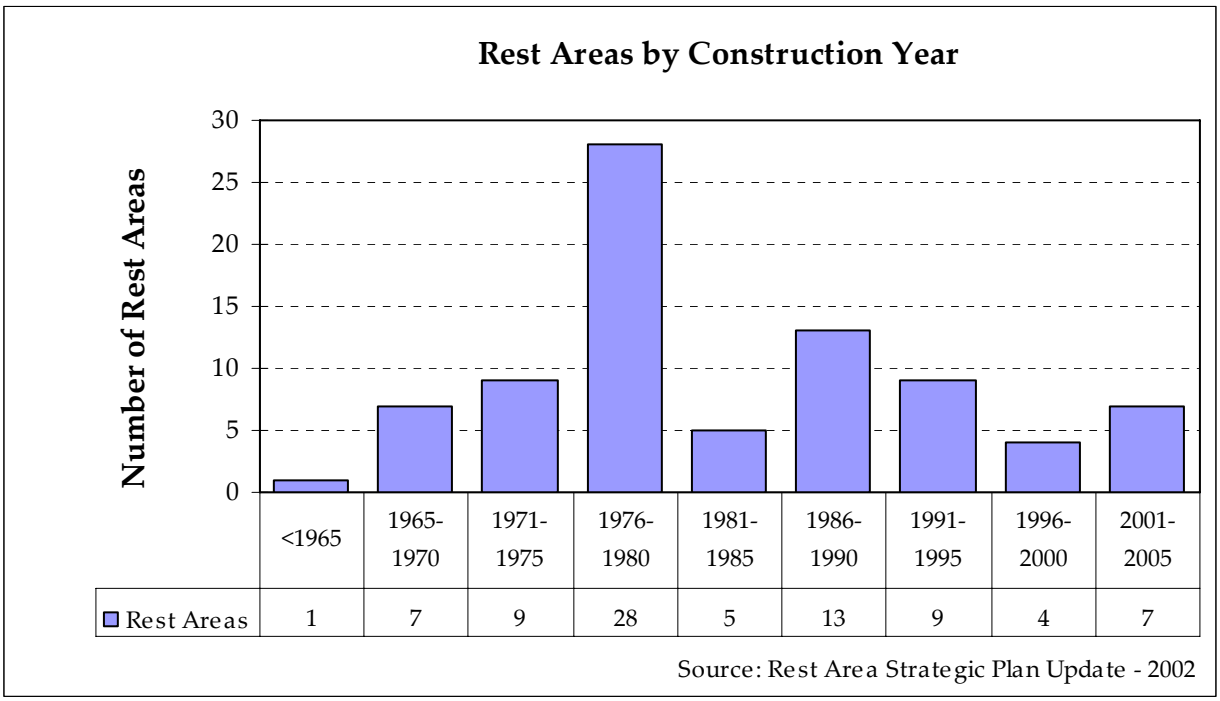
6.1.8.2 Rest Areas

MDOT rest areas and roadside parks are part of the trunkline highway system[2]. They are a valuable asset to MDOT and a primary point of contact with the public. The role of the rest area has evolved from the "safety rest area" to facilities that support travel, tourism, and serve as an important marketing and public contact tool for those states competing for tourist dollars. These facilities provide the contact and communication point between MDOT and the people they serve. In order to meet the needs of the public, MDOT must continue to provide high-quality facilities that MDOT's customers feel comfortable using and the department can be proud to call MDOT facilities.

[2] Source: Executive Summary, *Rest Area Strategic Plan Update* – 2002

In September of 1992, the *Rest Area/Welcome Center Strategic Plan* was completed and presented to the Highway Steering Committee. Many goals were identified as part of the 1992 plan and have been incorporated into the new building plans and developments. Since then, the Roadside Development Program has invested approximately $5 million per year in direct rest area improvements on facilities that serve approximately 50 million visitors at its 85 rest area facilities every year. This direct investment to the rest area program was increased to $9 million annually in 2004. **Figure 14** summarizes 83 rest areas by the year they were constructed. Two of MDOT's 85 rest areas are excluded from this summary; one is a rustic rest area and the other is closed.

Figure 14: Number of Rest Areas by Construction Year



Currently 37 rest areas have 500,000 or more visitors each year; 60 percent of those are of the current design and were considered in good condition at the end of 2005. Those facilities that receive the greatest use are the highest priority and need replacement or renovation. While not all facilities are high use, serving 500,000 or more visitors per year, the traveling public still expects basic needs and services and requires facilities that can provide unlimited access. These facilities shall meet current barrier-free access codes, contain infrastructure that meets current codes and standards, and have site amenities consistent with current standards of the Roadside Development Program. **Table 19** displays rest area attendance information and indicates that 44 percent of MDOT's rest areas serve over 500,000 visitors every year.

Table 19: Rest Area Attendance

Annual Attendance	*Number of Rest Areas*	*Percent*
Less than 100,000	6	7.1%
100,000 – 199,999	10	11.8%
200,000 – 299,999	9	10.6%
300,000 – 399,999	11	12.9%
400,000 – 499,999	12	14.1%
500,000 and over	37	43.5%
Statewide Total	85	100.0%

Source: *Rest Area Strategic Plan Update*, Table A - Attendance Ranking

6.1.8.3 Drainage Structures

MDOT's statewide highway system includes an extensive, engineered drainage system, which serves two distinct design functions. The first purpose is structural, to convey water away from the road to support pavement integrity. The second is to manage and convey storm water runoff from the roadway throughout the highway system and eventually back into the environment. Efforts are underway as part of the new MDOT storm water management plan, and in coordination with the department's asset management program, to inventory storm water system features including identification and mapping of outfalls, and inventorying of storm water control structures. A database has been developed to organize this data as it is compiled.

6.1.8.4 Weigh Stations

During the 1960s, 1970s, and 1980s MDOT invested in a system of weigh stations to support weight enforcement, primarily along interstate highways in southern Michigan. Motor carrier safety enforcement was formalized in the 1980s and safety inspection of vehicles was particularly emphasized as a targeted activity to be conducted along with weigh station operations.

While MDOT provides the infrastructure, weigh stations in Michigan are operated by the Michigan State Police, Motor Carrier Division (MSP/MCD). In the late 1990s, agreements were executed with MSP/MCD to de-emphasize traditional weigh station operations at the interior weigh stations and shift enforcement to more mobile patrols. Weigh stations located at Michigan's southern border (inbound) were retained and MDOT began working on technological tools to provide greater support for mobile patrols.

In addition, there are also some 17 truck safety turnout locations in the Upper Peninsula. These sites were mandated in MDOT's appropriation bills for the past several years. The

intent of these sites is to provide a safe place for log trucks to stop and secure their loads, reducing the incidence of log spills and accidents.

6.1.8.5 Type II Noise Abatement Barriers

Currently, there are 30 Type II noise abatement barriers located along MDOT's trunkline system. They are found predominantly in southern Michigan, primarily in Wayne, Washtenaw, Macomb, Oakland, and Kalamazoo Counties. The most recent State Transportation Commission Noise Abatement Policy (2003) contains no provision for addressing noise abatement barrier preservation and maintenance. Preservation and maintenance needs of existing noise barriers are currently under study and funding mechanisms will need to be identified.

6.1.8.6 Replacement of Existing Freeway Lighting Program

The Replacement of Existing Freeway Lighting Program is a new program to the MDOT road and bridge capital outlay program. The intent of the Freeway Lighting Rehabilitation Program is to identify and prioritize freeway lighting in need of rehabilitation. The department acknowledges the need for rehabilitation and has committed resource dollars for the next 10 years to accomplish this effort.

MDOT owns over 200 miles of continuous freeway lighting utilizing either median mounted lights or shoulder mounted lights. There are also 70 illuminated interchanges, with 50 of those illuminated by tower lights (or high mast lighting). The majority of freeway lighting is in Metro, Grand, Bay and University regions. In the Metro region alone, the department owns 104 miles of continuous freeway lighting and 40 interchanges illuminated with tower lights (high mast lighting). It is reasonable to suggest that rehabilitation efforts will be concentrated in regions with the most existing freeway lighting.

6.1.8.7 Pump Station Capital Rehabilitation Program

The intent of the Pump Station Capital Rehabilitation Program is to identify and prioritize storm water pump stations in need of complete electro-mechanical rehabilitation. Currently, MDOT acknowledges the need for rehabilitation and has committed resource dollars for the next nine years to accomplish this effort.

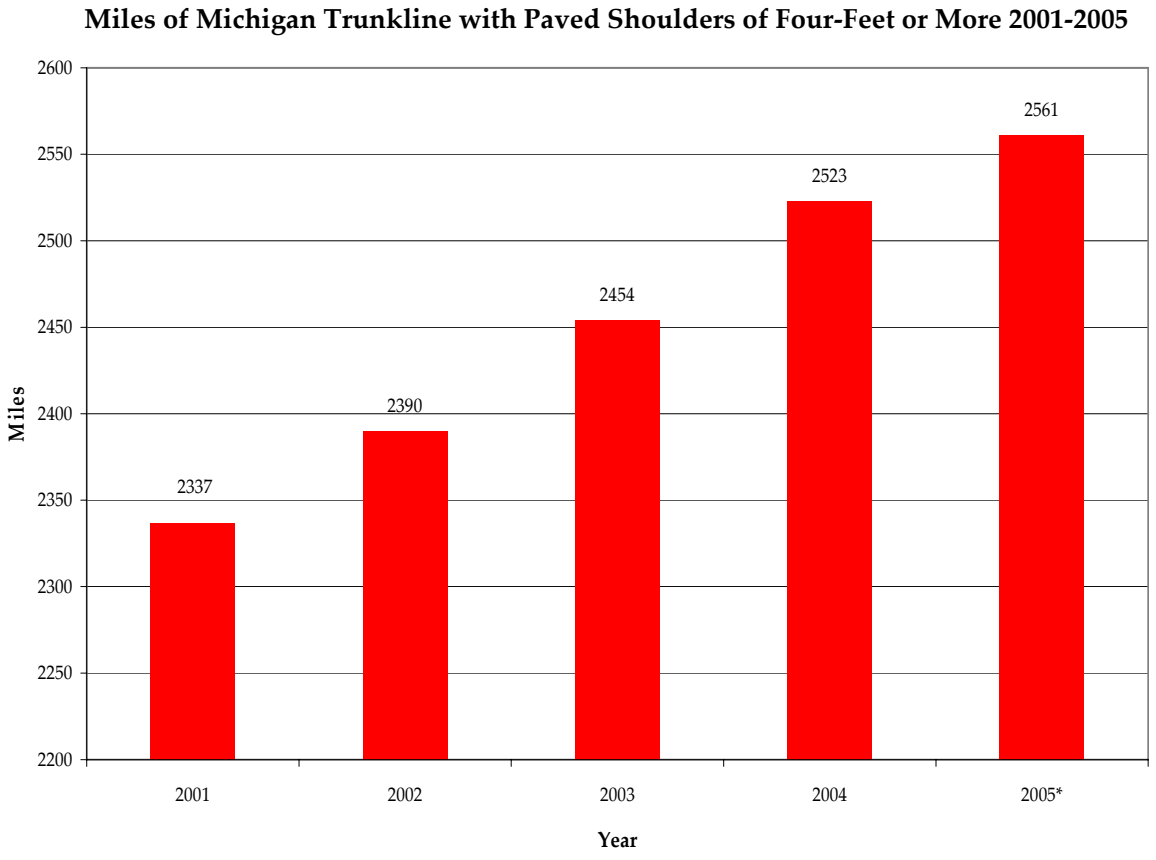
The department owns 169 pump stations. All regions have at least one pump station, with Bay, University and Metro having progressively the most. In Wayne County alone, MDOT owns 118 such facilities. The Maintenance Support Area (MSA), in conjunction with the Metro Region and the Wayne County Department of Public Works (DPW), currently performs and supports routine and emergency pump station maintenance services from the existing maintenance program. The Pump Station Capital Rehabilitation Program compliments the current pump station maintenance program. It is reasonable to suggest

that rehabilitation efforts must be concentrated in urban areas with larger populations of pump stations.

6.1.9 Non-motorized System Conditions

Non-motorized facilities often provide critical linkages between roadways and other components of Michigan's integrated transportation system. These facilities also support the safety of roadway traffic as well as walking and cycling activities important for recreation, the health, and quality of life for Michigan's residents. Paved shoulders four-foot wide or greater on non-freeway trunkline roadways provide a safer environment for non-motorized uses than do narrow shoulders. Wide shoulders can also better accommodate linkages to stand-alone, non-motorized networks such as sidewalks and recreational trails. In the last four years, Michigan has made significant progress in the availability of wide shoulders on non-freeway trunkline facilities. **Figure 15** illustrates how wide shoulders in Michigan have become more common in this period, increasing from 2,337 route miles of Michigan's system in 2001 to 2,561 in 2005.

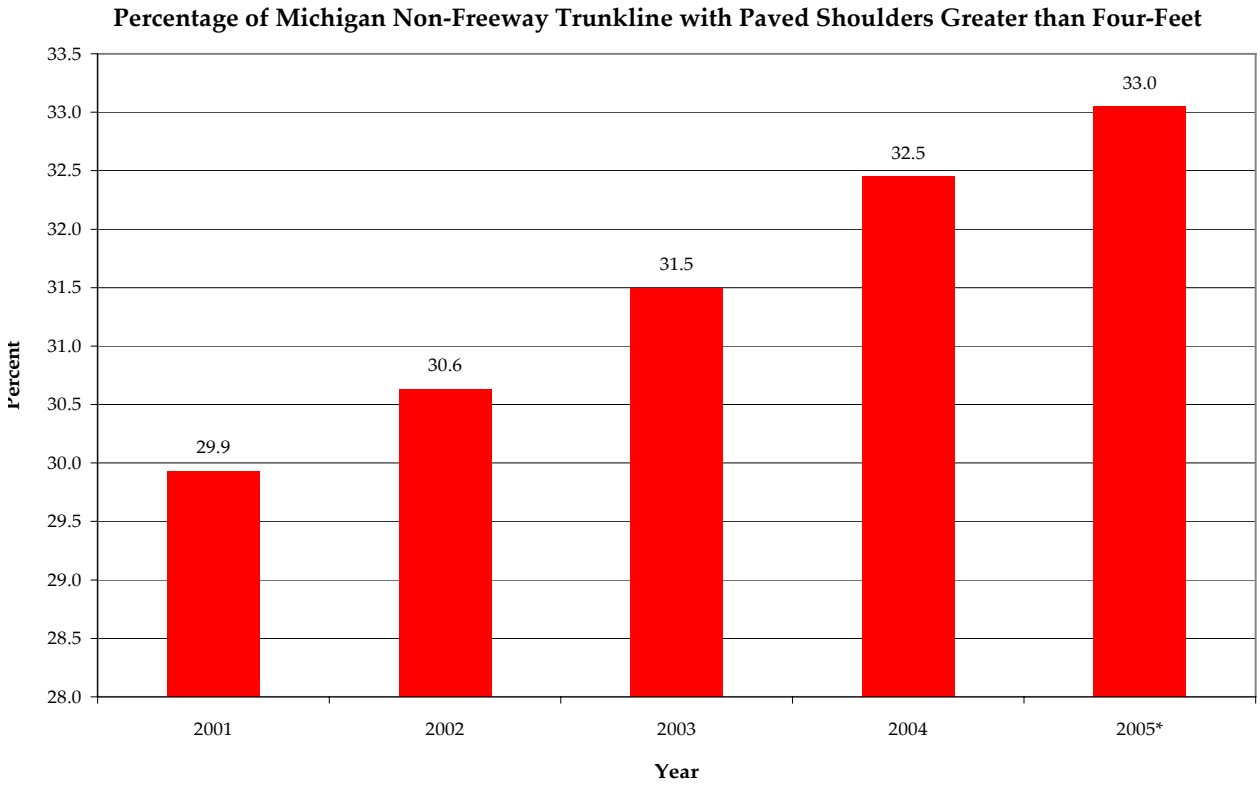
Figure 15: Increase in Non-Freeway Michigan Trunklines with Wide Shoulders: 2001-2005



Source: *MI Transportation Plan Non-Motorized Technical Report*

Figure 16 shows how these increases in shoulder width represent significant increases in the overall percentage of Michigan's trunkline route miles that have paved shoulders of more than four-feet.

Figure 16: Increases in Non-Freeway Michigan Trunklines with Wide Shoulders: 2001-2005



Source: *MI Transportation Plan Non-Motorized Technical Report*

6.2 Transit System Condition

The condition of the public transportation fleet statewide, as measured in the National Transit Database (NTD) by the average age of the vehicles and usage rates, has remained largely steady between 1996 and 2004. As shown in **Table 20**, the average age of buses shows a modest improvement in the age of the vehicles between 1996 and 2004. In 1996, the average age of the fleet was 9.1 years; it decreased to 6.4 years in 2001. This suggests older vehicles were retired and new vehicles entered the fleet. The average age increased again, to 7.9 years, in 2004. Also shown in **Table 20**, the age of the demand-response vehicle fleet is virtually unchanged between the design years, with 4.2 years in 1996 and 4.3 years in 2004.

Table 20: Fleet Size and Average Age of Fleet

	Fleet Size				*Average Age of Fleet in Yrs*	
	Bus	*Demand-Response*	*Light Rail*	*Total*	*Bus*	*Demand-Response*
1996	1,461	458		1,919	9.1	4.2
2001	1,738	863	12	2,613	6.4	3.6
2004	1,586	910	12	2,508	7.9	4.3

Source: Federal Transit Administration National Transit Database

Note: Includes Michigan transit agencies reporting to NTD at year shown only.

Two key indicators of transit system conditions defined by the Federal Transit Administration (FTA) are the peak-to-base ratio and the percent-spare-ratio. The peak-to-base ratio is the number of vehicles operated in passenger service during the peak period divided by the number operated during the base period. The percent-spare ratio is the total active fleet less the peak vehicle requirements divided by the peak vehicle requirements. For example, the percent spare is the portion of the fleet that is still spare, or not deployed during peak vehicle requirements. The definition of the percent spare ratio is:

Percent spare ratio =
(total active fleet – total vehicle requirement)/peak vehicle requirement

Usage indicators such as peak-to-base ratio and the percentage of spare vehicles available to operators suggest modest improvements between the period between 1996 and 2004. The average peak-to-base ratio in 1996 was 1.6; 2004 shows and improvement to 1.4 (see **Table 21**). In terms of percent of spares, in 1996, on average, Michigan operators had 27 percent spares; this increases slightly to 30 percent in 2004, exceeding the FTA recommended guideline of 20 percent. High peak-to-base ratios indicate both the smaller transit operations in Michigan (smaller operators are known to have higher ratios), as well as effective management by Michigan's transit operators. The percent spares for the demand-response fleet shows similar patterns; operators had a spare rate of approximately 27 percent in 1996 and 2004.

Table 21: Average Rates of Vehicle Usage Levels

	Average Peak-to-Base Ratio		*Average Percent Spares*	
	Bus	*Demand-Response*	*Bus*	*Demand-Response*
1996	1.6	n/a	26.5	26.9
2001	1.4	n/a	19.8	22.3
2004	1.4	n/a	30.3	27.3

Source: Federal Transit Administration National Transit Database

Note: Includes Michigan transit agencies reporting to NTD at year shown only. Does not include light rail vehicles.

Chapter 7. System Operational Performance

The operational performance of the system pertains to the mobility provided by the system in all of its components to connect users with activities. The mobility available on the highway and transit components of Michigan's transportation system are two key aspects of operational performance that lend themselves to analysis in this report.

7.1 Highway Operational Performance

The Level of Service (LOS) is a measure of mobility and congestion on highways based on the Highway Capacity Manual. The *Highway and Bridge Technical Report* of *MI Transportation Plan* extensively applies LOS analysis to Michigan's highways and bridges. The following analysis looks at the LOS at each of the following hours: 30th, 50th, 100th, 200th, 500th, 700th, and 1000th highest hours for 2005, 2015, and 2030, in miles, to determine how long the congestion lasts and in turn reveal how the system operates. When reviewing this analysis, it is important to remember that one year consists of 8,760 hours (24 hours/day * 365 days/year = 8,760 hours/year). **Table 22:** Percent of Total Hours Represented by Highest Hours illustrates the percent of each hour examined to the total hours in a year.

Table 22: Percent of Total Hours Represented by Highest Hours

30 HH	*50 HH*	*100 HH*	*200 HH*	*500 HH*	*700 HH*	*1000 HH*
0.3%	0.6%	1.1%	2.2%	5.7%	8.0%	11.4%

Source: *Highway and Bridge Technical Report* of *MI Transportation Plan*

This concept is further examined by the following example. Assume that the highest traffic volumes on a roadway all come in the weekday peak hours and that the peak hours are two hours long. The lowest peak hour volume in the year would represent the 520th HH (2 hours/day * 5 days/week * 52 weeks/ year = 520th Highest Hour).

7.1.1 Trunkline System Miles

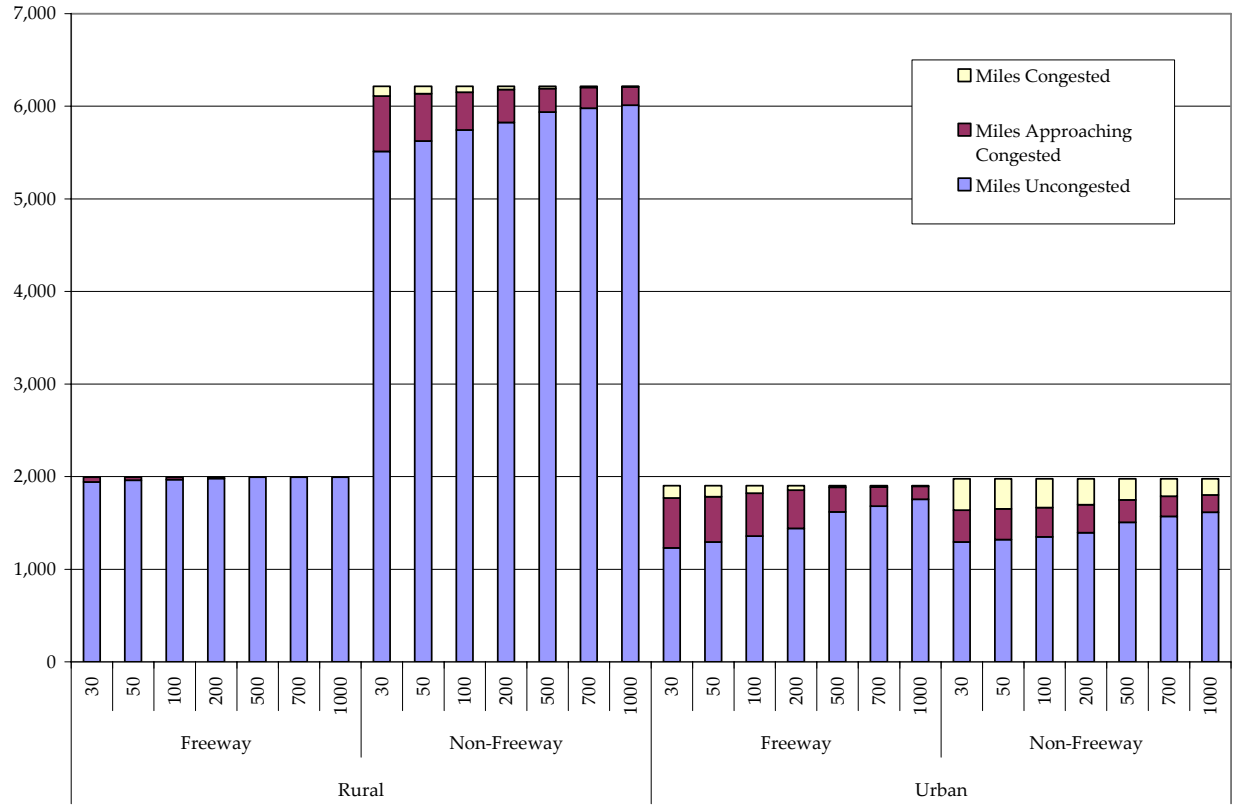
Table 23, Table 24, and **Table 25, as well as Figure 17, Figure 18,** and **Figure 19** show the expected duration of congestion in 2005, 2015, and 2030. **Figure 20** shows miles of uncongested, approaching congested, and congested roadway by type of road and HH for 2005, 2015, and 2030. It can be seen that from 2005 to 2030 both congested and approaching congested miles increase over time. Congested miles account for five percent of the trunkline miles in 2005 and increase to 12 percent in 2030. Approaching congested miles account for 12 percent of miles in 2005 and increase to 16 percent of the miles in 2030. Not only is congestion getting worse with time, but the congested conditions are lasting longer. Looking at the 1000th HH in 2005 two percent of the miles are congested and by 2030 this increases to three percent. In 2005, roads approaching congested account for four percent of the roads while in 2030 they account for nine percent.

Table 23: 2005 Duration of Congestion in Miles on State Trunkline System

	System	*Level of Service*	*30th*	*50th*	*100th*	*200th*	*500th*	*700th*	*1000th*
Rural	Freeway	Uncongested	1941	1961	1969	1979	1993	1993	1993
		Approaching Congested	52	32	24	14	0	0	0
		Congested	0	0	0	0	0	0	0
	Non-Freeway	Uncongested	5513	5626	5743	5826	5937	5978	6013
		Approaching Congested	598	510	408	354	256	226	198
		Congested	105	79	64	35	22	11	4
Urban	Freeway	Uncongested	1231	1295	1359	1441	1619	1681	1754
		Approaching Congested	539	488	463	413	266	207	141
		Congested	131	117	79	47	16	12	6
	Non-Freeway	Uncongested	1294	1320	1349	1395	1507	1571	1615
		Approaching Congested	344	331	317	302	240	218	186
		Congested	340	327	312	281	231	189	176
	Total Congested		577	523	455	363	269	213	186
	%of 30th		100%	91%	79%	63%	47%	37%	32%
	%of Total Miles Congested		5%	4%	4%	3%	2%	2%	2%

Source: Michigan Department of Transportation
Congestion Management System & Statewide Travel Demand Model

Figure 17: 2005 Duration of Congestion in Miles



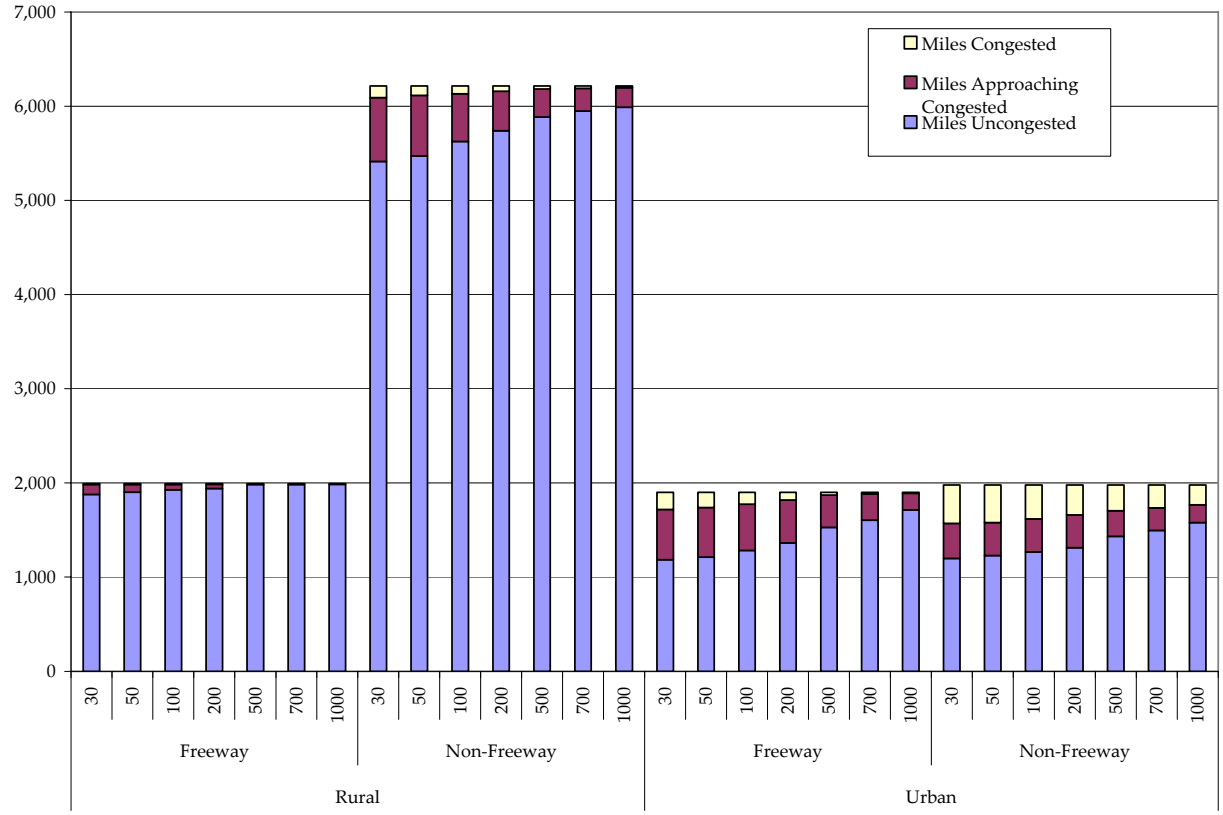
Source: *Highway and Bridge Technical Report* of *MI Transportation Plan*

Table 24: 2015 Duration of Congestion in Miles on State Trunkline System

	System	*Level of Service*	*30th*	*50th*	*100th*	*200th*	*500th*	*700th*	*1000th*
Rural	Freeway	Uncongested	1880	1903	1928	1941	1984	1984	1986
		Approaching Congested	104	81	55	45	9	9	7
		Congested	9	9	9	7	0	0	0
	Non-Freeway	Uncongested	5413	5472	5625	5738	5886	5948	5989
		Approaching Congested	680	642	507	421	297	242	207
		Congested	123	101	83	56	32	25	20
Urban	Freeway	Uncongested	1186	1213	1285	1363	1528	1605	1713
		Approaching Congested	533	525	490	455	344	277	178
		Congested	182	162	126	83	29	18	10
	Non-Freeway	Uncongested	1198	1229	1268	1312	1434	1496	1580
		Approaching Congested	371	349	351	350	271	237	188
		Congested	409	400	360	317	273	244	211
	Total Congested		723	672	578	462	334	288	240
	%of 30th		100%	93%	80%	64%	46%	40%	33%
	%of Total Miles Congested		6%	6%	5%	4%	3%	2%	2%

Source: Michigan Department of Transportation
Congestion Management System & Statewide Travel Demand Model

Figure 18: 2015 Duration of Congestions (in miles)



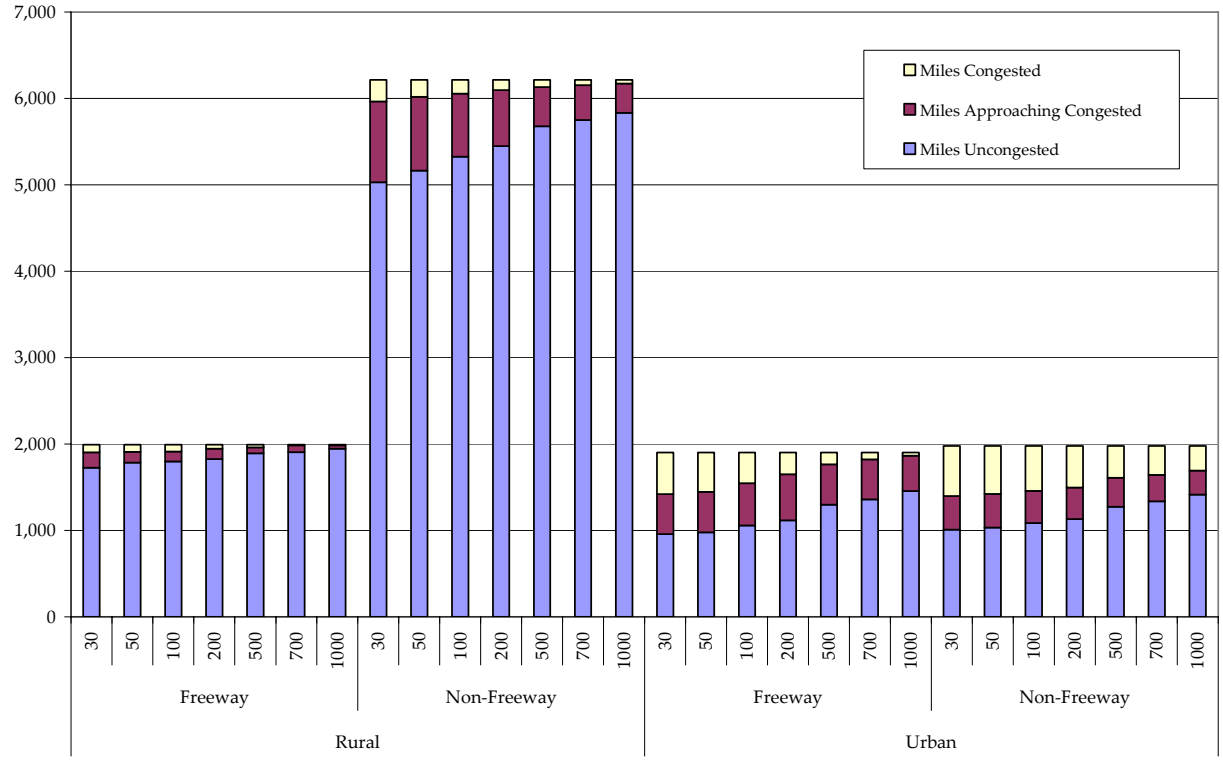
Source: *Highway and Bridge Technical Report* of *MI Transportation Plan*

Table 25: 2030 Duration of Congestion in Miles on State Trunkline System

	System	*Level of Service*	*30th*	*50th*	*100th*	*200th*	*500th*	*700th*	*1000th*
Rural	Freeway	Uncongested	1728	1784	1798	1824	1893	1907	1946
		Approaching Congested	176	125	115	122	68	77	39
		Congested	90	84	79	46	31	9	7
	Non-Freeway	Uncongested	5031	5164	5327	5447	5678	5749	5832
		Approaching Congested	934	853	729	648	453	404	341
		Congested	250	198	159	119	84	62	42
Urban	Freeway	Uncongested	957	976	1058	1117	1299	1359	1455
		Approaching Congested	464	468	489	533	464	463	410
		Congested	480	456	354	251	137	79	36
	Non-Freeway	Uncongested	1011	1032	1087	1132	1273	1337	1416
		Approaching Congested	386	390	372	363	338	306	279
		Congested	581	557	519	483	367	335	283
	Total Congested		1,401	1,294	1,112	900	619	485	368
	%of 30th		100%	92%	79%	64%	44%	35%	26%
	%of Total Miles Congested		12%	11%	9%	7%	5%	4%	3%

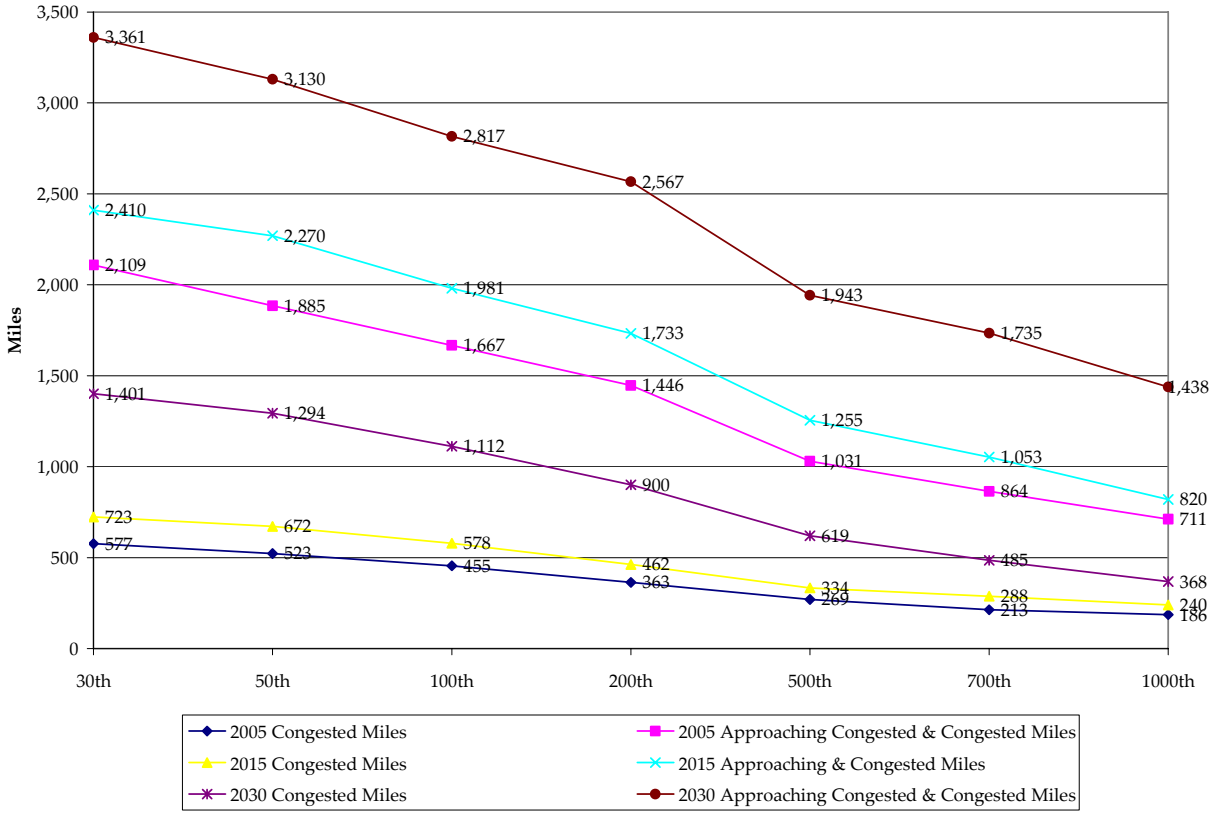
Source: Michigan Department of Transportation
Congestion Management System & Statewide Travel Demand Model

Figure 19: 2030 Duration of Congestion in Miles



Source: *Highway and Bridge Technical Report* of *MI Transportation Plan*

Figure 20: Approaching Congested and Congested Miles by Highest Hour



Source: *Highway and Bridge Technical Report* of *MI Transportation Plan*

7.1.2 Highway System Performance

Section 4.1.2,Trends in Congested vs. Uncongested Roads of the *Highway and Bridge Technical Report* of *MI Transportation Plan* compares miles, annual VMT, and annual CVMT by roadway type and uncongested, approaching congested, and congested, for 1995, 2004, 2015, and 2030. **Table 26** summarizes the 1995 system congestion analysis from the *Highway and Bridge Technical Report*. Key findings regarding congestion are:

- Seven percent of the miles were congested and 13 percent of the miles were approaching congested, accounting for 20 percent of the mileage at or approaching congested.
- Fourteen percent of the VMT was congested and 25 percent of the VMT was approaching congested, accounting for 39 percent of the VMT at or approaching congested.
- Ten percent of the CVMT was congested and 21 percent of the CVMT was approaching congested, accounting for 31 percent of the CVMT at or approaching congested.
- While only 20 percent of the mileage was at or approaching congested, 39 percent of the VMT and 31 percent of CVMT were traveling on these roads.

- Twenty-five percent of the miles were urban, but the urban roads account for 57 percent of the total VMT and 44 percent of the total CVMT.

Table 26: 1995 Miles, Annual Vehicle Miles Traveled (AVMT), Annual Commercial Vehicle Miles Traveled (ACVMT) on State Trunkline System

	System	*Level of Service*	*Miles*	*% Total*	*VMT in Millions*	*% Total*	*CVMT in Millions*	*% Total*
Rural	Freeway	Uncongested	2,177	18%	7,623	17%	1,311	32%
		Approaching Congested	119	1%	1,065	2%	151	4%
		Congested	8	0%	67	0%	7	0%
		Subtotal	2,305	19%	8,755	19%	1,469	36%
	Non-Freeway	Uncongested	5,352	45%	7,091	16%	557	14%
		Approaching Congested	823	7%	2,054	5%	141	3%
		Congested	433	4%	1,510	3%	111	3%
		Subtotal	6,608	55%	10,655	23%	808	20%
		Rural Subtotal	8,913	75%	19,410	43%	2,278	56%
Urban	Freeway	Uncongested	860	7%	5,808	13%	677	17%
		Approaching Congested	444	4%	7,069	16%	535	13%
		Congested	128	1%	3,608	8%	213	5%
		Subtotal	1,432	12%	16,486	36%	1,425	35%
	Non-Freeway	Uncongested	1,210	10%	7,734	17%	286	7%
		Approaching Congested	139	1%	716	2%	25	1%
		Congested	225	2%	1,184	3%	64	2%
		Subtotal	1,573	13%	9,633	21%	375	9%
		Urban Subtotal	3,005	25%	26,119	57%	1,800	44%
		Total	11,918		45,529		4,078	

	Freeway	Non-Freeway
Uncongested	LOS A-C	LOS A-C
Approaching Congested	LOS D-E	LOS D
Congested	LOS F	LOS E-F

Source: Michigan Department of Transportation Congestion Management System

Table 27 summarizes the 2004 system congestion analysis from the *Highway and Bridge Technical Report*. Key findings regarding congestion in 2004 are:

- Five percent of the miles were congested and 12 percent of the miles were approaching congested, accounting for 17 percent of the mileage at or approaching congested (a three percent reduction from 1995).
- Eleven percent of the VMT was congested and 27 percent of the VMT was approaching congested, accounting for 38 percent of the VMT at or approaching congested (a one percent reduction from 1995).
- Seven percent of the CVMT was congested and 21 percent of the CVMT was approaching congested, accounting for 28 percent of the CVMT at or approaching congested (three percent reduction from 1995).
- While only 17 percent of the mileage was at or approaching congested, 38 percent of the VMT and 28 percent of the CVMT were traveling on these roads.
- Thirty-two percent of the miles were urban but the urban roads accounted for 64 percent of the total VMT and 54 percent of the total CVMT, accounting for a seven percent growth in miles, seven percent growth in VMT and ten percent growth in CVMT.
- From 1995 to 2004, there was a 28 percent reduction in congested miles, with less than one percent growth in congested VMT and an 18 percent reduction in congested CVMT.
- From 1995 to 2004, there was a four-percent reduction in miles approaching congested, but a 30 percent increase in VMT and a 20 percent increase in CVMT approaching congested. While there are less miles of roadway approaching congested, these roads see increases in VMT and CVMT.
- From 1995 to 2004, there is a 29 percent growth in urban miles, 32 percent growth in urban VMT and a 48 percent growth in urban CVMT. This illustrates that, not only is Michigan getting more urban, but the urban areas are representing a larger part of the overall travel in Michigan.

This again illustrates the effects of the reclassification of approximately 600 miles of rural roads to urban roads in this period as well as an update to the highway capacity manual methodology, which obscures the picture of traffic growth.

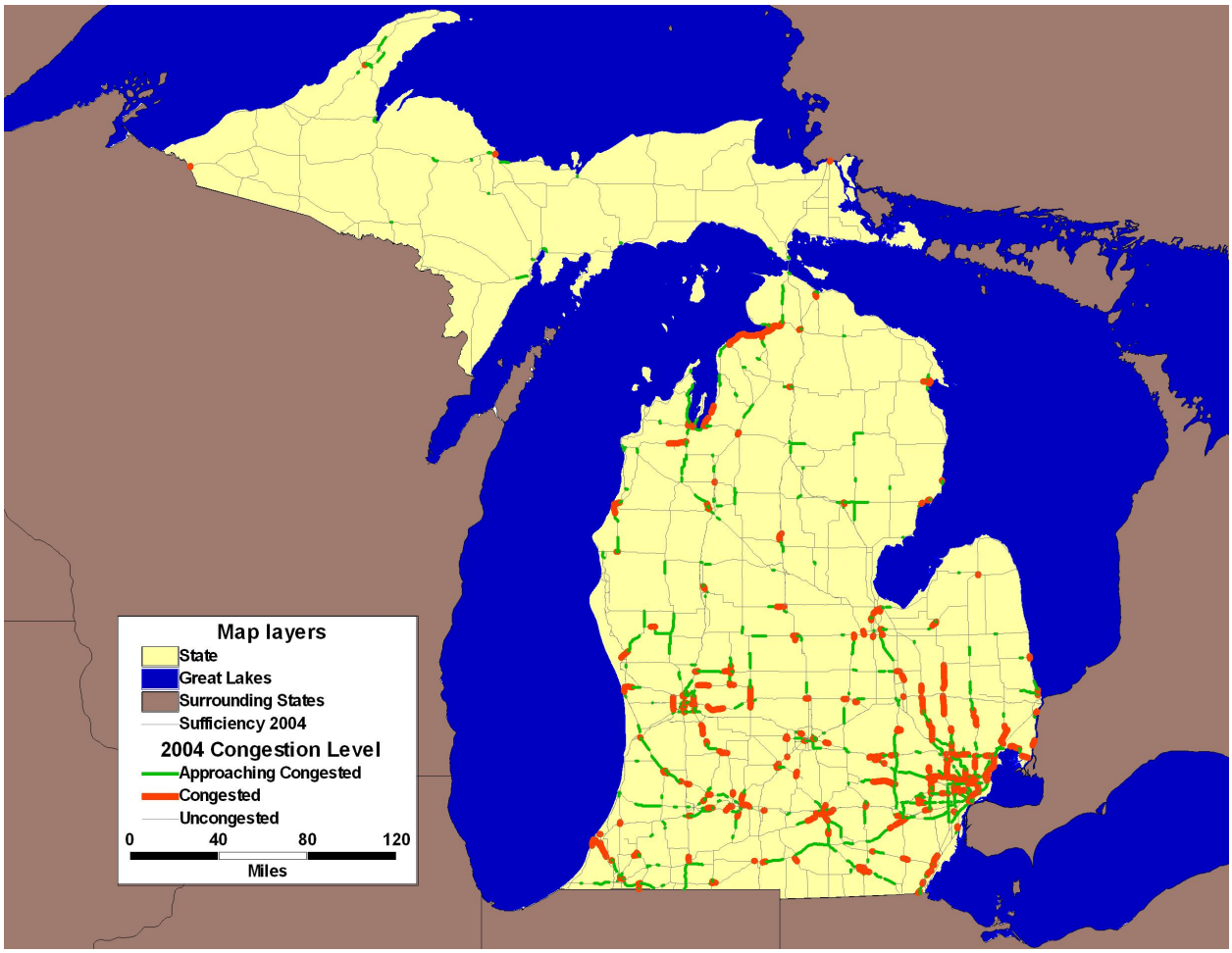
Table 27: 2004 Miles, Annual Vehicle Miles Traveled (AVMT), Annual Commercial Vehicle Miles Traveled (ACVMT) on State Trunkline System

	System	*Level of Service*	*Miles*	*%Total*	*VMT in Millions*	*%Total*	*CVMT in Millions*	*%Total*
Rural	Freeway	Uncongested	1,941	16%	8,196	15%	1,367	28%
		Approaching Congested	52	0%	489	1%	53	1%
		Congested	0	0%	0	0%	0	0%
		Subtotal	1,993	16%	8,685	16%	1,420	29%
	Non-Freeway	Uncongested	5,539	46%	8,069	15%	688	14%
		Approaching Congested	570	5%	1,920	4%	135	3%
		Congested	106	1%	591	1%	28	1%
		Subtotal	6,215	51%	10,579	20%	851	17%
		Rural Subtotal	8,208	68%	19,264	36%	2,272	46%
Urban	Freeway	Uncongested	1,266	10%	10,114	19%	1,208	25%
		Approaching Congested	506	4%	9,032	17%	722	15%
		Congested	129	1%	3,464	6%	202	4%
		Subtotal	1,901	16%	22,610	42%	2,132	43%
	Non-Freeway	Uncongested	1,301	11%	6,832	13%	317	6%
		Approaching Congested	339	3%	2,710	5%	116	2%
		Congested	338	3%	2,325	4%	92	2%
		Subtotal	1,978	16%	11,867	22%	524	11%
		Urban Subtotal	3,879	32%	34,476	64%	2,656	54%
		Total	12,087		53,741		4,927	

	Freeway	Non-Freeway
Uncongested	LOS A-C	LOS A-C
Approaching Congested	LOS D-E	LOS D
Congested	LOS F	LOS E-F

Source: Michigan Department of Transportation Congestion Management System

Figure 21: 2004 Congestion Levels



Source: Michigan Department of Transportation, Statewide Travel Demand Model

Figure 21 illustrates the location of the 2004 congested and approaching congested roadways. It can be seen that the congested and approaching congested roadways are primarily in urban areas or the areas surrounding urban areas.

Table 28 summarizes the 2015 system congestion analysis from the *Highway and Bridge Technical Report*. Key findings regarding congestion in 2015 are:

- Six percent of the miles are projected to be congested and 14 percent of the miles are projected to be approaching congested, accounting for 20 percent of the mileage at or approaching congested (a three percent increase from 2004).
- Fourteen percent of the VMT is projected to be congested and 28 percent of the VMT is projected to be approaching congested, accounting for 42 percent of the VMT at or approaching congested (a four percent increase from 2004).
- Nine percent of the CVMT is projected to be congested and 23 percent of the CVMT will be approaching congested, accounting for 32 percent of the CVMT at or approaching congested (a four percent increase from 2004).
- While only 20 percent of the mileage is projected to be at or approaching congested, 42 percent of the VMT and 32 percent of the CVMT were traveling on these roads.
- Thirty-two percent of the miles (based on the 2004 urban areas) are urban and account for 64 percent of the total VMT and 54 percent of the total CVMT.
- From 2004 to 2015, there is a 26 percent increase in congested miles, 48 percent increase in congested VMT, and 57 percent increase in congested CVMT.
- From 2004 to 2015, there is a 15 percent increase in miles approaching congested, 23 percent increase for VMT approaching congested, and 24 percent increase for CVMT approaching congested.
- From 2004 to 2015 there is no growth in urban miles (since this was based on the 2004 urban areas), but a 14 percent growth in urban VMT and 15 percent growth in urban CVMT.

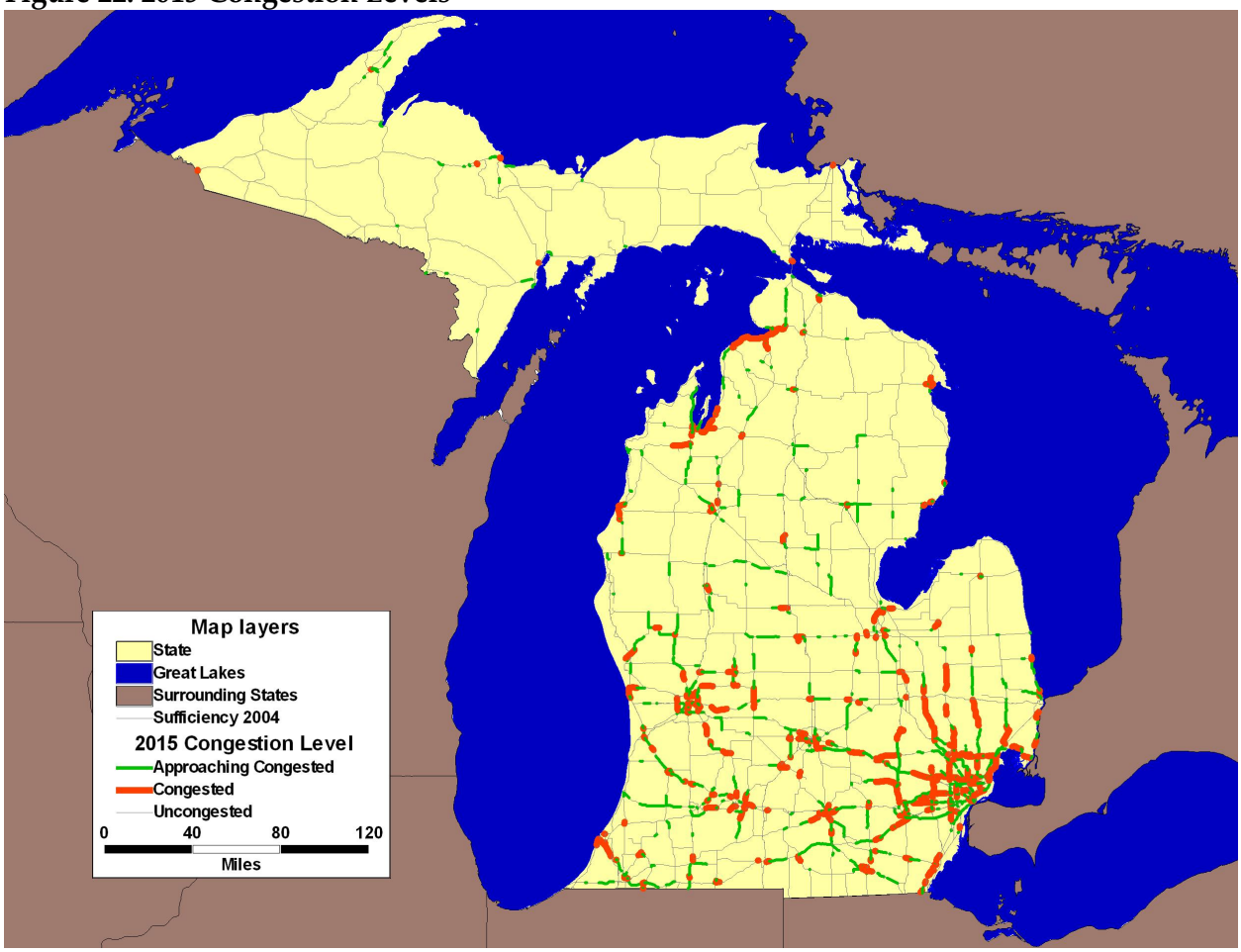
Table 28: 2015 Miles, Annual Vehicle Miles Traveled (AVMT), Annual Commercial Vehicle Miles Traveled (ACVMT) on State Trunkline System

	System	*Level of Service*	*Miles*	*%Total*	*VMT in Millions*	*%Total*	*CVMT in Millions*	*%Total*
Rural	Freeway	Uncongested	1,880	16%	8,937	15%	1,505	27%
		Approaching Congested	104	1%	1,209	2%	144	3%
		Congested	9	0%	161	0%	14	0%
		Subtotal	1,993	16%	10,308	17%	1,663	29%
	Non-Freeway	Uncongested	5,413	45%	8,737	14%	759	13%
		Approaching Congested	680	6%	2,505	4%	166	3%
		Congested	123	1%	805	1%	41	1%
		Subtotal	6,215	51%	12,047	20%	966	17%
		Rural Subtotal	8,208	68%	22,355	36%	2,629	46%
Urban	Freeway	Uncongested	1,186	10%	10,353	17%	1,320	23%
		Approaching Congested	533	4%	10,276	17%	818	14%
		Congested	182	2%	5,159	8%	315	6%
		Subtotal	1,901	16%	25,788	42%	2,452	43%
	Non-Freeway	Uncongested	1,198	10%	6,723	11%	312	5%
		Approaching Congested	371	3%	3,367	5%	146	3%
		Congested	409	3%	3,345	5%	136	2%
		Subtotal	1,978	16%	13,435	22%	593	10%
		Urban Subtotal	3,879	32%	39,222	64%	3,046	54%
		Total	12,087		61,578		5,675	

	Freeway	Non-Freeway
Uncongested	LOS A-C	LOS A-C
Approaching Congested	LOS D-E	LOS D
Congested	LOS F	LOS E-F

Source: Michigan Department of Transportation
Congestion Management System & Statewide Travel Demand Model

Figure 22: 2015 Congestion Levels



Source: Michigan Department of Transportation, Statewide Travel Demand Model

Figure 22 illustrates the location of the 2015 congested and approaching congested roadways. It can be seen that the congested and approaching congested roadways are primarily in urban areas or the areas surrounding urban areas; however, roadways connecting urban areas to each other are also starting to have increases. Some rural roadways are approaching congested.

Table 29 summarizes the 2030 system congestion analysis from the *Highway and Bridge Technical Report*. Key findings regarding congestion in 2030 are:

- Twelve percent of the miles are projected to be congested and 16 percent of the miles are projected to be approaching congested, accounting for 28 percent of the mileage at or approaching congested (an 11 percent increase from 2004).
- Thirty percent of the VMT is projected to be congested and 25 percent of the VMT is projected to be approaching congested, accounting for 55 percent of the VMT at or approaching congested (a 17 percent increase from 2004).
- Twenty-two percent of CVMT is projected to be congested and 23 percent of the CVMT will be approaching congested, accounting for 45 percent of the CVMT at or approaching congested (a 17 percent increase from 2004).
- While 28 percent of the mileage is projected to be at or approaching congested 55 of the VMT and 45 percent of the CVMT is traveling these roads.
- Thirty-two percent of the miles (based on the 2004 urban areas) are urban and account for 63 percent of the total VMT and 53 percent of the total CVMT. By 2030, we start to see larger increases in travel in the rural areas shown by the one-percent reduction in both VMT and CVMT in the urban areas.
- From 2004 to 2030 there is projected to be a 145 percent increase in congested miles, 257-percent increase in congested VMT, and 361 percent increase in congested CVMT.
- From 2004 to 2030 there is projected to be a 34 percent increase in miles approaching congested, a 32-percent increase for VMT approaching congested, and a 51 percent increase of CVMT approaching congested.
- From 2004 to 2030 there is no growth in urban miles (since this was based in the 2004 urban areas), but a projected 36-percent increase in urban VMT and a 38-percent increase in urban CVMT.

In general, between 2004 and 2030 increases in VMT, CVMT, congested miles, congested VMT, and congested CVMT are projected and will place a heavy burden on the trunkline system.

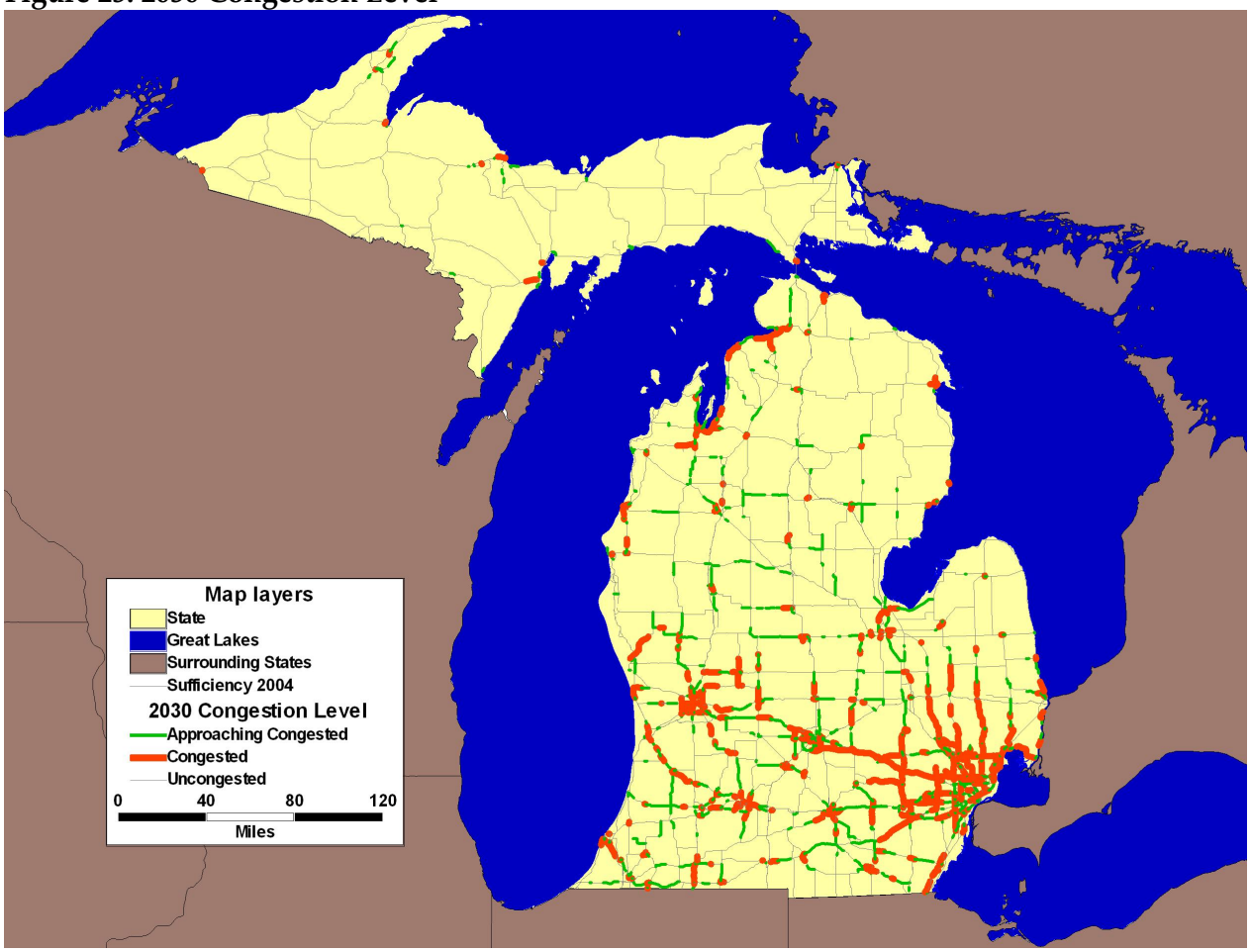
Table 29: 2030 Miles, Annual Vehicle Miles Traveled (AVMT), Annual Commercial Vehicle Miles Traveled (ACVMT) on State Trunkline System

	System	*Level of Service*	*Miles*	*%Total*	*VMT in Millions*	*%Total*	*CVMT in Millions*	*%Total*
Rural	Freeway	Uncongested	1,728	14%	9,065	12%	1,541	22%
		Approaching Congested	176	1%	2,202	3%	336	5%
		Congested	90	1%	1,638	2%	174	3%
		Subtotal	1,993	16%	12,905	17%	2,051	30%
	Non-Freeway	Uncongested	5,031	42%	8,984	12%	798	12%
		Approaching Congested	934	8%	3,658	5%	253	4%
		Congested	250	2%	1,753	2%	99	1%
		Subtotal	6,215	51%	14,396	19%	1,149	17%
		Rural Subtotal	8,208	68%	27,301	37%	3,201	47%
Urban	Freeway	Uncongested	957	8%	8,656	12%	1,209	18%
		Approaching Congested	464	4%	9,054	12%	801	12%
		Congested	480	4%	13,163	18%	956	14%
		Subtotal	1,901	16%	30,872	42%	2,966	43%
	Non-Freeway	Uncongested	1,011	8%	6,006	8%	286	4%
		Approaching Congested	386	3%	3,725	5%	163	2%
		Congested	581	5%	6,213	8%	255	4%
		Subtotal	1,978	16%	15,944	22%	704	10%
		Urban Subtotal	3,879	32%	46,816	63%	3,670	53%
		Total	12,087		74,117		6,870	

	Freeway	Non-Freeway
Uncongested	LOS A-C	LOS A-C
Approaching Congested	LOS D-E	LOS D
Congested	LOS F	LOS E-F

Source: Michigan Department of Transportation
Congestion Management System & Statewide Travel Demand Model

Figure 23: 2030 Congestion Level



Source: Michigan Department of Transportation, Statewide Travel Demand Model

Figure 23 illustrates the location of the 2030 congested and approaching congested roadways. It can be seen that urban areas now are mostly congested and the roadways connecting urban areas to each other are now congested as well. Some rural roadways are approaching congested.

7.1.2.1 Existing and Emerging Capacity Needs

If MDOT were to remedy today's congestion by adding lane miles to the trunkline system, it would require adding 722 lane miles of trunkline freeway and 1,387 miles of trunkline non-freeway to the statewide system. It would increase the overall size of the trunkline system by more than seven percent. **Table 30** shows the number of lane miles that would need to be added to Michigan's trunkline system to remedy today's congestion by adding lanes to the trunkline system.

Table 30: Expansion Backlog for Michigan Trunklines 2005

Estimated Backlog	*Expansion Lane Miles for Congested Facilities in 2005*		*Total Backlog for Expansion Lane Miles*	*Total System Lane Miles by Region in 2005*	*Regional Shares of Overall Statewide Increases In Lane Miles*
Expansion Needs in 2005	*Freeway*	*Non-Freeway*	*Lane Miles Added*	*Lane Miles*	*% of Statewide Lane Miles Added*
MDOT Bay Region	41	130	171	4,272	8.1%
MDOT Grand Region	62	201	262	2,771	12.4%
MDOT Metro Region	417	285	702	4,436	33.3%
MDOT North Region	3	270	273	4,572	13.0%
MDOT Southwest Region	29	204	233	3,433	11.1%
MDOT Superior Region	0	43	43	3,960	2.1%
MDOT University Region	170	254	423	4,052	20.1%
Statewide Total	722	1,387	2,109	27,496	100.0%

Source: Michigan Department of Transportation Suffiency Data, 2005

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

It is understood that improvements in transit, non-motorized facilities, and carpool lots, and changes in land use, may all be leveraged to improve mobility on the integrated system. It is also possible that targeted reconstruction and modernization of roadways will improve localized capacity performance without requiring major expansion in the number of lanes. The *Integration Technical Report* of *MI Transportation Plan* addresses possible sources of leverage to use of improvements of different components to moderate the needs for costly expansion projects. MDOT's leverage in delivering an integrated system is important both because of users' need for an integrated system based on the *2030 Preferred Public Vision* of *MI Transportation Plan*, and because of the costs of adding lanes to MDOT's trunkline system. If roadways alone must be improved to carry increases in traffic to the year 2030, **Table 31** shows the number of new lane miles that would have to be added to the trunkline system to provide uncongested operational performance (this is in addition to the lane miles needed to address the expansion backlog shown in **Table 30).**

Table 31: Expansion Accruing Needs for Michigan Trunklines 2006-2030

Estimated Accruing	*Expansion Lane Miles for Congested Facilities to 2030*		*Total Backlog for Expansion Lane Miles*	*Total System Lane Miles by Region in 2005*	*Regional Shares of Overall Statewide Increases In Lane Miles*
Expansion Needs to 2030	*Freeway*	*Non-Freeway*	*Lane Miles Added*	*Lane Miles*	*% of Statewide Lane Miles*
MDOT Bay Region	1	174	175	4,272	7.9%
MDOT Grand Region	60	235	295	2,771	13.4%
MDOT Metro Region	349	403	751	4,436	34.0%
MDOT North Region	0	209	209	4,572	9.5%
MDOT Southwest Region	3	185	188	3,433	8.5%
MDOT Superior Region	0	28	28	3,960	1.2%
MDOT University Region	230	332	562	4,052	25.5%
Statewide Total	642	1,564	2,207	27,496	100.0%

Source: Michigan Department of Transportation Suffiency Data, 2005

Note: Lane miles may differ slightly from Highway Performance Monitoring System. (Different source)

Assuming lane miles are added to address congestion on state roadways to the year 2030, the addition of 2,207 new lane miles would increase Michigan's lane miles by an additional eight percent (which would combine with the 7.5 percent increase in lane miles for today's congestion for an overall 2030 system with 15 percent more lane miles than exist today). More than one-third of these new lane miles would have to be added in the Metro Region, with the least additional lane miles added in the less densely populated North and Superior regions.

7.2 Transit Operational Performance

To broadly measure trends in transit systems performance, the study team examined changes in key indicators typically used in the public transportation industry. In addition to data from Michigan's Public Transportation Management System (PTMS) the data include performance measures as reported in the National Transit Database (NTD). Data reported from the NTD include agencies reporting to the NTD only.

Table 32 shows how the transit costs per mile, per passenger, and per vehicle hour in Michigan have changed in the period from 1996 to 2004.

Table 32: Operating Expense Ratios

	Cost Per Mile	*Average Annual Percent Change*	*Cost Per Passenger*	*Average Annual Percent Change*	*Cost Per Vehicle Hour*	*Average Annual Percent Change*
1996	$3.93		$3.38		$57.97	
2001	$4.26	1.7%	$4.41	6.1%	$65.18	2.5%
2004	$4.62	2.8%	$5.06	4.9%	$66.68	0.8%

Source: Michigan Public Transportation Management System, Performance Indicators Report

Overall, the costs of transit per mile have increased at a faster rate in the period from 2001 to 2004 than from 1996 to 2001. While these increasing costs represent the inflationary effects of increasing fuel and other expenses, the rate of increase in costs per passenger, and costs per vehicle hour has been slower from 2001 to 2004 than it was from 1996 to 2001. This indicates that in the face of increasing real costs, Michigan's transit operations are increasingly efficient reducing the costs per passenger or vehicle hour even in the face of overall increasing mileage costs.

Tables 33 and **34** show that corresponding indicators relating to unlinked passenger trips had cost increases between 1996 and 2001, followed by decreases. These data suggest that after 2001, fixed-route service effectiveness improved, with more passengers served per mile and per hour. Statewide unlinked passenger trips per vehicle revenue hour were marginally lower in 2004 ($20.15) than in 1996 ($20.39).

Table 33: Unlinked Passenger Trips per Performance Indicators for Fixed-Route Systems

	Vehicle Revenue Mile	*Average Annual Percent Change*	*Vehicle Revenue Hour*	*Average Annual Percent Change*
1996	$1.54		$20.39	
2001	$1.63	1.3%	$20.69	0.3%
2004	$1.58	-1.1%	$20.15	-0.9%

Source: Federal Transit Administration National Transit Database

Note: Includes Michigan transit agencies reporting to NTD at year shown only. Does not include light rail vehicles.

For demand-response services, the trend in unlinked passenger trips per vehicle revenue mile and per vehicle revenue hours suggests improvement between 1996 and 2004. Both unlinked passenger trips per vehicle revenue mile and per vehicle revenue hour were lower in 2004 than in 1996, suggesting improved service effectiveness.

Table 34: Unlinked Passenger Trips per Performance Indicators for Demand-Response Systems

	Vehicle Revenue Mile	*Average Annual Percent Change*	*Vehicle Revenue Hour*	*Average Annual Percent Change*
1996	$0.23		$3.05	
2001	$0.22	-2.4%	$2.94	-3.6%
2004	$0.21	-4.0%	$2.98	1.4%

Source: Federal Transit Administration National Transit Database

Note: Includes Michigan transit agencies reporting to NTD at year shown only.

Chapter 8. System Safety Performance

This section examines crashes and injuries statewide for different highway classifications, different modes, and different vehicle types in Michigan. The *Safety Technical Report* of *MI Transportation Plan* examines some of the causes of highway-related fatalities, fatalities and injuries by different vehicle groups, and the distribution of crashes by age of passengers. For transit safety, this section examines injuries and fatalities by mode and by passenger miles of travel.

This analysis describes safety statistics. It does not describe the various programs used by MDOT and its partners to increase highway and transit safety. These programs are examined comprehensively in the *Safety Technical Report*.

Figure 21 shows overall crash incidence in Michigan from 1994 to 2004. Overall, crash rates have declined from the years 2000-2004, with consistent declines in crashes involving injuries and fatalities. The *Safety Technical Report* of *MI Transportation Plan* explores many of the contributing factors to injury and fatality rates over the 10-year period.

Figure 21: Overall Crash Incidence in Michigan from 1994 to 2004

CRIMINAL JUSTICE INFORMATION CENTER

Michigan Traffic Crash Decade-At-A-Glance

Produced by Criminal Justice Information Center (517)322-1150

	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994
Total Crashes	373,028	391,486	395,515	400,813	424,867	415,675	403,766	425,793	435,477	421,073	398,050
Total Injuries	99,680	105,555	112,484	112,292	121,832	124,601	131,578	137,548	142,553	146,303	142,200
Total Fatalities	1,159	1,283	1,279	1,328	1,382	1,386	1,367	1,446	1,505	1,537	1,419
Fatal Crashes	1,055	1,172	1,175	1,206	1,237	1,249	1,235	1,283	1,339	1,386	1,262
Death Rate*	1.2	1.3	1.3	1.4	1.5	1.5	1.5	1.6	1.7	1.8	1.7
Fatal Crash Rate**	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.5	1.6	1.5
Restraint Use***	51.0%	49.8%	51.4%	47.4%	48.0%	40.4%	38.5%	38.5%	44.5%	41.6%	40.2%
Alc/Drug-Inv Fatal Crashes	385	403	421	458	457	484	476	481	487	512	475
% of Alc/Drug-Inv Fatal Crashes to total fatal crashes	36.5%	34.4%	35.8%	38.0%	36.9%	38.8%	38.5%	37.5%	36.4%	36.9%	37.6%
Alcohol/Drug-Inv Fatalities	418	442	463	504	515	541	525	544	555	566	530
% of Alc/Drug-Inv Fatalities to total fatalities	36.1%	34.5%	36.2%	38.0%	37.3%	39.0%	38.4%	37.6%	36.9%	36.8%	37.4%
OUIL Arrests *(all agencies)*	55,056	55,728	57,782	58,562	60,889	61,803	60,971	60,665	61,119	59,584	55,264
Regtd Vehicles *(Millions)*	9.93	9.92	9.00	8.89	8.57	8.40	8.20	8.10	8.10	7.80	7.67
MVMT *(Billions)*	100.2	98.2	96.5	96.5	94.9	93.1	91.6	89.2	87.7	85.7	85.6
Population *(Millions)*	10.08	10.08	10.05	9.99	9.93	9.86	9.77	9.77	9.59	9.55	9.50

* Death Rate = Persons killed per 100 million MVMT
** Fatal Crash Rate = Fatal crashes per 100 million MVMT
*** Restraint Use by deceased occupants of motor vehicles equipped with safety belts

11/18/2005

Source: Michigan State Police Criminal Justice Information Center

In addition to the data in **Figure 21**, the federal government keeps statistics on Michigan fatalities, reporting detailed crash rates relative to the number of registered vehicles, licensed

drivers, vehicle miles traveled, and overall population. **Figure 21** provides an overview of Michigan's crash, injury, and fatality rates from the perspective of enforcement, where a greater level of detail about issues such as restraint use and alcohol and drug involvement is available.

The federal government also reports statistics tracking fatality trends for different driver, vehicle, and roadway conditions. Because of different reporting protocols, there are some differences in how fatality rates are reported at the federal level. However, the federal statistics are useful for understanding long-term trends in Michigan's most severe (fatal) crashes.

In the 10 years between 1994 and 2004, Michigan's overall fatalities decreased by 16.5 percent. **Table 35** shows the trend in Michigan's overall incidence in fatal crashes in the 10-year period from 1994 to 2004.

Table 35: Fatal Crash Trend on Michigan Roadways

Year	*Fatal Crashes*
1994	1,264
1995	1,379
1996	1,339
1997	1,283
1998	1,234
1999	1,245
2000	1,237
2001	1,206
2002	1,173
2003	1,172
2004	1,055
10-Year Change	-16.5%

Source: FARS

Michigan's reduction in fatal crashes has occurred even as exposure to safety risk (as indicated by VMT) has increased. Fatality rates can be assessed with regard to fatalities per resident, per licensed driver, per vehicle, or per million VMT. **Table 36** gives different crash rates for Michigan over the 10-year period from 1994 to 2004.

Table 36: Trend in Fatality Rates in Michigan 1994-2004

Year	*Fatalities*	*Resident Population (Thousands)*	*Fatality Rate per 100,000 Population*	*Licensed Drivers (Thousands)*	*Fatality Rate per 100,000 Licensed Drivers*	*Registered Motor Vehicles (Thousands)*	*Fatality Rate per 100,000 Registered Vehicles*	*Vehicle Miles Traveled (Billions)*	*Fatality Rate per 100 Million VMT*
1994	1,421	9,584	14.83	6,602	21.52	7,687	18.49	85	1.67
1995	1,530	9,660	15.84	6,659	22.98	7,802	19.61	86	1.79
1996	1,505	9,739	15.45	6,717	22.41	8,160	18.44	90	1.67
1997	1,446	9,785	14.78	6,751	21.42	8,179	17.68	92	1.58
1998	1,366	9,820	13.91	6,803	20.08	8,283	16.49	94	1.45
1999	1,382	9,864	14.01	6,863	20.14	8,458	16.34	96	1.44
2000	1,382	9,956	13.88	6,925	19.96	8,619	16.03	98	1.41
2001	1,328	10,006	13.27	6,977	19.03	8,653	15.35	99	1.34
2002	1,277	10,043	12.72	7,025	18.18	8,738	14.61	100	1.28
2003	1,283	10,082	12.73	7,065	18.16	8,756	14.65	101	1.27
2004	1,159	10,113	11.46	7,103	16.32	8,627	13.43	103	1.12
10-Year Change	-18.4%	5.5%	-22.7%	7.6%	-24.2%	12.2%	-27.4%	21.2%	-32.9%

Source: FARS

While from 1994 to 2004, Michigan's resident population increased by six percent, the fatality rate per resident decreased by more than 22 percent. Michigan's number of licensed drivers increased by eight percent, while the fatality rate per licensed driver decreased by 24 percent. Michigan's VMT (on trunkline and non-trunkline facilities) increased by 21 percent, while the fatalities per 100 Million VMT declined by nearly 33 percent. These statistics indicate that roadway travel in Michigan has consistently become safer in the last 10 years. Improvements in safety result from a combination of driver, roadway, and vehicle factors and technologies as well as engineering, enforcement, and educational activities of the state.

Table 37 shows comparative fatality trends by vehicle type from 1994 to 2004. The table also shows trends in non-motorized fatalities in Michigan. Safety has improved most consistently for motorists in passenger cars and large trucks, with a 31 percent reduction in overall fatalities for passenger car occupants from 1994 to 2004 and more than a 50 percent reduction in fatalities for large truck occupants.

Table 37: Trend in Fatalities by Vehicle or Traveler Type 1994-2004

	Occupants by Vehicle Type							*Non-motorists*				
Year	*Passenger Cars*	*Light Trucks*	*Large Trucks*	*Motorcycles*	*Buses*	*Other/ Unknown*	*Total*	*Pedestrian*	*Pedalcyclist*	*Other*	*Total*	*Total*
1994	848	244	18	72	0	22	1,204	182	30	5	217	1,421
1995	899	296	6	83	5	21	1,310	187	30	3	220	1,530
1996	855	316	15	61	1	25	1,273	192	33	7	232	1,505
1997	832	318	6	63	0	27	1,246	165	31	4	200	1,446
1998	746	319	10	56	2	28	1,161	171	28	6	205	1,366
1999	746	316	12	83	1	19	1,177	173	26	6	205	1,382
2000	710	341	13	86	2	28	1,180	170	29	3	202	1,382
2001	672	337	9	97	0	20	1,135	162	24	7	193	1,328
2002	634	327	8	87	0	21	1,077	175	22	3	200	1,277
2003	636	324	12	81	1	27	1,081	166	32	4	202	1,283
2004	577	298	8	81	0	33	997	137	21	4	162	1,159
10-Year Change	-32.0%	22.1%	-55.6%	12.5%	N/A	50.0%	-17.2%	-24.7%	-30.0%	-20.0%	-25.3%	-18.4%

Source: FARS

However, there has been a 22-percent overall increase in fatalities for occupants of light trucks (including SUVs). **Table 7,** on page 17, shows that light trucks (including SUVs) have accounted for an increasing share of Michigan's vehicles, therefore it is not surprising that overall fatalities for light trucks have increased in the last 10 years. However, while in the 10-year period, the number of trucks (including SUVs) registered in Michigan have increased by 62 percent (from 2,272,700 in 1994 to 3,691,719 in 2004); the increase in crashes has increased by only 22 percent. This indicates that the number of fatalities involving truck occupants has not increased as sharply as the number of trucks on the road. The same is true of motorcycles. **Table 7** shows that the number of motorcycles registered in Michigan has more than doubled from 1994 to 2004; however, **Table 37** indicates that motorcycle fatalities have increased by only 12 percent.

Michigan has always had relatively few fatalities involving buses (including intercity and transit vehicles, as well as other buses). The last year in which more than two bus fatalities occurred was 1995, when five fatalities were reported.

Non-motorized safety has also improved significantly, with pedestrian fatalities declining by 25 percent and cycling fatalities declining by 30 percent from 1994 to 2004, even as population has increased. Improvements in non-motorized conditions such as shoulder widths (shown in **Figures 15** and **16**) may be a factor contributing to these reductions.

8.1 Highway Safety Performance

Because crashes and fatalities on MDOT's roadways may result from driver, vehicle, or roadway factors, it must be understood that facilities with high crash or fatality rates may not always be targets for reconstruction or modernization improvement. However, examining fatal

crash propensity on different functional systems is one way of pinpointing those areas where safety performance might be improved through a combination of education, engineering, and enforcement activities. It is expected that interstates, urban freeways, and principal arterials will have a larger number of crashes, due to higher volumes on these facilities. However, it is also expected that crash rates (crashes per million vehicle miles traveled) will be less on these facilities, which are designed to higher standards.

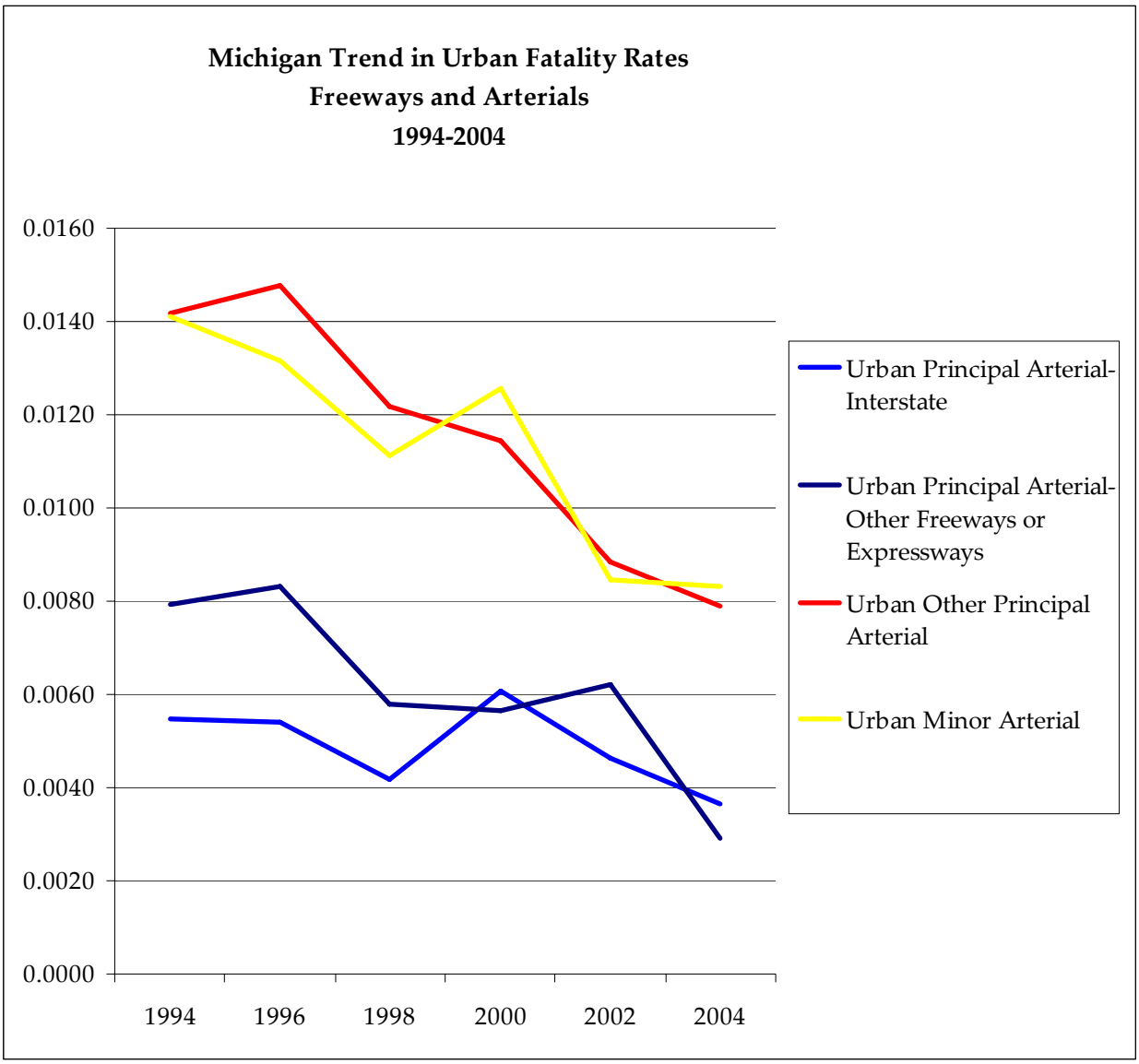
Table 38, Figure 22, and **Figure 23** show the fatalities and fatality rates per million VMT (MVMT) on Michigan's roadways by National Functional Classification. The table includes fatalities both on Michigan's trunkline and non-trunkline facilities. Collectors and local streets have been omitted from the charts because they account for a relatively small share of Michigan's trunkline miles, and relatively high levels of variability may show inconsistent trends and patterns.

Table 38: Trends in Fatality Rates per MVMT for National Functional Roadway Classifications in Michigan 1994-2004

		Year							
	National Functional Classification	*1994*	*1996*	*1998*	*2000*	*2002*	*2004*	*Ten-Year Change*	*Average Annual % Change*
Rural	Rural Principal Arterial-Interstate	0.005	0.007	0.007	0.005	0.005	0.005	-6.5%	-0.6%
	Rural Principal Arterial-Other	0.016	0.016	0.013	0.011	0.013	0.012	-24.3%	-2.4%
	Rural Minor Arterial	0.022	0.023	0.019	0.019	0.015	0.014	-36.6%	-3.7%
	Rural Major Collector	0.028	0.022	0.022	0.019	0.021	0.017	-39.0%	-3.9%
	Rural Minor Collector	0.030	0.035	0.044	0.026	0.032	0.029	-5.4%	-0.5%
	Rural Local Road or Street	0.038	0.053	0.045	0.048	0.048	0.043	14.8%	1.5%
	Total Rural	0.020	0.021	0.019	0.017	0.017	0.019	-6.7%	-0.7%
Urban	Urban Principal Arterial-Interstate	0.005	0.005	0.004	0.006	0.005	0.004	-33.5%	-3.4%
	Urban Principal Arterial-Other Freeways or Expressways	0.008	0.008	0.006	0.006	0.006	0.003	-63.1%	-6.3%
	Urban Other Principal Arterial	0.014	0.015	0.012	0.011	0.009	0.008	-44.2%	-4.4%
	Urban Minor Arterial	0.014	0.013	0.011	0.013	0.008	0.008	-40.9%	-4.1%
	Urban Collector	0.015	0.012	0.009	0.014	0.012	0.005	-67.8%	-6.8%
	Urban Local Road or Street	0.010	0.010	0.013	0.010	0.011	0.007	-31.0%	-3.1%
	Total Urban	0.011	0.011	0.009	0.010	0.008	0.006	-45.5%	-4.6%
Total		0.0148	0.0148	0.0132	0.0126	0.0117	0.0102	-31.2%	-3.1%

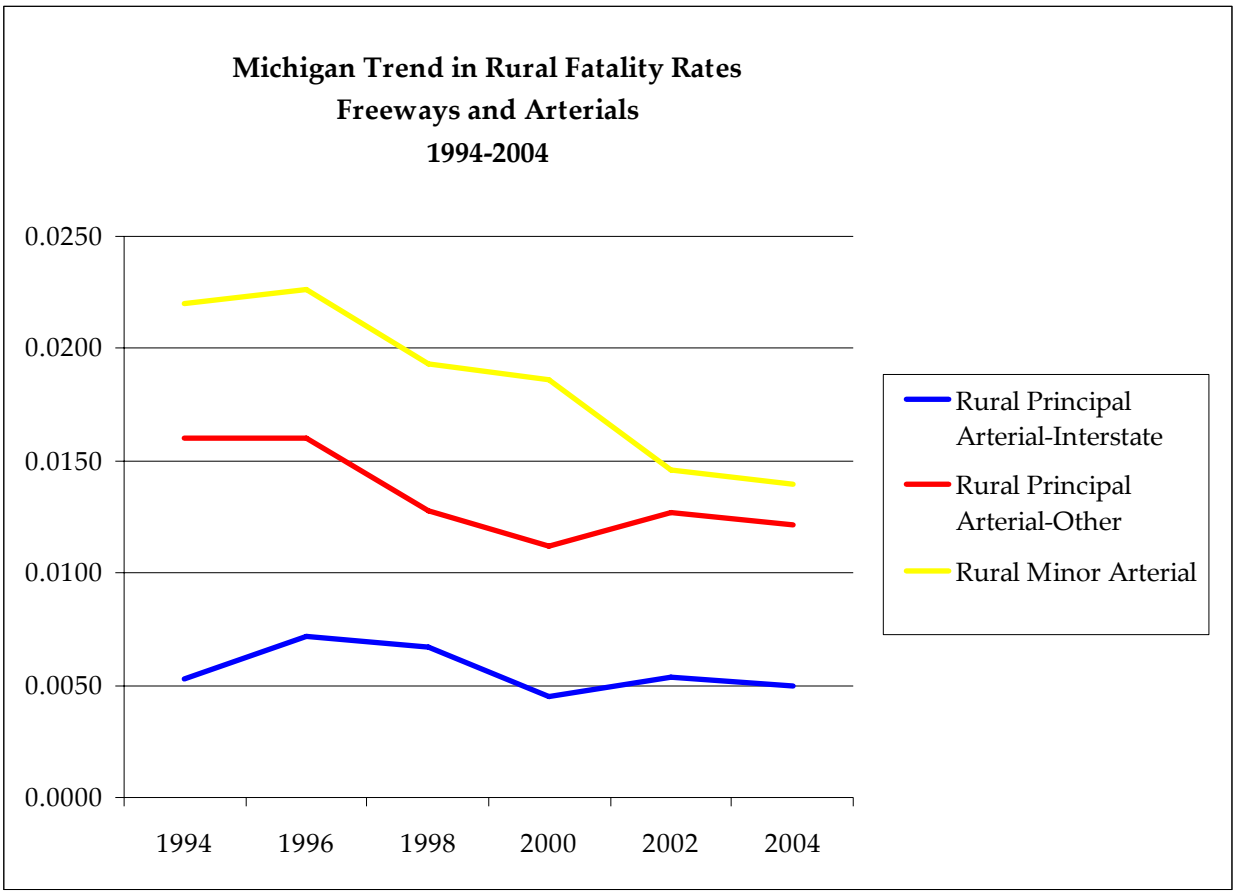
Source: FARS

Figure 22: Michigan Trend in Urban Fatality Rates Freeways and Arterials 1994-2004



Source: FARS

Figure 23: Michigan Trend in Rural Fatality Rates Freeways and Arterials 1994-2004



Source: FARS

Federal statistics show that fatality rates have declined significantly on Michigan's urban principal and minor arterials, where volumes have increased steadily, and crash incidents have gone down. Rates have reduced at a lesser rate on rural arterials, where speeds are high, and where rates of VMT growth have been less. This indicates that urban arterials have carried consistently higher levels of traffic from 1994 to 2004 (as shown in **Table 4** on page 15) without proportional increases in fatal crash incidents. While fatalities have also declined on rural arterials, fatality rates have been higher, and the pace of decline has been slower. This shows that while VMT on rural arterials has declined (as some areas have been re-classified from urban to rural); the decrease in fatalities on those roads that remain rural has not been as great as the decrease in fatalities on those roads that are urban.

When making urban-rural comparisons, it is important to note the difference between fatality rates and crash rates. Crash rates are often higher than fatality rates in urban areas because of the higher density of traffic and slower speeds. Because speed is the key determinant of injury severity in most crashes, rural roads often have higher rates of fatalities and lower overall crash rates.

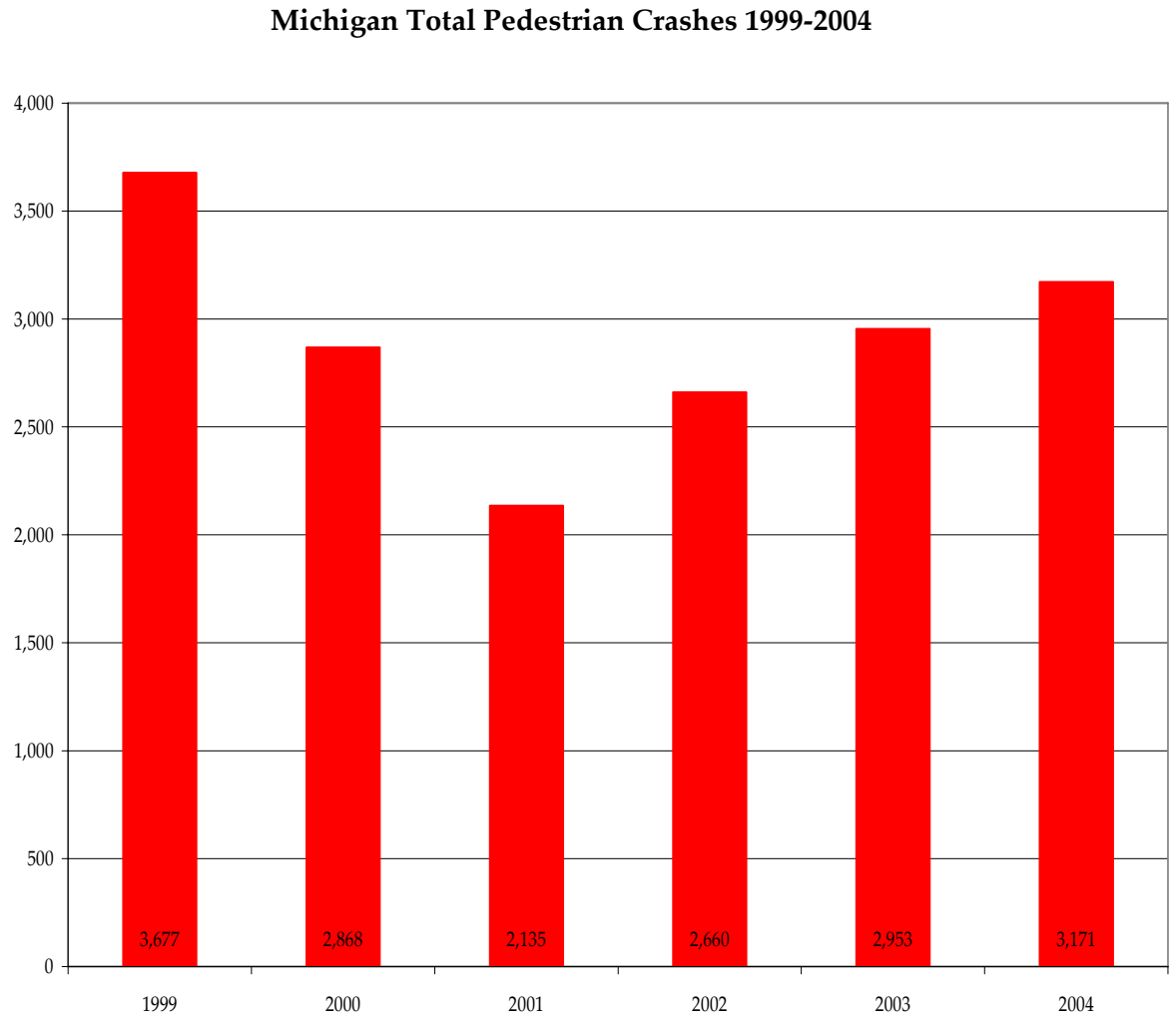
In all areas, interstates and freeways have the lowest fatality rates. Despite their high design speeds, the full control of access and the design standards of interstates make interstates less

prone to crashes than other facility types. Nationally, interstate crashes are known to be more severe and more often fatal than on other roads, the low incidence of these events results in lower overall fatality rates for interstates. Interstate and freeway fatality rates have declined the most in Michigan's urban areas, where volumes have increased steadily with still decreasing numbers of crashes occurring. Rural interstates have had the least amount of change in fatality rates of any national roadway classification in Michigan.

8.2 Non-motorized Safety Performance

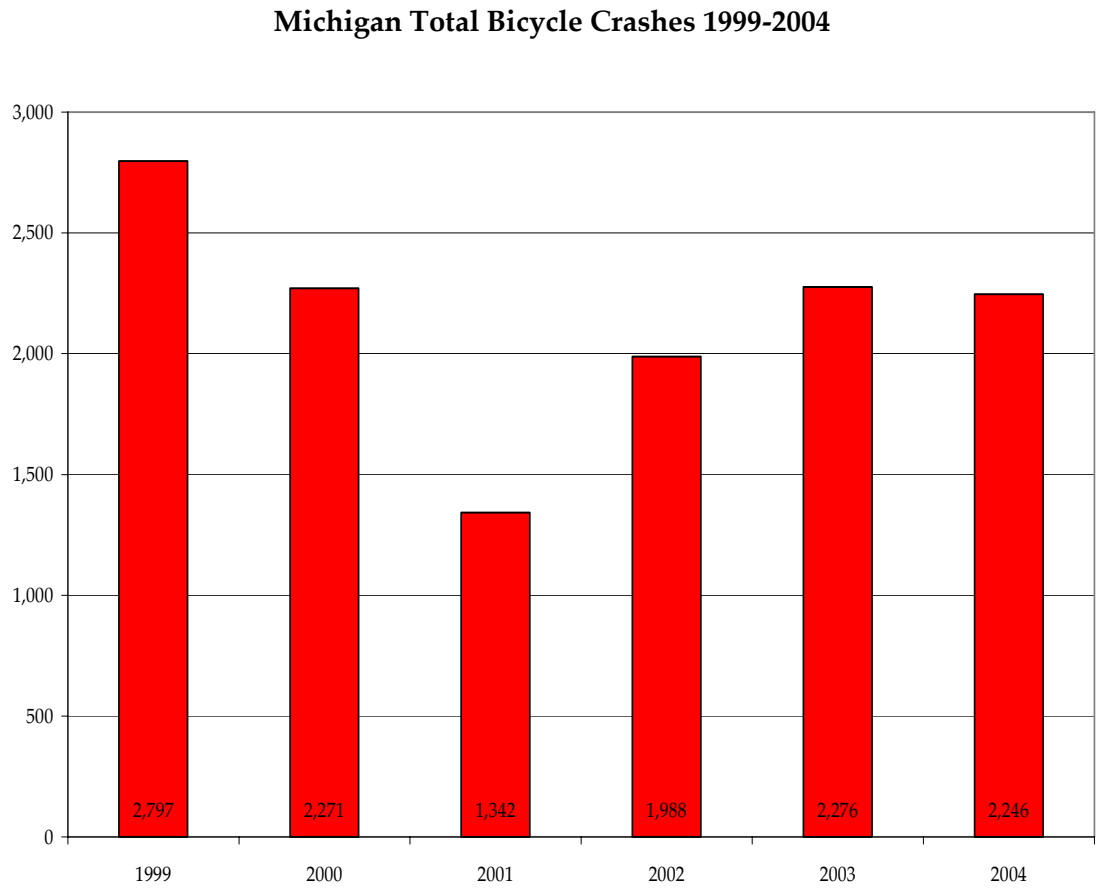
As **Table 36** indicates, fatalities among pedestrians and cyclists in Michigan had significantly declined from 1994 to 2004. However, in recent years there has been a slight increase in non-fatal bicycle and pedestrian crashes. **Figure 24** and **Figure 25** show the recent increase in pedestrian and bicycle crashes from 1999 to 2004 as reported in the *Non-motorized Technical Report* of *MI Transportation Plan*.

Figure 24: Total Pedestrian Crashes, (1999-2004)



Source: Michigan Office of Highway Safety Planning

Figure 25: Total Bicycle Crashes, (1999-2004)



Source: Michigan Office of Highway Safety Planning

Without exposure data (data capturing how the number of pedestrians and cyclists have increased or decreased), it is not clear what is accounting for recent increases in non-motorized, non-fatal crashes. It is unknown if increases in pedestrian activity have led to higher exposure to crash risk.

However, the trend demonstrates the importance of preventing both fatal and non-fatal crashes. Modernization of roadways and safe pedestrian and bicycle connections between modes in Michigan's integrated system, together with education and enforcement activities, will play a role in reducing the number of bicycle and pedestrian crashes and injury levels moving Michigan towards the Governor's Traffic Safety Advisory Commission's goal of reducing the number of bicycle and pedestrian fatalities.

Chapter 9. Conclusion and Summary of Improvement Needs

The long-term condition and performance of Michigan's transportation system depends on the strategic investment of resources into the state's highway and bridge, transit, non-motorized and other assets. This report explored the issues accounting for existing and accruing needs in six major funding categories:

- Roadway Preservation;
- Roadway Reconstruction;
- Roadway Expansion;
- Bridge Preservation;
- Bridge Rehabilitation and Reconstruction; and
- Transit

For roadway categories, the lane miles of existing and accruing improvements needed are summarized in **Table 39**. The costing of these needs, in addition to transit and other needs, form the basis for the baseline improvement needs for each system component as introduced in the Investment and *Revenue Gap and Investment Packages Report* of *MI Transportation Plan*.

Table 39: Summary of Roadway Improvement Lane-Mileage Needs

	Backlog (2005)		*Accruing (2006 to 2030)*	
	State Total (Lane Miles) or Number of Bridges		*State Total (Lane Miles) or Number of Bridges*	
Improvement Type	*Freeway*	*Non-Freeway*	*Freeway*	*Non-Freeway*
Preservation				
Resurfacing	820	1,324	3,696	9,428
Preventative Maintenance	850	2,975	18,462	32,866
Modernization				
Reconstruction	543	264	5,964	2,620
Expansion				
Capacity Improvement (Adding Lanes)	722	1,387	642	1,564
Bridge Work (Number of Bridges)				
Rehabilitation or Replacement	410	54	1,765	523
Preventative Maintenance	313	18	1,852	481
Big Bridge (Rehab, Replacement, PM)	1	1	70	36

Source: Michigan Department of Transportation

Note: Roadway needs and needs for non-roadway components are represented by costs in the *Revenue Gap and Investment Packages Report* of *MI Transportation Plan.*

In the investment and gap analysis, funding needs and potential sources of financial leverage between funding categories are explored. Additional needs quantified in the *Revenue Gap and Investment Packages Report* include:

- Intercity Passenger Needs;
- Aviation Needs;
- Needs for Ferries;
- Non-motorized Needs (Not covered by roadway categories);
- Needs for Ports;
- Intercity Passenger Transportation; and
- Carpool Lots and Non-Pavement roadway needs (Not covered by roadway categories)

While some of these categories do not lend themselves to an assessment of conditions and performance within the scope of the current report, the *Intercity Passenger Technical Report, Aviation Technical Report, Freight Profile Technical Report, and Non-motorized Technical Report* provide context for the costing of needs of these components. The full costing of needs (for all categories) is provided in the *Revenue Gap and Investment Packages Report* of *MI Transportation Plan*. The *Integration Technical Report* identifies linkages between components and offers decision principles for leveraging available resources in ways that will support the long-term conditions and performance of both the components explicitly addressed in this *Conditions and Performance Technical Report*.

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