

2018

REPORT CARD FOR MICHIGAN'S INFRASTRUCTURE



Michigan Section of the American Society of Civil Engineers
INFRASTRUCTUREREPORTCARD.ORG/MICHIGAN



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EXECUTIVE SUMMARY

Infrastructure is the fundamental facilities and systems serving a country, state, county, township, or city and is necessary for its economy to function. Infrastructure includes roads, bridges, water and sewer systems, dams, transit, aviation, railways, energy and schools. Infrastructure is the foundation of our everyday lives and touches all parts of how we live, work and play in Michigan. It is the backbone of Michigan's economy.

Quality infrastructure allows Michigan to be a frontrunner in various sectors including: research and development, manufacturing, farming, and tourism. Our transportation system (roads, bridges, transit, rail, etc.) allows Michiganders to travel to work every day, or Up North for summer weekends by the lake. Water systems deliver drinking water to our homes, communities, and businesses. School buildings provide a safe place for our children to learn. Sewer and treatment systems protect our neighborhoods from floods, and our lakes, rivers, and beaches from raw sewage, E. coli and other toxins.

Unfortunately, most of Michigan's infrastructure is old and outdated. In older Michigan cities, some systems date back to the late 1800s. For close to a decade the state suffered from a poor economy, resulting in Michigan under investing in infrastructure repairs and replacement. Imagine not changing your car's tires for 10 years. Now we are faced with highways that are full of potholes, bridges that are being propped with temporary supports, sinkholes destroying homes, and beaches being closed due to contamination. In general, most investments during those years were a result of emergencies. Emergency repairs can be inconvenient, cause safety issues, and are more costly than doing routine infrastructure maintenance or replacement.

Michigan residents, business owners, and policymakers must decide how much we value the personal and economic advantages that come from a modern, safe and efficient infrastructure network. The Michigan legislature took the first step in 2015 by increasing the investment in our transportation system, but much more needs to be done. The 21st Century Infrastructure Commission created by the Governor determined that an additional \$4 billion annual investment is needed to maintain our infrastructure. The good news is there are solutions to Michigan's infrastructure problems. We must support innovative policies, increase state funding, prioritize public health and safety, and be informed and vocal advocates for infrastructure. Maintenance and replacement must happen proactively instead of reactively. Just as you change your car's oil regularly, we must replace pipelines, repair dams, fix bridges, and resurface roads as needs arise.

This document was created to help Michigan understand the state of our infrastructure. As civil engineers, our daily focus is on roads, bridges, water and wastewater systems, our energy grid and more. Civil engineers plan, design, construct, and maintain our infrastructure networks. It is not only what we were trained and educated to do, it is our job and our passion! The ASCE-MI 2018 Report Card provides an opportunity to share that information with the public. This document is a snapshot for residents, businesses, and policymakers to engage in conversation about where we are and where we want to be. We hope that this information provides the insight needed to start that conversation.

2018

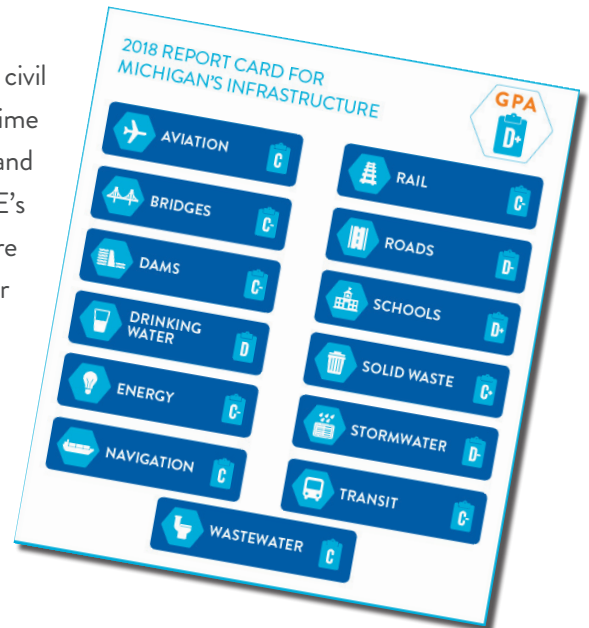
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ABOUT THE INFRASTRUCTURE REPORT CARD

GRADING CRITERIA

ASCE-MI's 2018 Report Card Committee is a group of dedicated civil and environmental engineers from Michigan, who volunteered their time to collect and analyze data, prepare, review, and revise each section, and develop the final Report Card. The committee worked with ASCE's Committee on America's Infrastructure and ASCE Infrastructure Initiative staff to provide Michigan with a snapshot of the state of our infrastructure, as it relates to us at home, and on a national basis.



The Report Card Sections are analyzed based on the following eight criteria:

CAPACITY Does the infrastructure's capacity meet current and future demands?

CONDITION What is the infrastructure's existing and near-future physical condition?

FUNDING What is the current level of funding from all levels of government for the infrastructure category as compared to the estimated funding need?

FUTURE NEED What is the cost to improve the infrastructure? Will future funding prospects address the need?

OPERATION AND MAINTENANCE What is the owners' ability to operate and maintain the infrastructure properly? Is the infrastructure in compliance with government regulations?

PUBLIC SAFETY To what extent is the public's safety jeopardized by the condition of the infrastructure and what could be the consequences of failure?

RESILIENCE What is the infrastructure system's capability to prevent or protect against significant multihazard threats and incidents? How able is it to quickly recover and reconstitute critical services with minimum consequences for public safety and health, the economy, and national security?

INNOVATION What new and innovative techniques, materials, technologies, and delivery methods are being implemented to improve the infrastructure?

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GRADING SCALE



EXCEPTIONAL: FIT FOR THE FUTURE

The infrastructure in the system or network is generally in excellent condition, typically new or recently rehabilitated, and meets capacity needs for the future. A few elements show signs of general deterioration that require attention. Facilities meet modern standards for functionality and are resilient to withstand most disasters and severe weather events.



GOOD: ADEQUATE FOR NOW

The infrastructure in the system or network is in good to excellent condition; some elements show signs of general deterioration that require attention. A few elements exhibit significant deficiencies. Safe and reliable with minimal capacity issues and minimal risk.



MEDIOCRE: REQUIRES ATTENTION

The infrastructure in the system or network is in fair to good condition; it shows general signs of deterioration and requires attention. Some elements exhibit significant deficiencies in conditions and functionality, with increasing vulnerability to risk.



POOR: AT RISK

The infrastructure is in poor to fair condition and mostly below standard, with many elements approaching the end of their service life. A large portion of the system exhibits significant deterioration. Condition and capacity are of significant concern with strong risk of failure.



FAILING/CRITICAL: UNFIT FOR PURPOSE

The infrastructure in the system is in unacceptable condition with widespread advanced signs of deterioration. Many of the components of the system exhibit signs of imminent failure.

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 AVIATION 

 RAIL 

 BRIDGES 

 ROADS 

 DAMS 

 SCHOOLS 

 DRINKING
WATER 

 SOLID WASTE 

 ENERGY 

 STORMWATER 

 NAVIGATION 

 TRANSIT 

 WASTEWATER 



SOLUTIONS TO RAISE THE GRADE

If Michigan is ready to improve our infrastructure, ASCE-MI has some suggestions to start raising the grade:

1. SUPPORT INNOVATIVE POLICIES:

Michigan needs to be a leader in preparing our infrastructure for the future. We are the nation's gateway to Canada, the Great Lakes state (surrounded by 20% of America's freshwater), and the home of the automobile. Through investment and modernization, we can lead the way. With the greatest concentration of the auto industry in the world, Michigan must be a leader in freight movement and autonomous vehicles.

To better understand the problems that Michigan's infrastructure is facing, the state needs more and better data. As recommended by the 21st Century Infrastructure Commission, the Michigan legislature has proposed the creation of the Michigan Infrastructure Council (MIC), which will bring together policy experts, utility and infrastructure owners, regional representatives, finance experts, and statewide department directors to set up a statewide asset management system. This will ultimately lead to the development and publication of a 30-year integrated infrastructure strategy that will be updated every five years. The MIC will also include chairs from existing and future entities of the Michigan Public Services Commission, the Transportation Asset Management Council, and the Water Asset Management Council (a new council proposed by the Michigan legislature). The MIC will lead to greater insights into the condition of Michigan's infrastructure, the challenges we face in maintaining our infrastructure, and will provide more strategic solutions.

2. INCREASE STATE FUNDING:

The Michigan legislature took the first steps to increasing investment in our transportation network in 2015. To build on this action, the legislature must follow through and appropriate transportation funds in years 2019 to 2021 as promised. Additionally, the Michigan Department of Environmental Quality is in the process of redesigning the Clean Water State Revolving Fund and Drinking Water Revolving Fund, both of which provide financial support to

water systems through federal-state partnerships.

ASCE encourages Michigan citizens to be vocal and reach out to elected officials to let them know Michigan needs consistent and reliable funding to maintain and improve our transportation and water infrastructure and not wait for our systems to fail.

3. PRIORITIZE PUBLIC HEALTH AND SAFETY:

"Safety First" must be the approach to all of Michigan's infrastructure decisions. Integrated asset management is the critical first step in developing a foundation for safe and reliable infrastructure in Michigan. Asset management consists of continually inventorying and assessing the condition of Michigan's infrastructure so smart investments can be made to improve public health and safety.

Safety can further be improved by properly maintaining Michigan's infrastructure. Emergency infrastructure repairs are more costly and can lead to property damage, injuries and fatalities. Regular maintenance requires sufficient and reliable sources of funding. Proactive investment in infrastructure yields savings down the line and ensures the health and welfare of Michiganders. Autonomous vehicles have the potential of significantly reducing vehicle crashes that result in injuries and fatalities.

4. BE INFORMED, BE VOCAL:

ASCE's Michigan Section encourages you to learn more about your community's infrastructure needs and how your tax dollars are being spent to improve the state's infrastructure. Attend town halls or legislative events and get to know your elected officials. Use the Report Card for Michigan's Infrastructure to effectively inform lawmakers and the public about where to direct limited resources and how to improve Michigan's infrastructure.

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AVIATION

GRADE: C

SUMMARY

Michigan's 234 airports, including 18 commercial airports, contribute more than \$22 billion annually to the state's economy. Scheduled airlines transported more than 39 million passengers to and from Michigan airports in 2016, and the Detroit Metropolitan Airport was ranked 18th nationwide in total passengers for 2016. Beginning in 2008, as a result of the economic downturn, Michigan's aviation industry saw a significant decrease in aircraft operations. However, projections show a steady increase in general aviation activity and substantial growth for corporate and commercial activity over the next 15 years. Despite these projections, funding for airport infrastructure at the state and local level has declined in recent years.

BACKGROUND

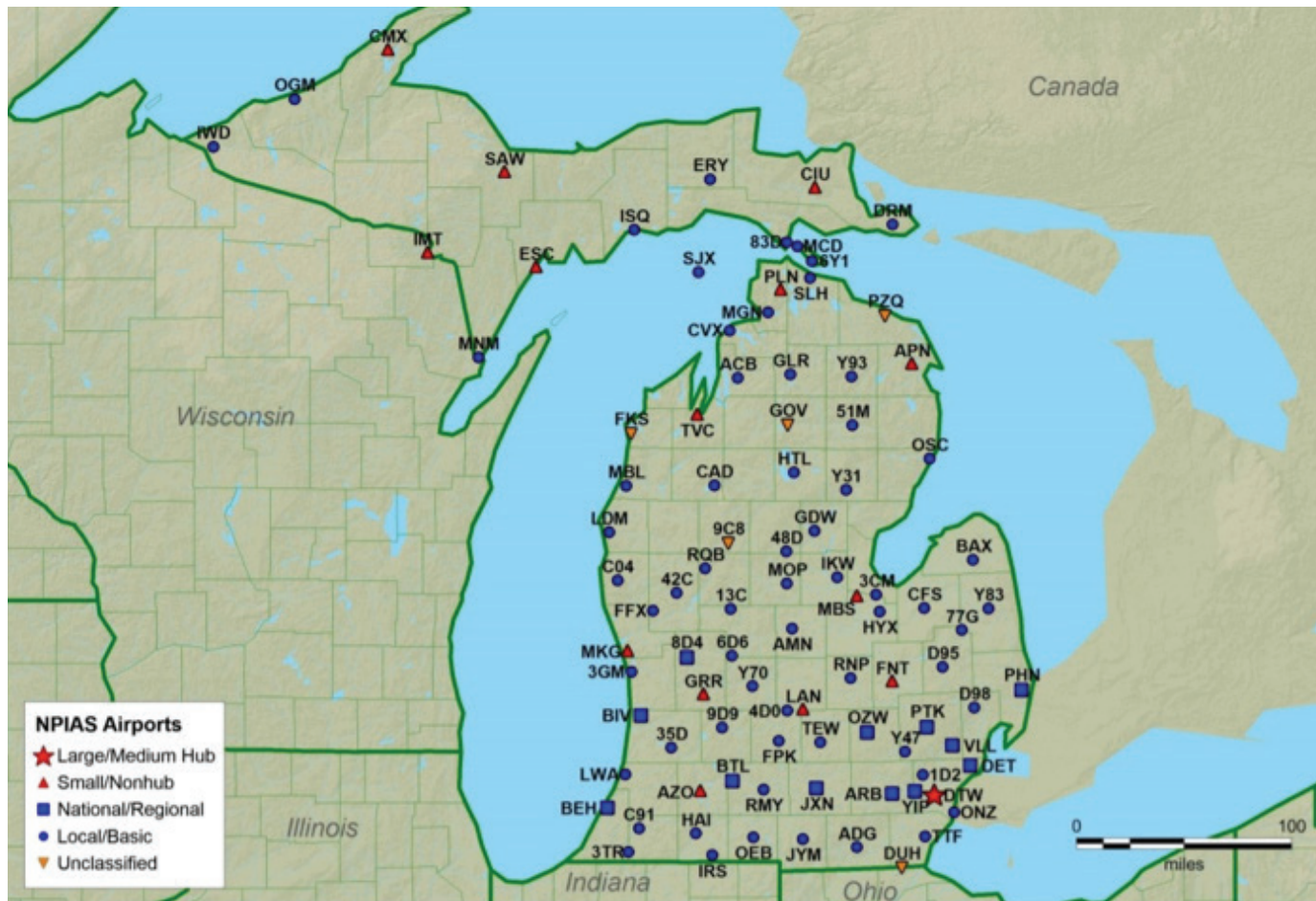
Aviation is an integral part of Michigan's transportation system, moving people and goods throughout the state, nation, and world. Michigan has a vibrant and diverse aviation community consisting of the airlines, business aviation, and recreational flyers. Every Michigan citizen is impacted by the benefits aviation provides.

The airports that support these activities are significant assets and essential to Michigan's economy. Good airports play a notable role when people and businesses consider Michigan as a place to live and work. Business growth in Michigan relies on a safe and efficient aviation system. With the geographic challenges of Michigan, access to all parts of the state in support of business, tourism, and emergency relief is critical. The economic impact of aviation in Michigan is estimated at more than \$22 billion annually.

Michigan has 234 airports across the state, including 18 commercial airports, which provide passenger air service. The 18 commercial air service airports include one large hub, two small hub, seven non-hub and eight Essential Air Service (EAS) facilities. These airports are geographically well-situated and meet Michigan's air service needs within the service threshold of 60 minutes or less surface travel time.



FIGURE 1. MAP OF NPIAS AIRPORTS IN MICHIGAN

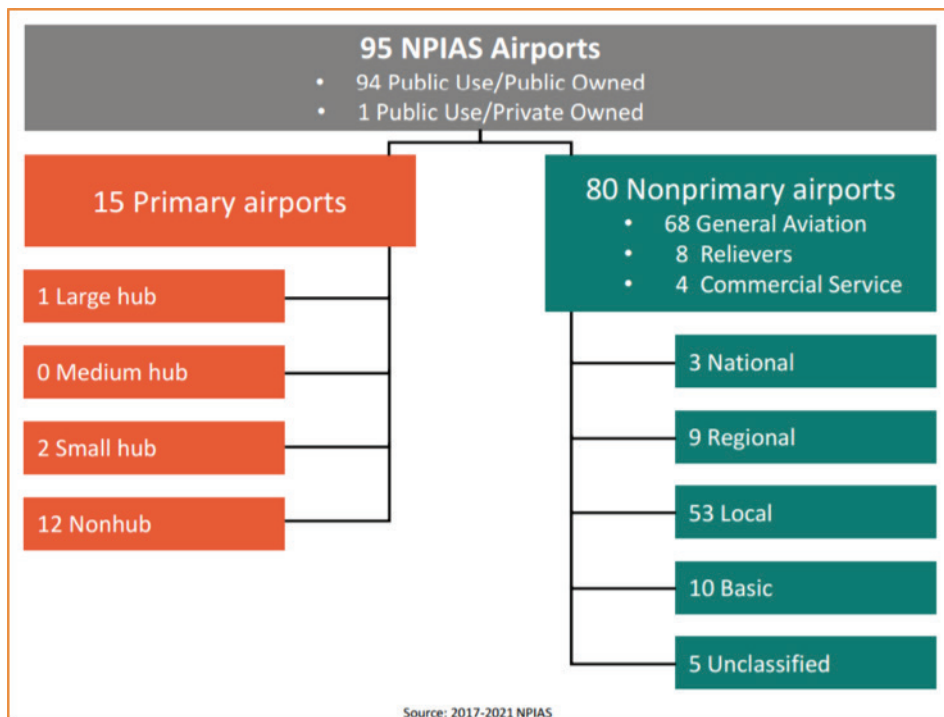


The Michigan Airport System has remained stable both in capacity and condition. The number of airports in the system and services provided are relatively unchanged. The system of airports remains a vital part of Michigan's transportation link to national and global markets.

There are 95 airports in Michigan listed in FAA's National Plan of Integrated Airport Systems (NPIAS) 2017-2021, which lists airports significant to national air transportation and thus eligible to receive Federal grants under the Airport Improvement Program (AIP). Figure 2 shows the breakdown of those airports into categories and types.



FIGURE 2. NPIAS AIRPORTS IN MICHIGAN



CAPACITY

Table 1 lists the airports in Michigan with regularly scheduled air service. Almost all of Michigan’s 10 million residents live within a 90-minute drive from one of these airports, and the large population centers are within a 30-minute drive from one of these airports.

TABLE 1. AIRPORTS IN MICHIGAN WITH REGULARLY SCHEDULED AIR SERVICE

ASSOCIATED CITY	AIRPORT NAME	FAA IDENTIFIER
Alpena	Alpena County Regional Airport	APN
Charlevoix*	Charlevoix Municipal Airport	CVX
Detroit	Detroit Metropolitan Wayne County Airport	DTW
Escanaba	Delta County Airport	ESC
Flint	Bishop International Airport	FNT
Grand Rapids	Gerald R. Ford International Airport	GRR
Hancock	Houghton County Memorial Airport	CMX
Iron Mountain	Ford Airport	IMT



TABLE 1. AIRPORTS IN MICHIGAN WITH REGULARLY SCHEDULED AIR SERVICE - CONTINUED

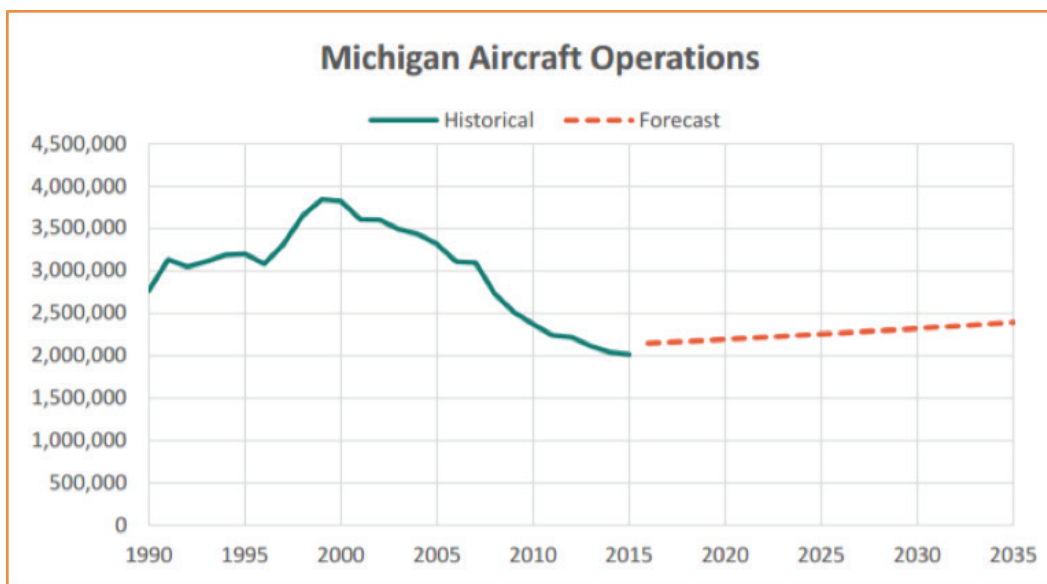
ASSOCIATED CITY	AIRPORT NAME	FAA IDENTIFIER
Ironwood	Gogebic-Iron County Airport	IWD
Kalamazoo	Kalamazoo/Battle Creek International Airport	AZO
Lansing	Capital Region International Airport	LAN
Manistee*	Manistee County- Blacker Airport	MBL
Marquette	Sawyer International Airport	SAW
Muskegon	Muskegon County Airport	MKG
Pellston	Pellston Regional Airport of Emmet County	PLN
Saginaw	MBS International Airport	MBS
Sault Ste. Marie	Chippewa County International Airport	CIU
Traverse City	Cherry Capital Airport	TVC

* Service at CVX and MBL varies

Source: MDOT Aeronautics

Although overall aviation activity (takeoffs and landings) throughout the state peaked in about 2000 and has declined steadily since then, aircraft operations have leveled off and are expected to begin and continue a slow and steady growth due to improved economic conditions in Michigan (see Figures 3 and 4 below).

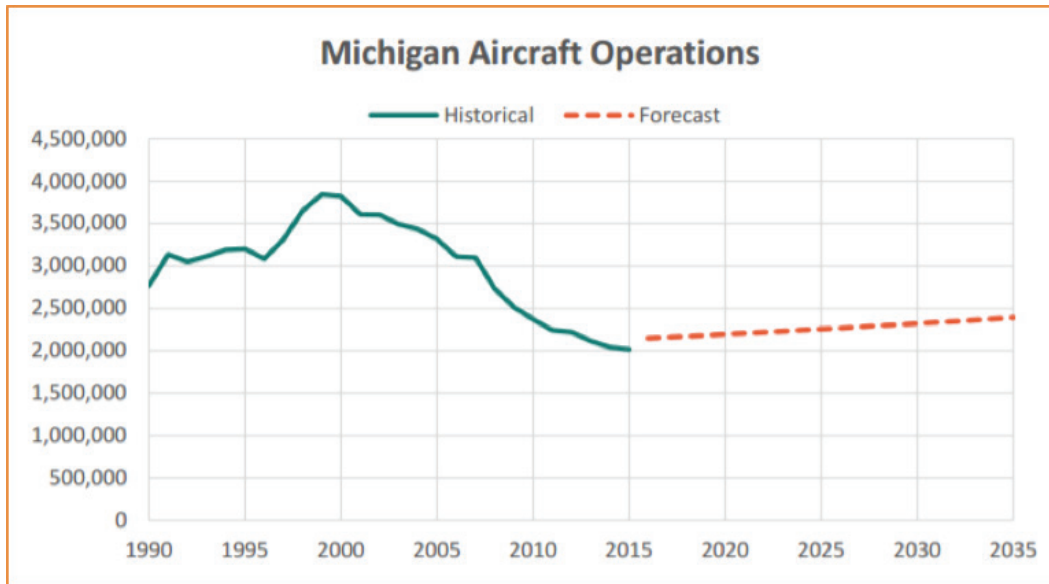
FIGURE 3. AVIATION ACTIVITY IN MICHIGAN, 1990-PRESENT AND FORECASTED



Source: MDOT MASP, <http://mdotmasp.com>



FIGURE 4. NUMBER OF AIRCRAFT IN MICHIGAN, 1990-PRESENT AND FORECASTED



Source: MDOT MASP, <http://mdotmasp.com>

Beginning in 2008, the aviation industry saw a significant decrease in aircraft operations, especially in the general aviation sector. Forecasts show a steady increase in general aviation activity, but more substantial growth is projected for corporate and commercial activity.

CONDITION

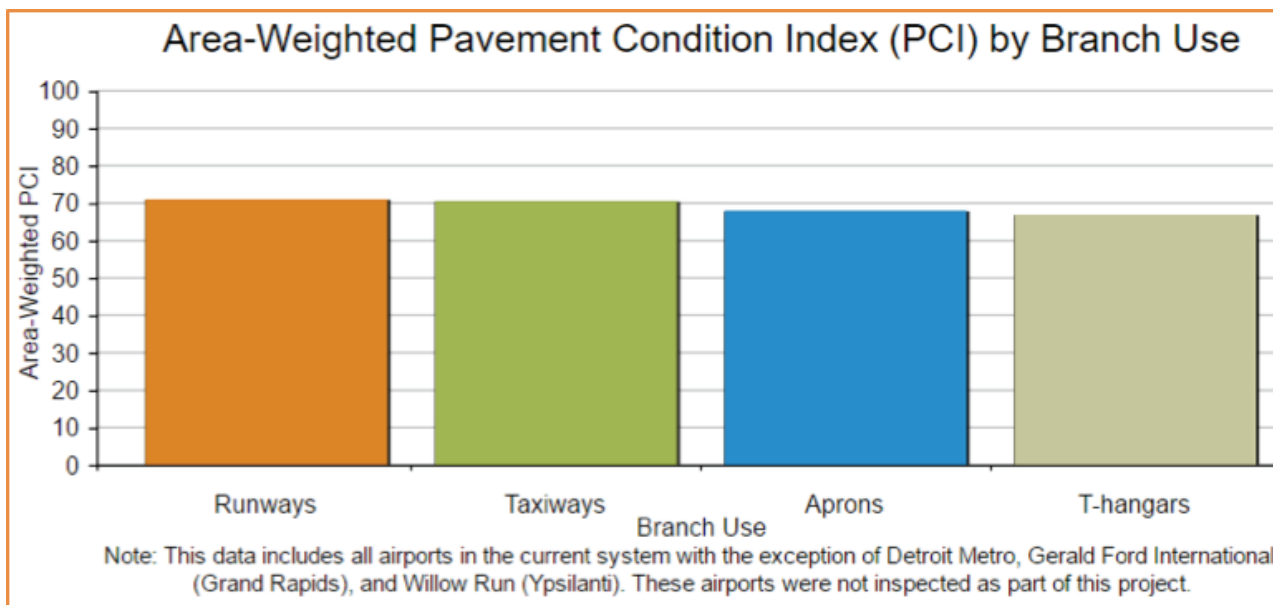
The condition and overall safety of the aeronautical infrastructure has been well monitored and maintained through an asset management concept described in the Michigan Aviation System Plan. This plan provides guidelines for maintenance and future development through a “systems approach.” This approach takes into consideration state, national, and local goals for safety and access to pertinent markets, to provide quality and economical aeronautical access in Michigan.

Through their Statewide Pavement Management System Update, the MDOT Office of Aeronautics evaluated almost all airports in Michigan in 2013 to 2015. This evaluation procedure uses the Pavement Condition Index (PCI) to quantify pavement conditions.

MDOT evaluated 153,331,665 square feet of airfield pavements from 2013 to 2015. Airfield pavements include runways (surfaces devoted to the landing and takeoff of aircraft), taxiways (surfaces utilized by aircraft to travel to and from runways), aprons (surfaces dedicated to aircraft parking), and T-hangar taxi lanes (smaller taxiways near and around hangars utilized to access hangars). The average PCI of airports in the state apart from independent airport authorities governing airports in Detroit, Grand Rapids, and Willow Run was 69. A PCI score of 69 is considered fair condition, in need of rehabilitation.



FIGURE 5. PAVEMENT CONDITION INDEX (PCI) AT AIRPORTS IN MICHIGAN



Source: MDOT Aeronautics 2015 Statewide Pavement Management Update, <http://mdotnetpublic.state.mi.us/apms>

INVESTMENT AND FUNDING

The bulk of capital funding improvements to the aviation system are provided with federal Airport Improvement Program (AIP) funding through the Federal Aviation Administration (FAA). Since 2005, this funding has remained flat. This funding program was most recently reauthorized by Congress under the Federal Aviation Administration Modernization and Reform Act of 2012, which has been extended until March 31, 2018. While Fiscal Year (FY) 2018 will probably be funded by continuing resolutions, a new authorization should be developed in 2018. Funding levels are unknown at this time but are being assumed at present levels. The funding categories and programs have remained unchanged since the 2005 report.

The stability of federal funding for airports remains a concern, as little progress has been made other than continuing resolutions at current funding levels. At the state level, fuel tax revenues have been flat while bond repayment obligations have increased, requiring the department to continually re-assess sources and participation levels in all aviation programs.

Although the federal Essential Air Service Program (EAS) has been under increased scrutiny for cost and effectiveness, it remains in effect for 2016, and is included in the new re-authorization. As of September 2015, air service is subsidized under the EAS Program at nine Michigan airports: Alpena County Regional (Alpena), Delta County (Escanaba), Houghton County Memorial (Hancock), Ford Airport (Iron Mountain), Gogebic County (Ironwood), Manistee-Blacker (Manistee), Muskegon County (Muskegon), Pellston Regional (Pellston), and Chippewa County International (Sault Ste. Marie). While no immediate changes are foreseen, continued EAS service is contingent upon federal funds being appropriated to the United States Department of Transportation (USDOT) for this program.



In the past, funding for the Small Community Air Service Development Program (SCASDP) was provided under the FAA Modernization and Reform Act of 2012 at the level of approximately \$5 million annually. Michigan communities enjoyed a good deal of success in securing SCASDP awards from USDOT, as shown below in Table 2. However, SCASDP funding was not included in the FY 2017 funding request by FAA, and the long-term future of the program is uncertain.

TABLE 2. FAA SCASDP AWARD BY FISCAL YEAR

YEAR	AIRPORT	CITIES SERVED	AMOUNT
2007	MBS International	Midland, Bay City, Saginaw	\$500,000
2007	Gogebic/Iron County	Ironwood	\$135,000
2008	Muskegon County	Muskegon	\$650,000
2009	Cherry Capital Airport	Traverse City	\$400,000
2010	Capital Region International	Lansing	\$750,000
2011	Delta County Airport	EsCANABA	\$72,500
2011	Kalamazoo	Kalamazoo	\$500,000
2011	Manistee County-Blacker	Manistee	\$50,000
2015	Cherry Capital Airport	Traverse City	\$750,000

Source: MDOT Office of Aeronautics

State funding for airports has been in decline for several years. The three cents-per-gallon Aviation Fuel Excise Tax has been unchanged since its inception in 1931 and revenue from the tax has slowly decreased since 2005. The \$6 million revenue to the State Aeronautics Fund (SAF) from the Airport Parking Tax has continued. However, an increasing amount each year is dedicated to bond indebtedness from the 2002 Airport Safety and Protection (ASAP) Program.

Forecasts of state revenue to the SAF are beginning to see some positive signs, mainly due to lower fuel costs, and there are reasons to be optimistic in the future as well. In response to federal policy clarifications, the Legislature recently enacted provisions to redirect an amount equal to 2% of the sales tax on aviation fuel. These funds will be split, with 65% going to Detroit Metro and 35% to the SAF. This represents a more stable and predictable source for state aviation programs and ensures a minimum level of funding to match federal aid and support the system of airports. In addition, due to the dependence on the price of fuel, as increases occur revenue will follow. These bills were signed into law on December 23, 2015.

Local budget concerns have caused local agencies to examine their level of support for their airports as well. Many have been forced to examine the level of services they can provide within their decreasing budgets. Reduced levels of local funding put more pressure on state funds to match federal aid.

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SAFETY AND RESILIENCE

Airports move people, goods, and services and are critical to Michigan's economy. This movement must occur safely at all times to ensure confidence and reliability in the system. Airports and airlines are responsible for ongoing safety and security upgrades to keep pace with changing mandates and security procedures.

Airport and aircraft operations must also continue during inclement weather, emergencies, and in all seasons. Many airports in Michigan support first responders such as police, fire, and medical units, and there are a number of military airfields in Michigan as well. All of these facilities support emergency operations and are critical to the response to natural and man-made disasters.

INNOVATION

Aviation-focused schools, academies, colleges, and university programs are available across the state to ensure that the next generation of high-tech and highly skilled aviation experts are available to compete for jobs in the aviation sector throughout Michigan. These include programs in pilot training, aircraft maintenance, aviation business administration, aeronautical engineering, flight science, and airspace engineering.

Michigan has a rich history of innovation, with the world's first paved airport in 1928 at Ford Airport in Dearborn (now home to Ford Proving Grounds), and the first mass-produced all-metal airliner, the Ford Tri-Motor, first produced in 1925. The same history and spirit of innovation should guide Michigan to consider new funding methods to address the state's aviation system needs.

Despite current funding challenges, Michigan maintains a complete and well-planned aviation system. This came about because of a continuing commitment by the state to maintain an active role in aviation planning and development. This commitment is evidenced by the state's decision to become a "block grant" state, which enables state, not federal, control of airport planning, programming, and development.

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RECOMMENDATIONS TO RAISE THE GRADE

- Add \$0.03 tax per gallon of aviation fuel sold to the current \$0.03 per gallon to help mitigate the state funding shortfall.
- Eliminate the \$0.015 credit on the \$0.03 per gallon aviation fuel tax that benefits passenger airlines to significantly increase available funding.
- Increase the state sales tax on aviation parts and supplies by \$.01 to help to boost the aeronautic state fund.
- Remove the federally-imposed cap on Passenger Facility Charges (PFCs) to allow airports a tool to invest in their own facilities.
- Explore innovative third-party funding such as privatization, public private partnerships and other innovative funding mechanisms to help increase the amount of funding available for the state's vital aviation needs.
- Pass a long-term FAA reauthorization bill in 2018.

SOURCES

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BRIDGES
GRADE: C-

SUMMARY

Michigan's over 11,000 bridges are critical connections in our surface transportation system providing crossings over waterways, roads and railroads. A deteriorating and inadequate highway transportation system costs Michigan motorists billions of dollars every year in wasted time and fuel, injuries and fatalities caused by traffic crashes, and wear and tear on their vehicles. Innovative bridge replacements (i.e. bridge slides



FORT STREET BRIDGE, DETROIT, MICHIGAN

and the use of prefabricated bridge elements) have helped reduce travel delays and disruptions during construction of new bridges in the last few years. Additionally, the Michigan legislature took the first steps to increasing investment in our transportation network in 2015. The 2015 infrastructure-funding package relies on a combination of increased user fees, registration fees and general funds. To build on the results of increased funding, the legislature must continue to appropriate the funds each year. These funds will assist state and local governments to move forward with numerous transportation projects. However, these funds are not sufficient to address the significant deterioration of the system. Approximately 1,234 bridges (11%) of the state's 11,156 bridges are structurally deficient, and the Michigan Department of Transportation (MDOT) anticipates, based on available funding, the number of state maintained bridges currently rated in poor condition will increase by 50% between 2016 and 2023, from 236 to 354 bridges.

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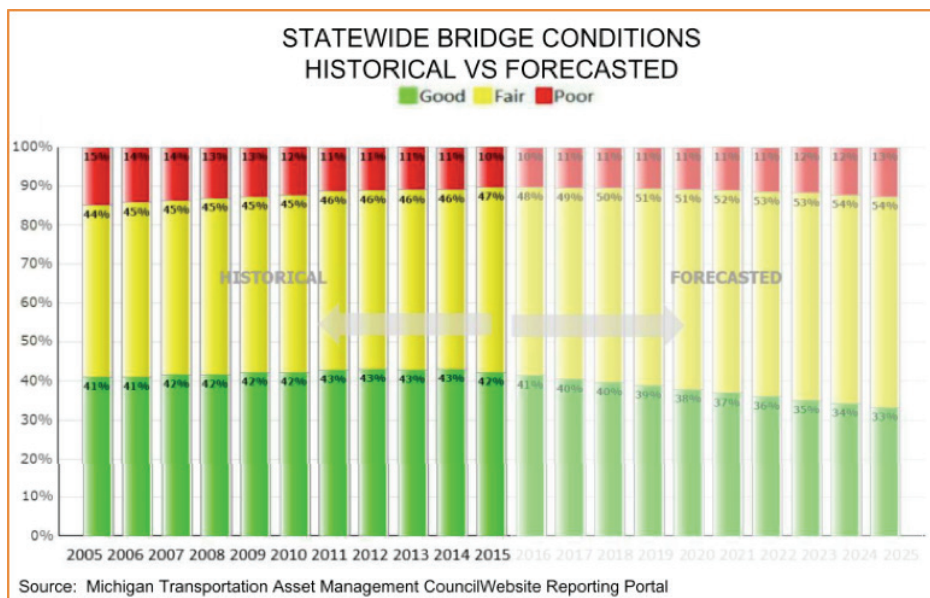
CONDITION AND CAPACITY

Safe and well-maintained bridges provide residents access to work, home, vacation areas, medical facilities, and schools, and allows businesses access to suppliers and markets. Michigan's population has increased each year from 2011 to 2016 and is currently at 9.9 million residents. Michigan has about 7.1 million licensed drivers. It is challenging for the agencies responsible for managing bridges to maintain and improve conditions due to the struggle of implementing a statewide-unified long-term asset management plan resulting from inadequate funding.

The Michigan Transportation Asset Management Council's forecasts of bridge conditions show an increase in bridges rated in fair condition, due to corresponding reductions in the percentage of bridges rated in good condition and poor condition.



M-8/I-75 BRIDGE, DETROIT, MICHIGAN



Without additional funding and implementation of a long-term plan, Michigan's bridges will continue to deteriorate and fail to meet demand. Bold action beyond the recently approved increases in state transportation funding is required to address long-term funding needs.

One in nine locally and state maintained bridges in Michigan show significant deterioration and are in need of repair. In 2008, 13% of the state's bridges were structurally deficient. In 2016 that figure had decreased to 11%, according to FHWA 2016 Bridge Inventory Data. However, the percentage of structurally deficient bridges in Michigan is still higher than the national average of 9.1%. 1,100 bridges in the state are posted for load, meaning vehicles of certain sizes and weights are prohibited from crossing the structure, thereby impeding the flow of goods and commerce and potentially impacting emergency services.

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INVESTMENT AND FUNDING

According to FHWA's 2016 National Bridge Inventory, 1,918 bridges in Michigan are in need of repair, with the total cost to the state estimated at \$7 billion. Current mechanisms for state funding utilize vehicle-registration fees and motor-fuel taxes for the bulk of the state's transportation revenue. However, revenue from motor-fuel taxes will decline over time as fuel-efficiency increases and hybrid and electric vehicles become a larger percentage of the vehicle fleet. Other mechanisms for generating funds like Mileage Based User Fees should be explored.

In 2015, Michigan's governor signed into law an infrastructure-funding package that relies on a combination of increased user fees, registration fees and general funds. The 2015 transportation package will provide roads, bridges and transit a total of \$4.2 billion in additional funding through 2023. However, \$2.3 billion of the additional \$4.2 billion is not guaranteed. Beginning in 2019 the funds will be distributed at the discretion of the Michigan Legislature.

Additionally, even with the increases in transportation funding implemented at the State level over the next several years, funding levels are not sufficient to reverse the rate of deterioration of Michigan's bridges. Additional funding is required to make necessary repairs to bridges. Inadequate investment in the transportation system today will mean not only accelerated deterioration of Michigan's bridges, but also increased future maintenance costs.

According to the Michigan Governor's 21st Century Infrastructure Commission Report published in November 2016, Michigan's roads and bridges will require an estimated annual investment of:

- \$1 billion in State funds for Interstate and U.S. Route freeways and bridges,
- \$600 million of State funds for other state highways and bridges, and
- \$600 million of State funds for other highly used roads and bridges under local jurisdiction.

At the Federal level, motor fuel and other truck-related taxes that support the Highway Trust Fund (the major source of federal surface transportation funding) are eroding. Federal motor fuel tax rates have not increased since 1993, and drivers of passenger vehicles with average fuel efficiency currently pay about \$96 per year in federal gasoline taxes. Because of inflation, the 18.4 cent-per-gallon tax on gasoline enacted in 1993 is worth only about 11.5 cents today. This trend will likely continue as demand for gasoline decreases with the introduction and adoption of more fuel-efficient and alternative fuel vehicles. To maintain spending levels of about \$45-\$50 billion a year for highway and transit programs and to cover revenue shortfalls, Congress transferred a total of about \$63 billion in general revenues to the Highway Trust Fund on six occasions between 2008 and 2014. This approach has effectively ended the long-standing principle of "users pay" in highway finance, breaking the link between the taxes paid and the benefits received by highway users. In August 2014, the Congressional Budget Office estimated that \$157 billion in additional revenues would be required to maintain current spending levels plus inflation between 2015 and 2024.

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INNOVATION

New technologies and materials are helping engineers build bridges to last longer and are improving maintenance techniques. Construction of bridges is faster or is being performed off-site resulting in less mobility impact to the public and businesses. New materials such as ultra-high performance concrete, high performance steel and composites can increase bridge life. Off-site construction of prefabricated beams, decks and substructures is occurring in order to reduce the amount of time traffic is disrupted while the bridge is being replaced. Bridges are being constructed adjacent to the existing bridge, and then traffic is switched over prior to the demolition of the existing bridge to minimize public and economic impact. MDOT has already successfully implemented several bridge slides and used prefabricated bridge elements in Michigan.

RECOMMENDATIONS TO RAISE THE GRADE

A deteriorating and inadequate highway transportation system costs Michigan motorists billions of dollars every year in wasted time and fuel, injuries and fatalities caused by traffic crashes, and wear and tear on their vehicles. Making needed improvements to Michigan's roads and bridges is key to providing a safer, more efficient transportation system that will decrease fatalities, decrease the amount of wasted time and money spent by motorists, and improve the State's economic livelihood. Therefore, we recommend the following to raise the bridge grade:

1. State leaders must acknowledge the bridge crisis and provide substantial and sustainable funding and asset management programs to assist Michigan in continuing on the road to success.
2. Bridge designers and owners should consider the costs of the bridge's entire lifecycle to make better long-term design decisions, and prioritize maintenance and rehabilitation.
3. Fix the federal Highway Trust Fund by raising federal motor fuel tax, creating a federal tax to replace the federal motor fuel tax, or studying and implementing mileage-based user fees.
4. Since Michigan receives a large amount of freight traffic, there should be a mileage based user fee implemented for freight movement or fees for permits related to truck size and weight.

DEFINITIONS

Structurally deficient – Bridges that require significant maintenance, rehabilitation, or replacement. These bridges must be inspected at least every year since critical load-carrying elements were found to be in poor condition due to deterioration or damage.

Functionally obsolete – Bridges that do not meet the current engineering standards, such as narrow lanes or low load-carrying capacity. A bridge that is both structurally deficient and functionally obsolete is only counted as structurally deficient.

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DAMS
GRADE: C-

SUMMARY

There are approximately 2,600 dams in Michigan, of which about two-thirds are older than their typical 50-year design life. In the next five years, about 80 percent of Michigan's dams will be over 50 years old. Many of Michigan's dams were originally constructed to support power or mill operations. Some of these dams still serve this original purpose. In some cases, dams no longer serve their original purpose, but continue to form impoundments for water supply or for recreational purposes. However, many of Michigan's dams are abandoned or are in need of repair or removal. Abandoned dams or dams that are in a deficient condition pose a safety hazard to downstream residents, a risk of environmental degradation, and other damage to downstream properties if the dam were to fail. While there has been some improvement with the overall condition of Michigan's dams (mostly through the removal of dams) since the last Michigan Report Card in 2009, Michigan must make more progress to address dams in need of repair or removal. Expanded funding is needed to provide additional staffing for the Michigan Department of Environmental Quality (MDEQ) Dam Safety Unit, and for resources for dam owners to address dam repair or dam removal projects.

BACKGROUND

Throughout history, Michigan has supported the intensive use of rivers for economic development. Dams can provide many benefits, but if left unmanaged, can pose risks to public safety, local and regional economies, and the environment in the event of dam failure. Many dam owners, including public agencies, do not have the financial capability to repair and maintain dams, or to remove aging and abandoned dams. Owners of dams are responsible for maintenance and repair of their dams, but many owners of non-revenue generating dams do not set aside money to fund projects for the eventual repair or removal of these dams. The lack of sufficient state, federal, or other public-funding mechanisms to assist dam owners with these projects means that abandoned, deficient, or crumbling dams continue to remain unaddressed. This poses safety hazards to downstream residents and poses a risk to Michigan's environment and economy.



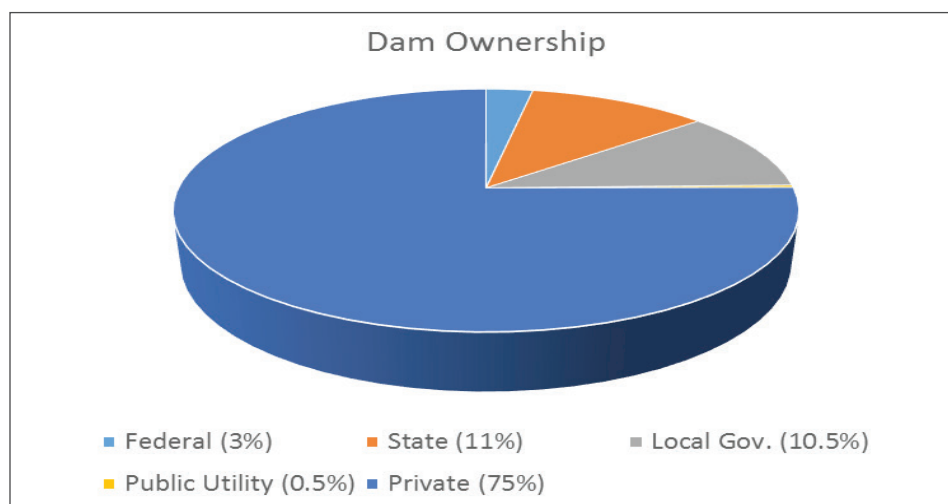
CONDITIONS AND CAPACITY

The Dam Safety Unit of the MDEQ maintains a database on dams in Michigan. There are approximately 2,600 dams in the MDEQ database or inventory. The 2,600 dams in the MDEQ database include 94 dams that generate hydropower and fall under the regulation of the Federal Energy Regulatory Agency (FERC). The National Inventory of Dams (NID), maintained by the U.S. Army Corps of Engineers, is a national dam database and lists 1,005 dams in their inventory for Michigan. The MDEQ's database contains more dams than the NID since the threshold for dam size included in the MDEQ database is lower than the threshold required for the NID.

Infrastructure age is a good indicator of overall condition since infrastructure (such as a dam) has a finite service life, allowing for the age of a dam to serve as a general qualitative indicator of condition. According to the MDEQ database, about two-thirds of Michigan's dams are older than the typical design life of 50 years. In the next 5 years, about 80 percent of Michigan's dams will be beyond their design life. Additionally, 271 of Michigan's dams were built prior to 1900, and have more than twice exceeded their typical 50-year design life. Michigan has averaged about two dam failures per year. While these failures typically have been on smaller dams without significant risk to public safety, these failures still result in environmental and economic damage.

Michigan has 140 "high" hazard potential dams (representing about 5 percent of Michigan's 2,600 dams). Hazard potential is not an indication of the dam's condition, but an indication of the potential for loss of life and property damage if the dam were to fail. A high hazard dam poses a high or serious risk of property damage or loss of life to downstream residents or a serious risk of environmental degradation if the dam were to fail. Almost 90 percent of Michigan's high hazard potential dams are greater than 50 years old. According to condition assessment data, Michigan's high hazard dams in the NID have an average rating of "Fair" (scoring about 79 on a 100-point scale). Average scores for Michigan's significant and low hazard dams in the NID are slightly higher than for high hazard dams, but remain in the rating range of "Fair".

The majority of dams (about 75 percent) in Michigan are under private ownership. The remaining dams are owned by a combination of local municipalities, the state and federal government, and public utility companies.



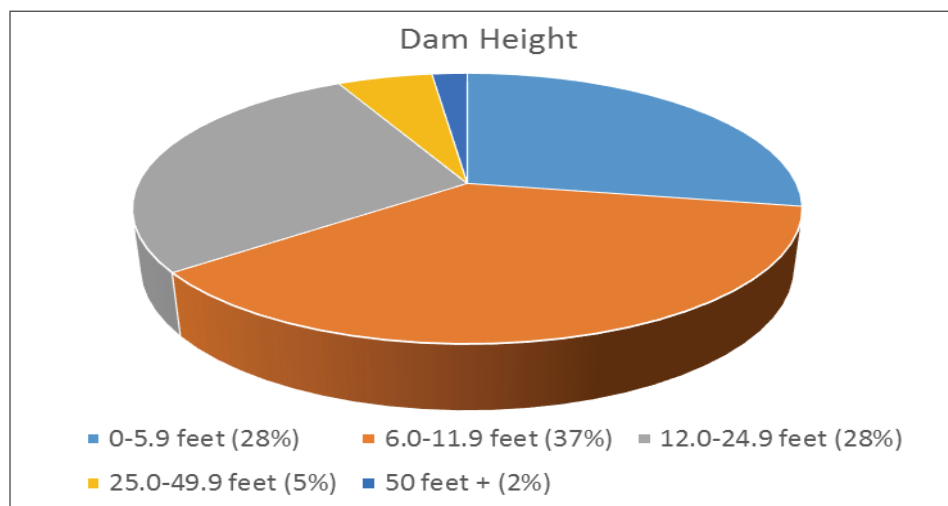
The MDEQ established its Dam Safety Program to ensure that a dam at serious risk of failure is identified and that dams are inspected and maintained in a safe condition. Dams regulated by the MDEQ must be inspected every three to five years, with the frequency of inspection depending on the hazard classification. Dams in Michigan regulated by FERC must also be inspected on a routine basis, with



the frequency of inspection a function of dam height and reservoir volume. Once dams are inspected, dam owners still need money to repair or remove the dams if the dams have deficiencies or pose a safety hazard. Deficiencies identified during dam inspections often remain uncorrected, sometimes for decades, because their owners do not have the money to repair or remove them.

Statistics on Michigan's 2,600 dams:

- About two-thirds of Michigan's dams have reached their typical 50-year design life;
- In the next 5 years, this number grows to approximately 80 percent;
- There are 271 dams over 100 years old;
- Only 86 new dams were built in the last 25 years;
- There are almost 300 dams with a "high" or "significant" hazard potential rating;
- The largest dam in Michigan has a height of 170 feet;
- 28 percent of dams are 6 feet in height or less;
- There are 94 dams in Michigan that are under the jurisdiction of FERC because of the amount of hydropower these dams produce; and,
- Since the early 20th century, more than 300 dam failures have been documented in Michigan.



There have been improvements to some of Michigan's dams since the 2009 ASCE Michigan Report Card. For example, 24 dams in Michigan have been removed since 2009, or an average of about three dams per year, and there are approximately 22 permit applications each year for repair work to dams regulated by the MDEQ. However, the combined rate of dam removals and repairs (about 25 total per year) is not keeping pace with the 241 dams that will exceed their expected design life in the next five years. There has been some good news in the fact that the slow but steady rate of removal of dams in Michigan since the 2009 ASCE Michigan Report Card has eliminated some problematic dams that have been a concern for many years in terms of their condition and potential for causing damage should the dam have failed. Primarily, because of these removals, the current grade of Michigan's dams has improved slightly to a "C-" from the 2009 grade of "D". The current grade is qualitatively consistent with the general condition of "Fair" assigned to Michigan dams in the NID.

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INVESTMENT, FUNDING, AND FUTURE NEED

The choice to either repair or remove a dam is often difficult as there are safety, social-cultural, biological, ecological, and economic factors involved. Dam removal costs are highly variable and dependent on factors such as sediment contaminant levels, sediment volumes, surrounding infrastructure, wetland-related issues, and more. The many factors involved illustrate why the cost for dam repairs/maintenance/removal can be so high.

Lack of funding for addressing Michigan's aging dams has continued to slow progress on addressing Michigan's dams. According to a 2007 study, about 120 of Michigan's dams need at least \$50 million for repairs or rehabilitation. According to the 21st Century Infrastructure Commission Report, \$225 million is needed in additional state funding over the next 20 years to manage our aging dams in Michigan. This funding amount includes an initial investment of \$10 million to perform field assessments, upgrade the dam database, and procure decision-support tools and training to evaluate repair and removal options for Michigan's 2,600 dams. The remaining funding of \$215 million is the projected need to maintain or in some cases remove dams identified for attention by the upgraded database and decision-support tools. As previously discussed, many dam owners, including public agencies, do not have the financial capability to repair and maintain their dam, or to remove their aging or abandoned dam. As Michigan's dams continue to age, the need for state or federal funding, or funding from other sources, will increase. The rate at which Michigan's aging dam infrastructure is degrading has generated financial demands that far exceed the available funding to repair or remove these dams.

Funding mechanisms, such as the Michigan Department of Natural Resources Dam Management Grant, are a start toward dam funding needs. However, this funding alone is inadequate to keep pace with the financial demands of aging dams. From 2013 to 2015, this fund awarded slightly over \$1 million in Dam Management Grants. The MDNR directed three-quarters of the grants to dam removal, leaving many needs related to dam repair unfunded.

Governor Rick Snyder's 2016-5 Executive Order outlines ambitious goals for Michigan for the next 30 to 50 years. The 21st Century Infrastructure Commission Report states "Michigan must raise current annual infrastructure spending levels by an additional \$4 billion per year to close the investment gap". Closing Michigan's infrastructure funding gap, including dams, will require a combination of local, state, federal, and private investments, as well as financing strategies to meet long-term needs.

Funding for oversight of Michigan's dams by the MDEQ Dam Safety Unit is also lagging. Considering Michigan has 2,600 regulated dams, Michigan falls below the national average for budget funding on a per dam basis.

PUBLIC SAFETY AND RESILIENCE

To improve public safety and resilience, the risk and consequences of dam failures must be lowered. Since the early 20th century, more than 300 dam failures have been documented in Michigan. A recent example in Michigan is the 2003 Silver Lake Dam failure near Marquette which resulted in \$100 million in damages and economic losses of \$1 million per day. Concern about dam safety and environmental quality has become more prevalent over the last decade as more aging dams require repair. One positive for Michigan in addressing public safety is that approximately 97 percent of high and significant hazard potential dams have an Emergency Action Plan (EAP). An EAP outlines steps to be taken in the event of impending failure of a dam. Implementation of measures in an EAP can help to reduce the severity of damage should the dam fail, and can reduce the risk of loss of life.

By their nature, dams have a low level of resilience since dams cannot "recover" once significant degradation or movement is experienced. Multiple layers of redundancy are typically not provided in dam design and construction should a component fail. Therefore, when there is a dam failure, the consequences in terms of downstream damage can be relatively severe. This highlights the importance of proactive maintenance and monitoring of Michigan's dam infrastructure. Innovations in remote sensing technology, such as cameras, inclinometers, or piezometers that provide data through a web connection, can be utilized to allow for relatively rapid data collection in real time for larger more remote dams.

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RECOMMENDATIONS TO RAISE THE GRADE

Some recommendations to improve the outlook for Michigan's dams include:

- Provide funding to the MDEQ Dam Safety Unit for additional staff to improve the dam inspection program and to support enforcement action for deficient dams. Currently, the MDEQ Dam Safety Unit has 3.3 full-time equivalent (FTE) staff. A 2006 informal audit of the MDEQ Dam Safety Unit by the Association of State Dam Safety Officials (ASDSO) recommended increasing the staffing level by 2 FTE staff.
- Create an asset management process to assist in making strategic and optimal decisions about dam improvements to ensure greater value for the investment. Establish performance metrics and ensure data transparency to the public regarding the condition of Michigan's dams.
- Develop educational materials and initiate a public relations campaign to educate the public on the need for proper maintenance and repair of dams, and to make the public aware of the current funding needs to address issues associated with Michigan's dams.
- Update the 2007 study to determine an appropriate current funding level to address the current condition of Michigan's aging dams. Set up a dedicated state fund for the repair, replacement, or removal of unsafe or failing dams, with the funding level based on the results of the recommended updated study.
- Provide funding to the federal program established to help dam owners with loans and matching grants for repair, replacement, or removal of unsafe, failing dams.

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DRINKING WATER

GRADE: D

SUMMARY

Michigan is nearly surrounded by the Great Lakes, which contain 21% of the world's fresh water, and is served by multiple subsurface aquifers¹. Yet certain drinking water system “owners” (e.g., municipalities) face scarcity concerns, contamination, and aging treatment/distribution systems that are not aligned with drinking water user needs. According to Public Sector Consultants (PSC) and 21st Century Infrastructure Commission reports, failure to adequately plan for and fund drinking water infrastructure could lead to major crises affecting millions of the State's residents. It is estimated that system owners in Michigan are underfunding system improvements for Safe Drinking Water Act (SDWA) compliance at between \$284 to \$563 million/year and this condition needs correction.

BACKGROUND

Approximately 77% of Michigan's population (9.9 million+/-) obtains their drinking water from the State's 1,400+/- Community Water Supply systems (CWS) with the balance supplied by Non-Community Water Supply (NCWS) systems or private wells - see Table 1. Aquifer or surface sources are employed depending on access, quality, and capacity need. Supply systems typically consist of a water source, transmission, treatment, and distribution to each user – see Definitions.

TABLE 1: MICHIGAN DRINKING WATER SOURCES AND REGULATORY OVERSIGHT

WATER SOURCE, SUPPLY SYSTEM (OWNER)	COUNT	% POP. SERVED	REGULATORY OVERSIGHT NOTES
Aquifer Wells (Private/ Agricultural owners)	Over 1.12 million wells	23%	Michigan Department of Environmental Quality (MDEQ) oversight; local health department (LHD) permitting; minimal water treatment
CWS – Aquifer Source (Note 1)	1,341 systems	19%	MDEQ oversight; review/approval of plans; significant water treatment
CWS – Surface Source (Note 1)	59 systems	58%	MDEQ oversight; review/approval of plans; significant water treatment
NCWS (Note 2)	10,000+ systems	Note 2	Primarily private owners serving 25+ people; MDEQ permit control with LHD oversight
TOTAL	>1.12 million wells; ~1,400 CWSs; 10,000+ NCWS	100%	MDEQ is primary State regulator for drinking water systems (Note 3)

¹ Groundwater refers to all subsurface water in a saturated soil zone termed an aquifer, which contain sufficient permeable material to yield significant quantities to wells and springs. Per the USGS, groundwater with less than 1,000 milligrams per liter (mg/L) of dissolved solids is considered freshwater (potable) and the remainder is considered “saline” (requiring extended treatment before most uses). 27% of Michigan wells tap deep bedrock aquifers whereas 73% tap much shallower glacial aquifers.

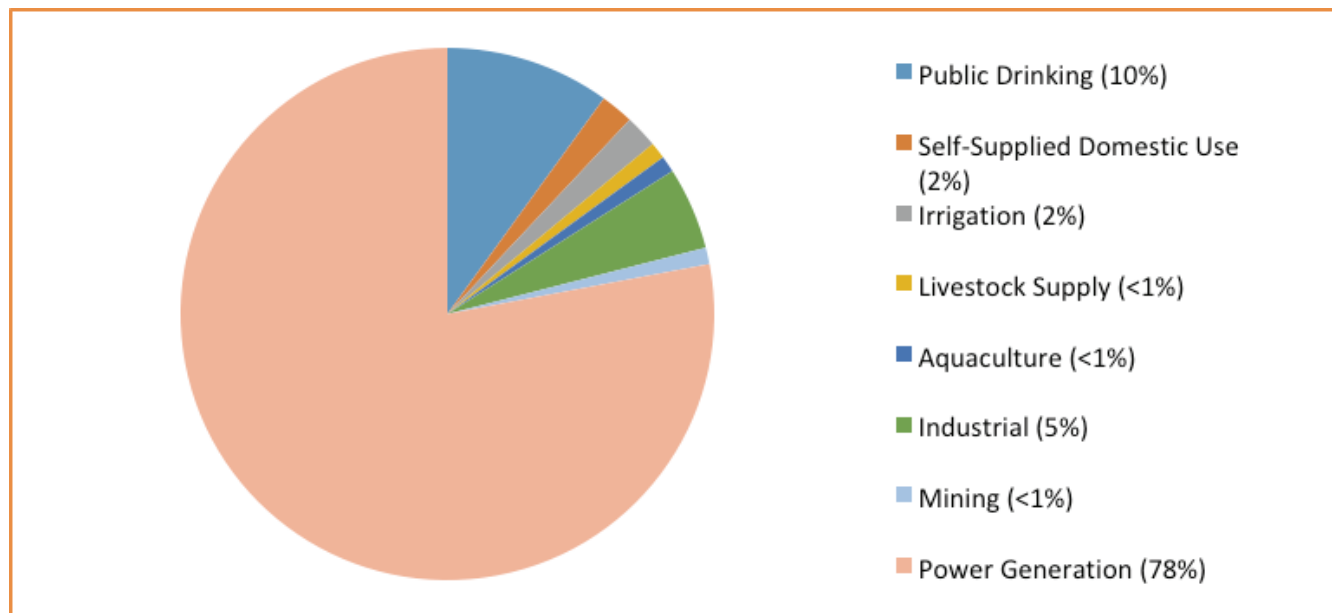


Notes:

1. Municipalities and water authorities own approximately 50% of CWSs with balance owned by the State (e.g., prisons) or private entities (e.g., housing communities, apartment complexes, and universities). Only 65 CWSs equipped with water treatment; over 232 CWSs purchase treated water from other treatment-equipped CWSs.
2. NCWSs typically owned by schools, restaurants, motels, campgrounds, churches, and others serving limited-use groups and are primarily supplied by wells; part-time head count not included in “% population served” column.
3. MDEQ responsible for establishing water quality standards, monitoring/assessing quality, reviewing/approving plans, testing with-drawals for adverse impacts, other water/wastewater regulations.

In its latest 2010 report, the U.S. Geological Survey (USGS) reported that system owners in Michigan withdrew nominally 10,800 million gallons of water per day (mgd) split between groundwater (694 mgd) and surface water (10,106 mgd). Approximately 79% of the surface water came from the Great Lakes. Uses are shown in Figure 1. Much of the water used by thermoelectric power is for “once through” cooling and after minimal treatment is returned to surface water as “wastewater” versus being consumed; see the Wastewater Chapter.

FIGURE 1: TYPICAL DAILY WATER USE - MICHIGAN



The Michigan SDWA (Public Act 399 of 1976) enacted the Federal SDWA (Public Law 93-523 of 1974) for primacy and cited the MDEQ as the primary state authority over the drinking water program (see Table 1, Michigan Rules R 325.10101 to R 325.12820, and Part 127, Act 368 (Public Health Code) also).



CAPACITY, CONDITION, AND PUBLIC SAFETY

Drinking water systems are considered critical in terms of public safety, regardless of the population served. Public safety is influenced by inlet water capability/quality, treatment adequacy, and transmission and distribution (T&D) performance metrics such as condition and capacity.

A. WATER SOURCE AND SOURCE TREATMENT

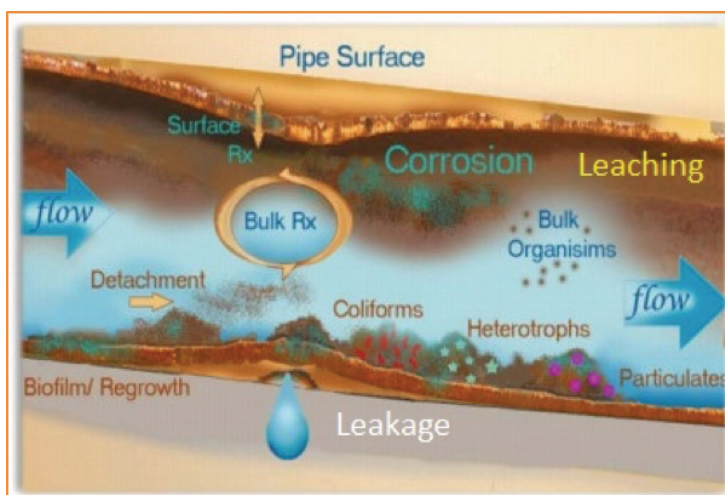
CWSs treat incoming raw water, with larger volume systems using multi-step processes (e.g., coagulation, sedimentation, filtration and chlorination). Many also use membrane filtration, lime/soda ash dosing (e.g., softening groundwater), and iron removal with oxidation/filtration to remove color, odor, arsenic, and impurities. Smaller volume systems tend to use simple screen filtration with corrosion inhibitors and disinfection additives. Well-based systems use little treatment beyond simple screening/softening and infrequently employ any quality monitoring. Larger CWSs possess significant underground T&D networks requiring both annual maintenance funds and periodic investment to replace/upgrade equipment. Michigan's abundant water sources have resulted in few instances where wastewater is recycled back into a potable water source.

All but six of 59 CWSs using surface water (Table 1) withdraw water from a Great Lake or connecting channel. These sources have sufficient capacity for user needs with active management. The remaining six CWSs with treatment withdraw water from inland rivers and are more likely to face withdrawal limits or source contamination. With increasingly stringent regulations, many of these systems have reverted to groundwater to supplement or replace surface water.

B. SYSTEM TREATMENT

Two treatment issues are prominent: (1) aging of existing equipment/processes; and (2) removing contamination caused by natural or anthropogenic substances (e.g., arsenic, nitrates, volatile organic compounds (VOCs)) or leaching from archaic piping/equipment (e.g., lead). Figure 2 addresses aging and treatment challenges. Many owners still employ dated treatment technologies.

FIGURE 2: DRINKING WATER SYSTEM CONTAMINATION AND AGING



Source: U.S. EPA

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Michigan communities such as Ann Arbor and Flint, Oscoda Township, and twelve other counties face the need to address contamination, either via source switching or enhanced treatment. Hexavalent chromium, VOCs, trihalomethanes (from chlorine-based disinfection), 1,4-dioxane, natural radioactive materials, polyfluoroalkyl substances (PFAS), trihalomethanes, and arsenic are being found in local sources at levels approaching federal limits, challenging existing treatment. Clearly, the impact of lead-based piping and leaching caused by a source water switch in the City of Flint has raised awareness of water quality.

C. SUPPLY SYSTEMS AND PIPELINES

Supply systems including transmission and distribution (T&D) pipelines account for most of Michigan's built water infrastructure. Significant portions are well over 50 years old and beyond design service life, difficult to inspect/maintain, and located in corridors with other utilities/roadways. Within Detroit CWS alone, approximately 80% of its T&D was installed prior to 1940. Per the 2016 Michigan Infrastructure report, between 10 and 50 percent of the treated water is lost through leakage.

Booster pumping stations and storage are more likely to be maintained or replaced because, like treatment, they are accessible, deterioration is apparent, and their failure results in more dramatic user impact. While treatment receives greater attention, piping, valves, and pumps perform important functions. T&D maintenance is commonly deferred, particularly when funds are strained due to other critical monetary needs. Water main breaks, low pressure, leakage from corrosion/impact, and isolation failures commonly accelerate T&D rehabilitation. Failures become more frequent with aging, as susceptible materials (e.g., unlined iron/steel) corrode or enable biofilm build-up - see Figure 2. A national database of water main breaks was not found; cursory source review for 2016 through 2017 found many reported breaks in Michigan along with associated service outages and secondary damage (as compared to other states). In terms of water quality, Michigan was found to have fewer reported violations of federal water quality standards than average in a 2017 report by the Natural Resources Defense Council (NRDC).

OPERATIONS AND MAINTENANCE (O&M)

While most CWSs have O&M budgets, user fees (in the form of water rates) are frequently insufficient to cover costs of replacing old equipment/processes. Too often, this equipment must reach a critical stage of deterioration approaching failure before being addressed, as budgets for preventive maintenance are insufficient. New regulations requiring disinfection byproduct (DBP) control, microbial/pharmaceutical removal, security, and on-line monitoring detecting contaminants at part-per-trillion levels intensify funding needs. Given public health impacts quickly created by loss of treatment events, owners must have emergency plans/budgets.

Some owners have implemented innovative technologies, more durable materials, periodic flushing, preventive valve maintenance, and more frequent inspection to extend service life. Technologies such as cathodic protection, ultraviolet purification, trenchless construction, and internal lining of existing piping have reduced excavations, outages, social disruption, and life cycle costs.

Supply system rehabilitation should factor in life cycle cost of options with those for adjacent infrastructure (e.g., street replacement, storm/sanitary sewer rehabilitation, utility updating) at the same time. Use of asset management tools, geographic information system (GIS) mapping, and on-line monitoring are also best practices as cited in MDEQ's required asset management guidelines and CWS reporting requirements (MDEQ, 2013 and MDEQ, 2017).

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INVESTMENT AND FUNDING

Rehabilitation is typically funded on an as-required basis, compliance with regulations, and in response to failures/aging. Rising treatment operating costs and insufficient user fees typically lead to funding gaps particularly when major rehabilitation or replacements are needed. Most system owners have recognized this and have begun investing in master planning, needs assessments, project development, and accessing state/federal funds in response.

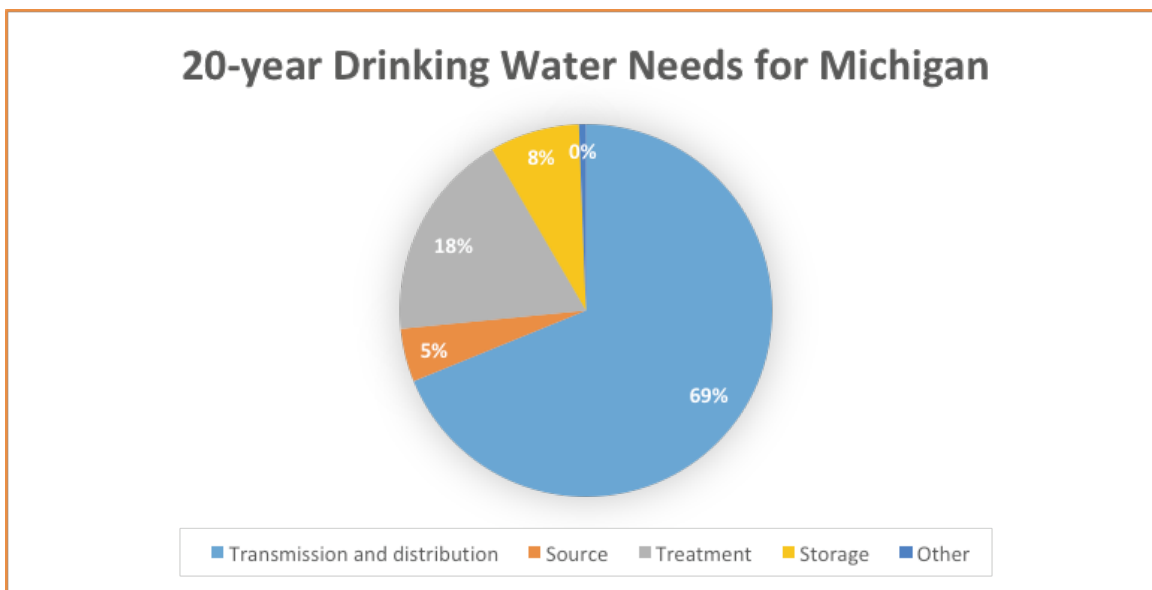
In 2017, the EPA awarded a \$100 million grant to MDEQ to fund drinking water upgrades in Flint. The funding, via the Water Infrastructure Improvements for the Nation (WIIN) Act of 2016, enables Flint to replace nominally 18,000 lead service pipelines and make other critical infrastructure improvements. The Karegnondi Water Authority's raw water system, supplying Lake St. Clair water to Genesee County, Flint, and other jurisdictions, is scheduled to begin delivery in 2017/2018 forming a robust regional water network with the Great Lakes Water Authority. \$35 million was also set aside for 2018 spending from the Michigan Infrastructure Fund although the amount allocated for Drinking Water investment is unclear. These investments are crucial to preserving water infrastructure, but proper oversight is needed to assure that planned results are achieved.

Analysis of Michigan's drinking water periodically occurs via the EPA Drinking Water Infrastructure Needs Survey and Assessment (DWINSA). The SDWA requires that the EPA conduct this national survey every four years; 20-year capital funds for public systems eligible to receive Drinking Water State Revolving Fund (DWSRF) monies with need are defined. States like Michigan provide at least a 20% match for federal funds received, into the DWSRF. Surveys were performed in 1995, 1999, 2003, 2007, and 2011; Michigan and other state's needs have been found underfunded in each Survey. The last Survey in 2011 stated that the 20-year need for Michigan was nominally \$13.8 billion (U.S. EPA, 2014), roughly aligned with Figure 3. Plans for 2019 funding have been requested by DWSRF management, focused on disadvantaged communities. In summary, some funding is being established for replacing Michigan's drinking water infrastructure but at insufficient levels.





FIGURE 3: 20-YEAR MICHIGAN INFRASTRUCTURE NEEDS



*Source: U.S. EPA, 2013

Appropriated funding from DWINSA must be directed to projects fitting the EPA established “criteria of need.” Federal /matching state funds placed in the DWSRF yield low interest loans offered to qualifying owners for public system upgrades. Additional federal funds are envisioned in 2018 to address national shortfalls; Michigan’s shortfalls have ranged between \$284 and \$563 million per year (PSC, 2016).

RESILIENCE AND INNOVATION

Michigan’s water infrastructure is subject to threats/stresses, including:

- Aging (including material degradation, dated treatment technology, leaching, biofilm buildup)
- Pollution
- Depleted/threatened aquifers or surface water withdrawal restrictions
- Hazardous materials
- Reduced urban demand vs. locally expanded demand (e.g., bottling, irrigation, oil/gas recovery) with shifting land use
- Climate, source quality, and weather change.

In general, existing Michigan systems are not considered resilient given their relative age and onset of damage including corrosion and fatigue. However, Michigan’s significant fresh water sources can support future user needs as long as systems are properly managed and resiliency is improved. Owners should track national best practices and innovations such as those which reduce life cycle costs, improve on-line monitoring of key parameters and contaminants, increase resilience, and use treated wastewater to replace fresh water (e.g., industrial uses).

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RECOMMENDATIONS TO RAISE THE GRADE

Many but not all owners have completed master planning; the ability to secure funds and follow through on needed rehabilitation appears to be the more critical and missed step regardless. It is essential that each drinking water system be managed to: (1) prevent failures and lower life cycle costs, and (2) actively upgrade treatment to align with federal/state regulations and source water quality changes. System aging and importance mandate that adequate funding be secured and best practices be actively applied to maintain water quality/quantity.

Asset management inclusive of on-line monitoring is recommended for prioritizing rehabilitation in all private and public drinking water systems, aligned with MDEQ and LHD standards and changes imposed by natural and industrial contaminants, demand, and water availability (e.g., aquifer recharge, quality). A code to protect drinking water assets should be prepared by the MDEQ, Water Use Advisory Council, and stakeholders to ensure best practices consistent with the 21st Century Infrastructure Commission report are followed. Such a code must address shortfalls in current MDEQ oversight and owner practices, such as state Lead and Copper Rule (LCR) compliance, antiquated electronic data reporting, data mismanagement, and other concerns cited in EPA's 2017 audit report. Such a code, with well-defined owner compliance requirements would greatly reduce the likelihood of emergency events such as the recent City of Flint water supply crisis.

Increased drinking water funding is clearly needed; state/local funds such as the DWSRF, green bonds, and user fees (increased where required) must first be investigated and aligned with owner needs before limited federal funds for drinking water infrastructure are pursued. Owners must continuously bring fiscal needs of source treatment and supply system aging to the forefront with politicians, lawmakers, and budget committees. Proper asset management with life cycle cost-based solutions should be used to secure resources and to establish priority system-related actions.

DEFINITIONS

Community water supply (CWS): water system that provides year-round service to not less than 25 residents or not less than 15 living units, including municipalities, apartments, nursing homes, and mobile home parks.

Life cycle cost: The sum of initial capital and O&M costs over the expected or actual service life (selecting rehabilitation/replacement based on least life cycle cost is desired).

Non-community water supply (NCWS): water system that provides drinking or potable water to 25 or more persons at least 60 days per year or has 15 or more service connections, including schools, restaurants, motels, campgrounds, and churches (divided into "transient" and "non-transient").

On-line monitoring: Active detection of water flow, quality, and system performance, for leakage identification, quality deviations, and rehabilitation needs.

Owner: State agencies, municipalities, water authorities, businesses, and private individuals who own and operate drinking water supply systems supplying either public or private users. See Table 1.

Private water supply: system that serves one resident user/service connection (typically via well on-site with basic treatment prior to user supply); 25% of Michigan population is served via private supply systems.

Public water supply: Any system serving multiple users and which is not "private", including CWSs, transient and non-transient NCWSs, and smaller Type III public supply systems.

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Supply system: Treatment and storage facilities and transmission and distribution (T&D) pipelines. Transmission conveys raw water (e.g., surface sources such as lakes and rivers and underground aquifers) to treatment. Treatment typically includes filtration, purification/softening, and disinfection process equipment. After treatment, distribution carries treated water directly to commercial and residential users or to storage (e.g., reservoirs, tanks, towers) for future use.

User: public, commercial, and individual consumers of drinking water (e.g., population served by system, collectively and individually).

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ENERGY GRADE: C-

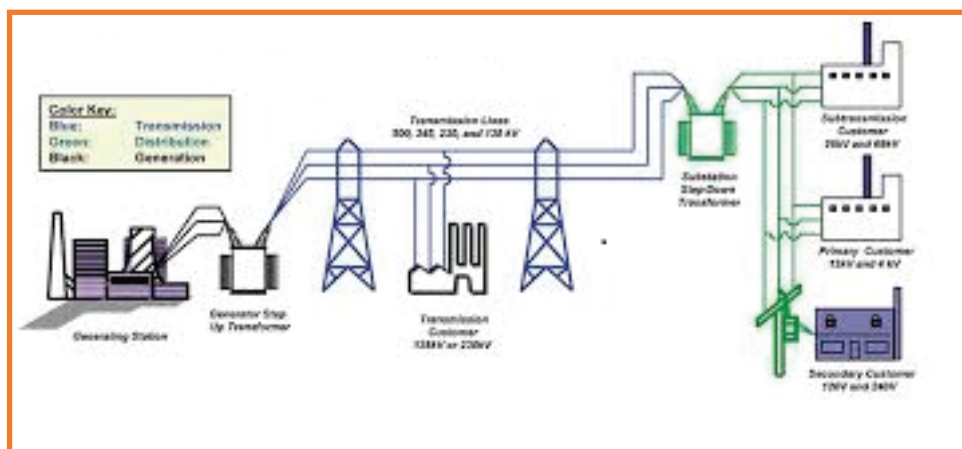
SUMMARY

Michigan's energy systems generally meet current needs. The status is threatened by increasing energy dependence and demand for high service reliability coupled with aging infrastructure, lack of investment to preserve function, exposure to physical and cyber threats, congestion, and dependence on externally sourced fossil and nuclear fuels. Diversification of the energy supply by expanding renewable energy, using electric transmission and distribution (T&D) systems, upgrading energy pipelines, and increasing resiliency are recommended to meet future needs, avoid energy disruptions, and lower the risk of future increased energy costs.

BACKGROUND

Michigan's energy infrastructure developed in parallel to industry demands and population center growth. Electricity generation focused on central, "base load" plants with high usage factors to meet local demands of steel mills, automotive manufacturing, other industry operations, and consumer needs (e.g. lights and appliances). T&D circuits were routed overhead from generation sources to consumers, as urban growth expanded into Michigan's Upper and Lower Peninsulas (UP, LP). Figure 1 below provides an overview of the electric power grid.

FIGURE 1. ELECTRIC POWER GRID

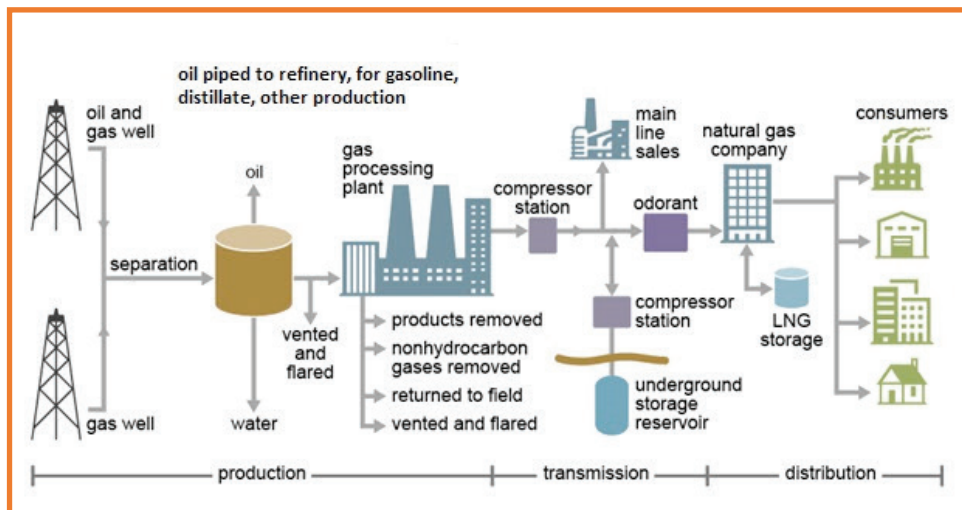


Source: U.S. Department of Energy (DOE)



Early central generation was built in southeast Michigan where heavy industry located due to Great Lakes and interstate roadway access. Generation spread to larger population bases, with expanded T&D infrastructure built in order to electrify rural areas (current owners per Table 1). Natural gas, petroleum and other energy pipelines were built by independent pipeline corporations (Table 1) to meet Michigan's growing demand, particularly in the southern LP where oil and gas deposits were discovered and where gas storage fields were defined. Figure 2 provides an overview of petroleum and natural gas systems.

FIGURE 2. PETROLEUM AND NATURAL GAS SUPPLY



Source: U.S. Energy Information Administration

Primary Michigan energy infrastructure owners are listed in Table 1. Aside from smaller public municipalities/cooperatives, ownership is primarily by private entities subject to public regulatory oversight. This is unique compared to other state infrastructure such as roads, which is publically owned, maintained, and regulated.



TABLE 1. PRIMARY MICHIGAN ENERGY INFRASTRUCTURE OWNERS

INFRASTRUCTURE	OWNERS	STATISTICS/NOTES
High Voltage Electricity Transmission	ITC Holdings (LP grid); American Transmission Co (UP grid)	High-voltage power grid; 138,000 kilovolts (kV) and higher via wires
Low Voltage Electricity Distribution	Alpena Power, Consumers Energy, DTE Electric, Indiana Michigan Power, Upper MI Energy Resources, Upper Peninsula Power, Wisconsin Electric Power (utilities); Wolverine Power (cooperative); others	Wires-based distribution from transmission wires to consumers. Other owners include cooperatives, municipalities, alternate energy suppliers (AESs)
Interstate Energy Pipelines (liquids, gases)	ANR (TransCanada), Enbridge, Great Lakes Gas Transmission, Northern Natural Gas, Panhandle Eastern, Trunkline, Vector	High pressure. Nexus, Rover gas pipelines being constructed from Marcellus shale region to MI. Over 10,000 pipe-miles (over 3,500 miles of liquids with balance natural gas)
In-State Energy Distribution Pipelines	Consumers Energy, DTE Energy, smaller distribution pipeline cos.	Low pressure. Over 100,000 gas gathering/distribution pipeline miles from processing to consumers
Michigan Refineries	(1) Petroleum Refinery (Marathon Detroit); (14) Gas Processing Plants, for in-state/interstate gas supplies	Refinery processes 132,000 barrels/day oil into gasoline, distillate, & related products. Processing plants purify/odorize/deliver to consumers
Michigan Gas Storage Fields	ANR, Blue Lake, Bluewater, Consumers Energy, DTE Energy, Southwest, Multiple smaller owners	1.1 trillion cubic feet storage in geological formations (MI – largest US volume); balances varying demand

Similarly unique, Michigan's electric infrastructure and energy costs are greatly affected by wholesale markets operated by the Midcontinent Independent Transmission System Operator (MISO). MISO oversees buying generation and selling electricity, as well as maintaining in-state grid stability and reliability. MISO markets and state/federal regulatory oversight both serve to control infrastructure investment and achieve low electricity rates. Gas and liquid (e.g., gasoline, distillate) transport lines into/through Michigan are subject to State and federal regulatory oversight and safety/security laws which address safe operation and new construction.

CAPACITY AND CONDITION

ELECTRICITY

Michigan's current electrical generation mix includes coal-fired, natural gas-fired, and nuclear power generation, and, to a smaller extent, renewables and other alternative sources (Table 2). Given its northern climate, Michigan has summer and winter peak demands in the range of nominally 29,000 to 30,000 MW. Per the 2017 Michigan Agency for Energy (MAE) report, a 2% demand reduction from 2016 has occurred from efficiency efforts and reduced air conditioning loads (cooler weather). Increasing renewable supply intermittency continues to challenge supply/demand stability in MISO markets.



TABLE 2. CURRENT ELECTRICITY GENERATION TRENDS/COMMENTARY

SOURCE	%	TREND	COMMENTARY
Petroleum	0.1	Rapidly decreasing use	Cost/emissions limits displacing use
Natural Gas	25.4	Increasing use	Operating cost, emissions, and speed of construction benefits
Coal	39.9	Decreasing use	Age/cost/emission factors
Nuclear	27.8	Existing reactors to operate until license expiry	Two reactors (Palisades, Fermi) serving MI; future additions not envisioned
Renewables	5.3	Increasing use	Regulations and costs/emissions driving growth
Others/Imports	1.5		Limited by cost and T&D constraints
TOTAL	100%		Efficiency is reducing demand; renewables and natural gas are key sources

Source: U.S. EIA, "2017 MI State Profile and Energy Estimates"

Given that Michigan's fossil fuel-based fleet is the second oldest in the country (average age of 49 years), investing in new generation and T&D to distribute remote renewables such as wind from the Thumb region to population centers are needed. Michigan's LP and UP configuration bordered by the Great Lakes challenges transmission import from Canada, between peninsulas, or from adjacent states, requiring lengthy T&D lines with points of congestion. Maintaining reliability and keeping electricity rates as low as achievable are goals.

In-state electricity demand has diminished since the 2007 economic slowdown. Specific factors include declines in residential demand, milder weather, reduced industrial production, and efficiency gains. Available 2017 statistics show Michigan has a reserve operating margin of 13% over recent year peak demand, which is close to U.S. norms. However, such margin is threatened by aging infrastructure and generation trends (Table 2). Power supply reliability is highly influenced by transmission grid condition, capacity, and performance, so MISO and private T&D owners (MISO participants) play vital roles in maintaining reliability. The Ludington Pumped Storage project is being expanded to 2,172 MW of renewable generation/storage, which greatly benefits resiliency.

Lack of robust transmission interconnection with the LP and Wisconsin has driven UP rates higher, and dispersed demand and reliance on older infrastructure have contributed to this. A 2017 MISO study requested by the Michigan Public Service Commission (MPSC) evaluated transmission expansion and generation alternatives, and confirmed that two smaller gas-fired generating plants, renewables, and local T&D upgrades were the most cost-effective solution. A new utility (Upper Michigan Energy Resources Corporation, or UMEREC) was formed to build, own, and operate this new generation.

No supply shortages or major transmission constraints are expected to impact the ability of UP/LP T&D owners to meet near term peak electric demands, but at least one new gas-fired, efficient generating plant is considered necessary for southeast Michigan to offset coal plant retirements and stabilize the grid.

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PETROLEUM AND NATURAL GAS

Michigan's natural gas and motor gasoline/distillate demands for 2017 were estimated to be 928 trillion Btu (844 billion cubic feet) and 4.6 billion gallons respectively, by the MAE. Michigan's annual oil and gas production today as a percent of total demand are roughly 4 and 12%. Both gasoline and distillate (diesel) oil use in the UP and LP are expected to increase slightly as prices stay low, although longer-term projections show decreasing demand. The 2017 MAE report indicates a 4.1% reduction in natural gas compared to 2016 demand, as a result of mild weather and lower electricity demand. Demand will continue to be met via interstate pipelines particularly as in-state oil and gas reserves are depleted, unless alternatives such as electric vehicles reduce gasoline needs. Michigan's gas storage capacity in the form of underground caverns, salt domes, and empty oil/gas reefs capable of receiving pressurized gas provides a buffer against winter heat demands and increased prices. Storage capacity use should be maximized to enhance fuel security. In summary, petroleum/natural gas systems appear adequate to meet future needs.

OPERATIONS AND MAINTENANCE (O&M)

O&M on Energy Systems is conducted by private owners (Table 1) to meet with forecasted demand, and market, reliability, and regulatory requirements. O&M spending is minimized so as to maintain low energy prices to consumers. According to a 2016 Eaton report, Michigan has been in the top five states in the last three years for number of electric power outages. Over 60% were caused by weather, falling trees, and faulty equipment or error. Increased focus on pipeline safety occurred after an Enbridge diluted bitumen pipeline failed near Marshall in 2010. Between 2010 and 2017, few pipeline failures were reported until a gas transmission line failed in November 2017 near Auburn Hills. Increased scrutiny is also being applied to parallel, 60-year old Line 5 pipelines carrying liquid petroleum underwater from LP to UP, given risks of line failure. Aging management with testing and replacement of high-risk pipelines are part of annual O&M conducted by each owner within constraints posed by MPSC oversight.

INVESTMENT AND FUNDING

While current capacity exceeds demand, base load electric generation is aging and more efficient. Meanwhile, lower-emission gas-fired generation and renewable energy systems are under increased development. Per 2016 state energy laws, new generation need must be proven in integrated resource plans (IRPs) filed by owners with the MPSC against alternative measures such as energy efficiency. Impacts of increased electric vehicle use (EV), alternate biofuels, reduced consumer energy demand (e.g., peak shifting), and others also need consideration.

As current electricity rates are reasonably low, increased investments needed for improved aging management and sustainability should not increase rates so as to jeopardize economic growth. This exists for other delivered energy (natural gas, gasoline) rates wherein new natural gas pipelines are under construction to meet future demands. However, it is critical for state energy costs to remain affordable.

PUBLIC SAFETY, RESILIENCE AND INNOVATION

Michigan's energy infrastructure has generally proven resilient against natural/human stresses since the 2003 regional grid blackout, although climate change and increasing cyber threats pose risks. Continued renewal of aging infrastructure, hardening communications, and innovative smart grid/metering technology use is needed to limit outages and economic impacts. Electric infrastructure owners are vested in smart metering/sensing and renewables deployment, balancing regulatory requirements, and economies of scale, while meeting consumer concerns. Improving grid-related outage statistics and avoidance of pipeline-related failures are critical.

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RECOMMENDATIONS TO RAISE THE GRADE

We recommend the following to raise Michigan's energy grade:

1. Stakeholders should continue pursuing reductions in energy demand, consumption and waste while maintaining rates as low as achievable to sustain and grow the economy (e.g., updating current energy code, pursuing grants and funds, and targeting efficiency and conservation).
2. Use select gas-fired distributed generation and renewable energy coupled with T&D investment to replace coal-fired generation, avoid capacity shortfalls (21st Century Infrastructure Commission report), overcome aging and congestion, and improve resilience. The 2017 solution to UP infrastructure is an example. The 2016 energy laws are expected to yield prudent infrastructure investments aligned with capacity needs and reduced T&D outages including companion emission reductions.
3. Creation of a life-cycle driven solutions for the Enbridge Line 5 underwater pipelines, given that petroleum spills pose significant risk to the Great Lakes. Planning and selection of a resilient solution is needed in 2018 to provide lead time to implement changes.
4. Concentrate focal points of near term investment to improve reliability metrics on new renewables, smart grid innovations, tree management, and aging infrastructure replacement.
5. High pressure pipeline test intervals should be reduced from 7 years to 5 years or less, and replacement of aging high-risk pipeline segments in urban areas should continue to occur by owners.
6. In 2018, the Nexus and Rover gas pipelines will increase low-cost natural gas supplies to meet future demands while increasing energy security (with increased opportunities for gas storage).

DEFINITIONS

British thermal unit (Btu): a measure of power, related to the heat content of various types of fuel; the amount of heat needed to raise the temperature of one pound of liquid water by one degree Fahrenheit.

Congestion: Flow of electricity or fluid in an energy system that is restricted or constrained below desired levels, either by the physical capacity or operational policies designed to preserve security and reliability.

Distributed generation: Scalable electricity generation located to where such is demanded (versus "centralized generation" which requires T&D infrastructure to distribute such to consumers).

Distribution lines: Wires that carry lower voltage electricity to consumers after transformation (voltage lower than 138 kV down to consumption-level voltage); term also used for pipelines delivering refined energy products (e.g., gasoline, odorized natural gas) at lower pressures to consumers.

Energy storage: Systems which capture energy produced via mechanical, electrical, and electrochemical means to enable energy dispatch at a later time when demanded.

Energy Systems (or Infrastructure): Systems which: (1) generate, transmit, and distribute electric power, and (2) collect, refine and transport fuels including solid (e.g., coal, biomass), liquid (e.g., oil, gasoline), and gaseous (e.g., natural gas) fuels, for delivery processing plants and consumers.

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Grid: Interconnected system of transmission and distribution lines and related equipment that delivers high-voltage electricity from power generating plants to “substations”, where carried voltage is transformed and lowered to that suitable for distribution to consumers. Michigan’s grid is part of the Eastern Interconnection grid in the United States.

Power generating plant: Facility that uses a conventional fuel source (e.g., coal, natural gas, oil, uranium), or that captures a renewable energy source, to produce electricity.

Processing plant: Facility which refines, purifies, or extracts energy products from raw fuel stock (e.g., petroleum, natural gas) into those products used in power generation, heating, vehicular fuels, and other commodity uses.

Renewable energy: Energy generation using biomass, hydroelectric, geothermal, wind and solar sources (for electricity or fuel manufacture)

Testing: A variety of inspection, testing, and analysis techniques used to evaluate the physical conditions of energy systems typically without causing damage. Testing includes nondestructive tests (NDT), leakage surveys, remote sensing via instrumentation, and drone inspections.

Transmission lines: Wires that carry high voltage electricity from power generation plants to locations where bulk electricity is needed (typically at 138 kV and higher); term also used for pipelines which carry liquids or gases typically under high pressure from origin (e.g., wells) to processing plants, storage, or consumers needing elevated pressure service.

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NAVIGATION

GRADE: C

SUMMARY

Michigan's navigation system includes coastal infrastructure, navigation harbors, channels, locks, and dams. The system contains approximately 50 harbors, 14 navigable waterways, the Soo Lock system, and numerous disposal facilities for depositing dredged material. Most of these harbors and waterways are recreational while some are commercial harbors.

The U.S. Army Corps of Engineers (USACE) is provided a limited amount of federal money each year to cover all maintenance and operations requirements including dredging, breakwater, confined disposal facility, etc. However, these annual funds have not kept pace with system needs, resulting in funding and need gaps that grow each year. Because commercial harbors are prioritized and exceed the available funding, recreational harbors are rarely maintained or improved. The USACE has only been able to perform some very minimal maintenance projects that serve recreation.

There is one major lock system in Michigan, the Soo Locks, located on the St. Mary's River in Sault Ste. Marie. The Soo Locks facility passes 80 million tons of commercial commodities annually. Construction of a second lock at this location is critical to sustaining the shipping industry. Likewise, maintenance activities must be provided to remain functional in the current lock system. A 2015 Department of Homeland Security study stated that a 30-day unscheduled closure of the Soo Locks would cost industry \$160 million and a breakdown lasting six months would cripple the United States economy with 11 million jobs lost. A shutdown of Great Lakes steel production caused by a sudden halt in ore transportation would in turn shutdown almost all North American appliance, automobile, construction, farm and mining equipment, and rail car production within weeks. Conversely, a new study commissioned by the U.S. Treasury Department stated that a second lock at this location will provide system resiliency that has an estimated economic benefit of \$1.7 billion.



BACKGROUND

The Great Lakes navigation system provides for interstate and international transportation of goods and materials. The system includes over 130 federal navigation projects with 610 miles of channels, 117 harbors, 140 miles of breakwaters, 20 dredged material disposal facilities, and the lock systems at Sault Sainte Marie, Chicago, and Buffalo. More than 50 of these harbors, 14 of the channels, and a significant portion of the breakwaters and dredged material disposal facilities lie within the State of Michigan.



The 10,000+ miles of Great Lakes shoreline includes some of the most beautiful, valuable, and vulnerable property in the Midwest. Cities and towns have flourished along the shores of the Great Lakes because of their natural beauty and the value they bring to commerce, navigation, and recreation. Most of these coastal cities were established as ports, taking advantage of the Great Lakes as their primary mode of transporting goods, material, and people.



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Over 65 coastal cities and towns around the Great Lakes Michigan shoreline have federal navigation projects that include channels into harbors or rivers, which are protected by navigation structures like breakwaters and piers. These facilities are authorized to safeguard navigation activities in the federal harbors from waves and ice. However, they also provide critical flood and storm protection for buildings, roads, and facilities that developed in their shadow along the urban waterfront. In some cases, urban waterfront includes critical infrastructure for power generation, water supply, and wastewater treatment.

CONDITION AND CAPACITY

Most of the federal harbors in the Great Lakes were constructed between 1860 and 1940. At some of these harbors, commercial navigation has declined or ceased completely over the past 50 years. Recreation has become the major industry at many of the harbors, in some cases completely replacing commercial shipping. Currently, only about 30 navigation projects in Michigan support commercial navigation. Approximately 80% of Great Lakes harbor structures are older than the typical 50-year design life expected at the time of construction. Many others are more than 100 years old.

The coastlines are subjected to harsh, rapid changes in weather and wave conditions. Waves exceeding 10 feet, created by strong winds blowing across the lake surface, can deliver a powerful force capable of moving large stones weighing many tons each. Often, large waves combine with up to eight feet of storm surge, creating a substantial rise in water level. The combination of storm surge and large waves, especially when accompanied by ice, generates powerful forces on harbor structures and breakwaters. These elements can be exposed to these forces many times each year, which weaken structures with each succeeding event. Several significant storm events have been experienced over the past five to ten years, which have resulted in increased shoaling of navigation channels and accelerated deterioration of navigation structures, particularly along the southwest coast of Michigan. The USACE has developed a proposed long-term coastal resiliency study for the Great Lakes, but to date no funding has been received to initiate such a study.

Many breakwater structures were built with timber substructure, and as such are subject to accelerated wood decay when exposed to the air during periods of low lake levels. Lakes Michigan-Huron experienced a prolonged period of lower than average levels until 2014, when a rapid recovery to average to above average levels was experienced. Lower lake levels also exacerbate the negative affects to navigation associated with a lack of maintenance dredging by further reducing available drafts.

The Soo Lock system is critical to Great Lakes shipping. Nearly 4,000 vessels pass through the locks annually, carrying more than 65 million tons of freight. The nearly 50-year old Poe Lock is the only lock capable of accommodating the largest vessels that carry 70% of all cargo passing through the Great Lakes. A redundant Poe-sized lock is needed to provide long-term capacity and reliability for operation of the system.

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OPERATIONS, MAINTENANCE, FUNDING AND FUTURE NEED

Federal funding for the maintenance and upkeep of federal harbors, breakwaters, piers, and channels is prioritized based on the national economic benefits of the facility related to commercial navigation. Navigation facilities that lack significant commercial navigation are not currently a high funding priority. Consequently, maintenance of recreational harbors and those with limited commercial traffic has been deferred and will continue to be deferred if funding levels do not significantly increase.

Constrained federal operations & maintenance (O&M) funding has resulted in assigning a lower priority to funding for those commercial harbors handling less than one million tons. The ongoing closure of coal-fired power plants at various Michigan harbors has resulted in the cessation of waterborne coal shipments, resulting in the likelihood that additional Michigan harbors will drop below this one-million ton threshold. With current available funding levels, the clear majority of harbor structures are not likely to be repaired in the foreseeable future. Over half of federal harbors are no longer considered a budget priority because they are not used commercially. With the lack of adequate maintenance, harbor structures will continue to deteriorate. Reduced maintenance could increase commercial shipping costs, reduce recreational usage opportunities, reduce protection of natural coastal assets, and reduce protection of infrastructure currently sheltered by harbor and breakwater structures. Replacement costs of harbor infrastructure, if not maintained, will be much more expensive than a maintenance investment today.



PIER WALKWAY WITH OUTER AND INNER LIGHTHOUSE IN ST. JOSEPH, MICHIGAN

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The Water Resources Reform and Development Act (WRRDA) of 2014 included several key provisions that have improved the federal funding environment for Great Lakes and Michigan harbors. The bill established funding targets for utilization of the Harbor Maintenance Trust Fund (the source of O&M funding for the USACE coastal dredging projects throughout the nation), including prioritizing 10% of funds to the Great Lakes. As a result, O&M funding levels have been improving. Great Lakes funding levels in fiscal year 2016 were 63% greater than in 2012. As a result of the passage of WRRDA, and its successor the Water Infrastructure Improvements for the Nation (WIIN) Act, the improved federal O&M funding climate has resulted in more consistent/reliable maintenance dredging of these harbors to maintain authorized depths, including those harbors that have dropped below one million tons of cargo being handled on an annual basis. This increased O&M activity is allowing the USACE to begin addressing backlog dredging and improving lock and breakwater maintenance levels.

While the funding levels for maintenance of commercial harbors in the state has improved, recreational harbors continue to be a lower federal priority with minimal funding allocated to maintenance of the numerous recreational harbors located throughout the state.

Operation and maintenance funding for harbors covers both coastal infrastructure (breakwaters, revetments and piers) and dredging.

Most federal navigable river channels located in Michigan waters handle substantial commercial navigation activity as they support multiple navigation/manufacturing facilities. As such, these projects receive reliable levels of operation and maintenance funding to ensure they can meet the minimum requirements of commercial navigation. However, there remains a need to address the presence of backlog shoaling in many of these projects, the removal of which would result in the navigation channels being cleared to their full authorized dimensions. Where the rivers or channels are navigable but do not support commercial use, then virtually no federal money is received.

The Corps of Engineers established a detailed Asset Renewal Plan that defines the requirements needed to maximize reliability and reduce the risk of catastrophic failure at the Soo Locks. The plan outlines the work necessary to reduce the risk of unscheduled closures of the Poe and MacArthur Locks and provide reliable infrastructure through the year 2035. Asset renewal priorities are continually reviewed and adjusted to address the highest risk components to the system. The Corps has seen increased funding for asset renewal requirements during recent budget cycles; however, constrained funding and competing demands nationwide prevent the Corps from fully funding critical asset renewal projects, jeopardizing the continued normal operation of the facility.

In addition to ensuring the reliability of the existing lock infrastructure at the Soo Locks, concerns exist over the fact that only one of the lock chambers (Poe Lock) is large enough to accommodate the largest Great Lakes freighters and as such that lock is considered the single point of failure for the overall Great Lakes navigation system. Congressional legislation in WRDA 2007 reinforced that a redundant Poe-sized lock is required and that the current Lock system must remain functional. A second lock would eliminate a single point of failure and would provide redundancy to this important navigation system. Currently, the USACE is in the process of completing an economic valuation study that is revisiting the benefits and costs associated with the authorized project to construct a new lock at this location.

RESILIENCE AND INNOVATION

The USACE has moved to a risk aversion decision-making process, to better prioritize which projects are addressed first. Asset renewal priorities are continually reviewed and adjusted to address the highest risk components to the system.

A redundant Poe-sized lock is needed to provide long-term capacity and reliability for operation of the system. A second lock at this location will provide system resiliency that has an estimated economic benefit of \$1.7 billion.

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RECOMMENDATIONS TO RAISE THE GRADE

1. Address the presence of backlog shoaling and authorize funding projects that result in the navigation channels being cleared to their full authorized dimensions.
2. Fund the construction of a redundant Poe-sized lock at Sault Ste. Marie and allocate funds to provide maintenance activities in the current Lock system to remain functionality.
3. Utilize the federal Harbor Maintenance Trust Fund (the source of O&M funding for USACE coastal projects throughout the nation) and the Inland Waterways Trust Fund to full authorized levels.
4. Proceed with the USACE detailed Asset Renewal Plan that defines the requirements needed to maximize reliability and reduce the risk of catastrophic failure at the Soo Locks thereby reducing the risk of unscheduled closures of the Poe and MacArthur Locks and providing reliable infrastructure through the year 2035.

DEFINITIONS

Dredging - The act of removing silt, sediment, and other material from the bottom of bodies of water.

Locks - A device used for raising and lowering boats, ships and other watercraft between stretches of water of different levels on navigable waterways.

SOURCES

State of Michigan, 21st Century Infrastructure Commission Report, dated November 2016

U.S. Department of Homeland Security, The Perils of Efficiency: An Analysis of an Unexpected Closure of the Poe Lock and its Impact, dated October 2015

U.S. Department of Treasury, 40 Proposed U.S. Transportation and Water Infrastructure Projects of Major Economic Significance, dated 2016

Information provided by USACE website research: <http://www.lre.usace.army.mil/Missions/Great-Lakes-Navigation/>

Information provided by USACE most recent operational condition assessments.

Information provided by USACE five-year development plan.

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RAIL
GRADE: C-

SUMMARY

Michigan's rail system has approximately 3,600 miles of track that are operated by 26 private railroad companies. With the exception of 665 miles owned by the Michigan Department of Transportation (MDOT) and operated under contract, the infrastructure is privately owned. While Michigan is a peninsula state, there are three international border crossings by rail to Canada, one of the United States' and Michigan's largest trading partner. About 20 percent of the total freight moves in Michigan are made via rail. The rail system moves over \$194 billion in commodities, the largest of which include coal, transportation equipment, and agricultural products. Approximately 33 million tons move into the state and 22 million tons move out of the state by rail. Four of the seven Class I railroads operate in Michigan, as does Amtrak. Freight rail movements are projected to increase 49.8 percent, to 148 million tons, by 2030. Public dollars fund public at-grade crossing improvements and some very limited capital improvements. The needs associated with the limited state programs outpace the public dollars available.

BACKGROUND

Michigan's rail system has approximately 3,600 miles of track that are operated by 26 private railroad companies. Except for 665 miles owned by the Michigan Department of Transportation (MDOT) and operated under contract, the infrastructure is privately owned. The Michigan economy relies heavily on rail infrastructure, in part due to the state's neighboring location with Canada and that it's situated in the middle of a major, tri-national trading corridor. In 2014, 101 million tons of goods were moved via rail throughout the state. Top commodities moved by rail are motor vehicles and parts, followed by metallic ores and agricultural products including grains, sugar beets and soybeans. Freight rail movements are projected to increase 49.8 percent, to 148 million tons, by 2030.

In addition to freight, the Michigan rail infrastructure also serves passengers. Michigan has three intercity passenger rail routes operated by Amtrak that cover 521 route miles and serve 22 station communities. These routes directly serve approximately 750,000 passengers per year. All three routes link to the national rail network operated by Amtrak via Chicago and are listed below.

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- The Pere Marquette Service connects Grand Rapids and Chicago via the CSX and Norfolk Southern (NS) corridors.
- The Blue Water Service connects Port Huron and Chicago via portions of Canadian National (CN), MDOT, Amtrak and NS corridors.
- The Wolverine Service connects Detroit/Pontiac and Chicago, with portions of the corridor owned by CN, NS, MDOT, Amtrak and Conrail. The Wolverine Service is part of the federally-designated high-speed rail corridor, with speeds up to 110 mph. The 135-mile segment between Kalamazoo and Dearborn is owned by MDOT.

There are two segments of additional light rail infrastructure in place, totaling approximately 3 miles, each in Detroit. The Q-Line operations began in May 2017. The People Mover has been in operation since 1987 and is expected to need capital improvements in the near future.

CAPACITY

Volume capacity constraints on the rail system is currently an infrequent issue in Michigan. However, the inability to accommodate increased capacity in the future is of concern, particularly in the Detroit metropolitan area, with federal freight forecasting models predicting a 50 percent growth in tonnage by 2030. MDOT recently completed a project in West Detroit to eliminate a congestion point for passenger and freight trains. However, a long-standing project to build a new consolidated intermodal freight terminal in Detroit to address long-term capacity limitations has not yet been constructed.

Railcars capable of carrying 286,000 pounds are becoming the nationwide standard for certain commodities. There are now some commodities moving up to 315,000 pounds per car. Heavier cars allow shippers to capitalize on the efficiencies and provide cost savings. However, limited segments of track and bridges cannot accommodate the heavier cars. More commonly, there are speed restrictions for heavier cars at bridges.

Unit train capacity is a broader concern. Unit trains ship a single commodity from origin to destination. To do that, there needs to be sufficient infrastructure to handle typically at least 90 cars at shipper/receiver facilities, as well as yards and sidings. Unit trains are particularly important for Michigan's agricultural industry to remain competitive in the national market. Typically, moving a commodity like corn via a unit train will provide a per-bushel savings to the farmer. Agricultural products are one of the top commodities that move by rail in Michigan.

Passenger rail ridership hit a record high in Michigan in 2013; and while ridership has been constrained by recent construction, it is expected to grow. With improvements to the services that have been implemented recently, such as internet access on passenger rail cars, as well as additional upcoming enhancements, it is expected that ridership growth will be only be strengthened. A capacity analysis for the Wolverine Service was completed in 2016 showing the analyzed impending need increase. To address that need there are plans to increase trips for the Wolverine Service to six trips per day by 2025 and up to 10 trips per day by 2035.

CONDITION

Track is generally kept in a condition appropriate for its current use. Unlike the highway system, rail speeds are assigned by segments of track, not routes. In turn, railroads can relatively quickly make track improvements when warranted. However, possibly even more so than the roadway system, due to the lack of alternative routing, trestle condition is critically important. Twenty-four of the 215 trestles (11%) on the MDOT-owned system are functionally deficient.

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MDOT rates crossing surface condition for all of the approximately 4,800 public railroad crossings in the state. A significant majority of the railroad crossings are currently rated as in good/fair condition. While MDOT has a long history of making investments in state trunk line crossing surfaces, a new local rail crossing surface program was added in 2017 to improve local rail crossing surfaces.

The overall condition of passenger rail stations is good, with several recently completed projects that renovated existing or constructed new stations. And while the condition of passenger rail equipment is not good, all equipment (cabs and coaches) is planned to be replaced soon.

PUBLIC SAFETY

There has been an approximate 20 percent reduction in car-train crashes at Michigan's public crossings over the past five years. Approximately 50 percent of the state's public crossings have active warning devices, such as lights and gates. However, crashes still occur at crossings with or without active devices.

Conversely, the recent rise in injuries/fatalities related to trespassing incidents are of concern. Michigan continues to work closely with law enforcement agencies and the railroad industry investigating opportunities to reduce these types of incidents.

Implementation of federally-mandated Positive Train Control (PTC) is in process. PTC is designed to stop a train before a train-train collision, derailment due to speed, movement due to a misaligned track switch or unauthorized entrance into a work zone. It is required to be implemented by 2020. MDOT is overseeing the implementation of PTC on the MDOT-owned portion of the accelerated rail corridor, which will be implemented before the federal deadline.

INVESTMENT AND FUNDING

Almost all of Michigan's rail infrastructure is privately owned and maintained. Therefore, the vast majority of funding for this infrastructure comes from the private sector. Historically, the larger Class I railroads invest at a level to sustain current and future operations, while the smaller short line railroads are less capable of providing this level of investment.

Under the Passenger Rail Investment and Improvement Act of 2008 (PRIIA), all three passenger rail routes are now state supported. MDOT covers all operational and maintenance costs associated with the services that ticket revenues do not. In addition, MDOT funds all maintenance and capital work on the Kalamazoo-Dearborn segment of the accelerated rail corridor it owns.

Beyond the intercity passenger rail services, public dollars fund public at-grade crossing improvements and some very limited capital improvements. The needs associated with the limited state programs outpace the public dollars available. Despite limited available funding, an effort was made to document planned rail projects in 2008 with the Michigan Rail Plan. Only a small number of these planned projects have been completed to date.

RESILIENCE

A series of recent unrelated access and transportation-pricing events in Michigan have demonstrated how easily the system can impact the industries it serves. However, on balance, the rail industry as a whole was able to respond to these events in ways that worked to minimize the impacts of these events on the businesses that depend on rail.

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RECOMMENDATIONS TO RAISE THE GRADE

1. Increase public funding for rail bridges and trestles, to improve functionally deficient structures and to improve speeds for heavier rail cars.
2. Improve capacity and efficiency of the system by constructing a consolidated intermodal freight terminal in the Detroit area, and by adding improved sidings, yards, and facilities to accommodate unit trains.
3. Increase and improve passenger rail service to meet current and projected demand.
4. Improve safety at rail crossings by providing more active warning devices.

SOURCES

Michigan State Rail Plan, dated September 2011

MI Transportation Plan, Freight White Paper, dated July 2016

Information provided by Michigan Department of Transportation, Transearch Data from IHS Global Insight

Information provided by Michigan Department of Transportation, Office of Rail

The Role of Rail Infrastructure in Michigan's Northern Lower Peninsula, dated September 2014

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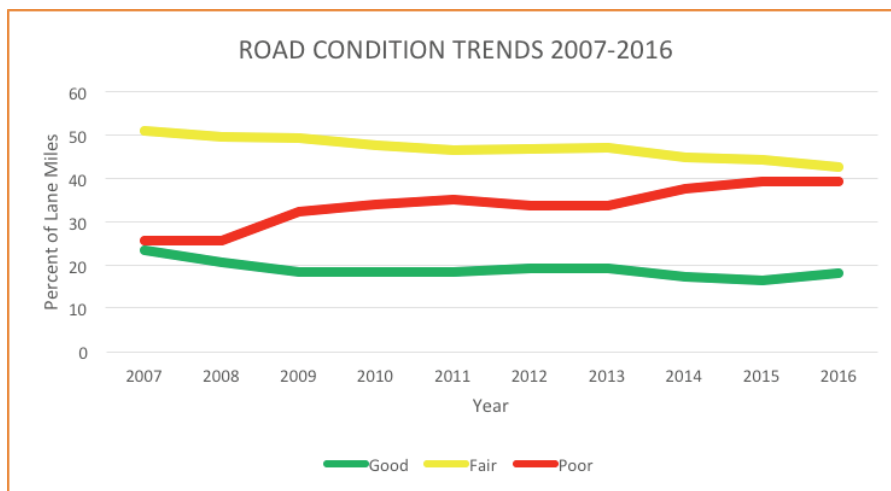
ROADS
GRADE: D-

SUMMARY

Based on a 2016 assessment, 39 percent of Michigan's 120,000 miles of paved roadways are rated in poor condition, 43 percent are rated in fair condition, and just 18 percent are rated in good condition. Nine years after a significant economic downturn, Michigan is recovering with its population and economy growing again, and vehicle travel is increasing in response to the growth. However, the rate of recovery may decrease if Michigan is not able to provide roads that are in good condition. In 2015, Michigan's governor signed into law a road-funding package that relies on a combination of increased user fees, registration fees and general funds. These funds will assist state and local governments to move forward with numerous transportation projects but is not sufficient to address the significant deterioration of the system. Due to a 7 percent increase in poor condition roads since the 2009 ASCE Michigan Report Card, Michigan's Road Grade has decreased from a "D" (based on 2009 report card) to a "D-" in 2018.

CONDITION AND CAPACITY

Michigan's road system is deteriorating. According to the Michigan Transportation Asset Management Council, the percentage of poor rated Michigan's federal-aid-eligible roads (i.e., state and primary local roads) continues to increase and the percentage of good and fair rated roads continues to decrease.

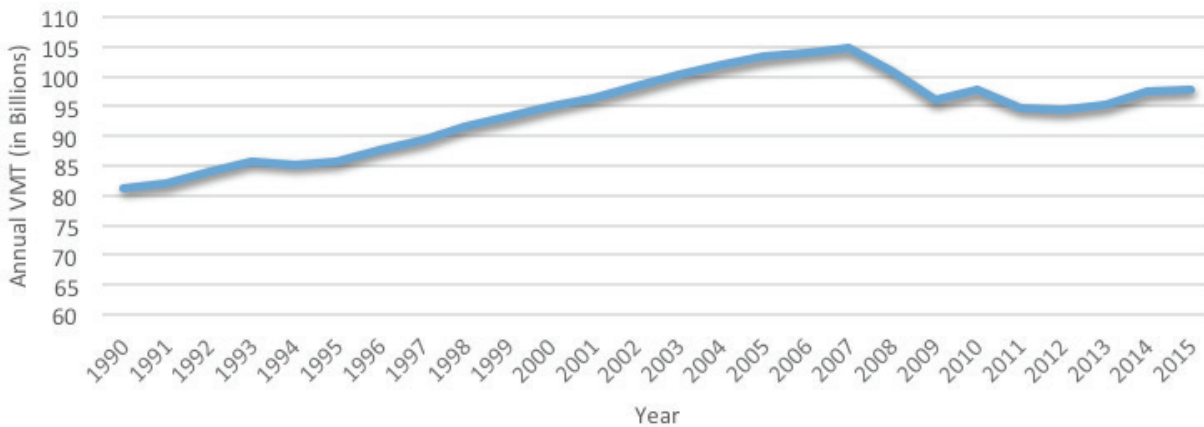




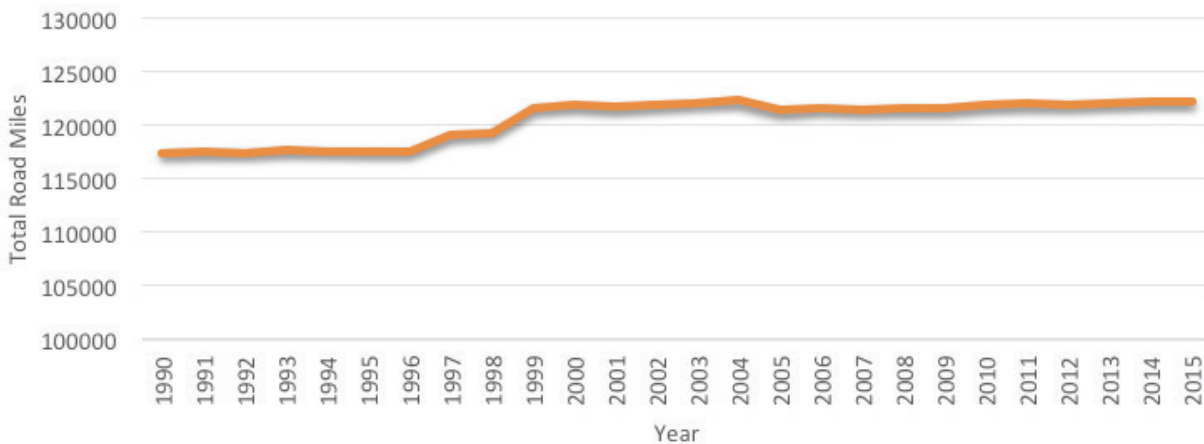
Michigan residents enjoy modern lifestyles relying on a high level of personal and commercial mobility. Annual vehicle travel in Michigan has increased over 20 percent between 1990 and 2015 and has increased 10 percent between 2013 and 2016. However, the number of roadway miles and lane miles have only increased approximately 4 percent, resulting in increased congestion and negative impacts to mobility.

Increased traffic volumes and congestion continue to impede motorists' travel and economic development. Increased vehicle miles traveled (VMT) will degrade the condition of an already deteriorated road network. In addition, traffic congestion will continue as a growing burden in Michigan's major urban areas impeding the State's economic development. In 2011, 39 percent of Michigan's urban highways (interstates and freeways) were congested compared to 23 percent in 2000.

ANNUAL VEHICLE MILES TRAVELED (VMT)



TOTAL ROADWAY LANE MILES



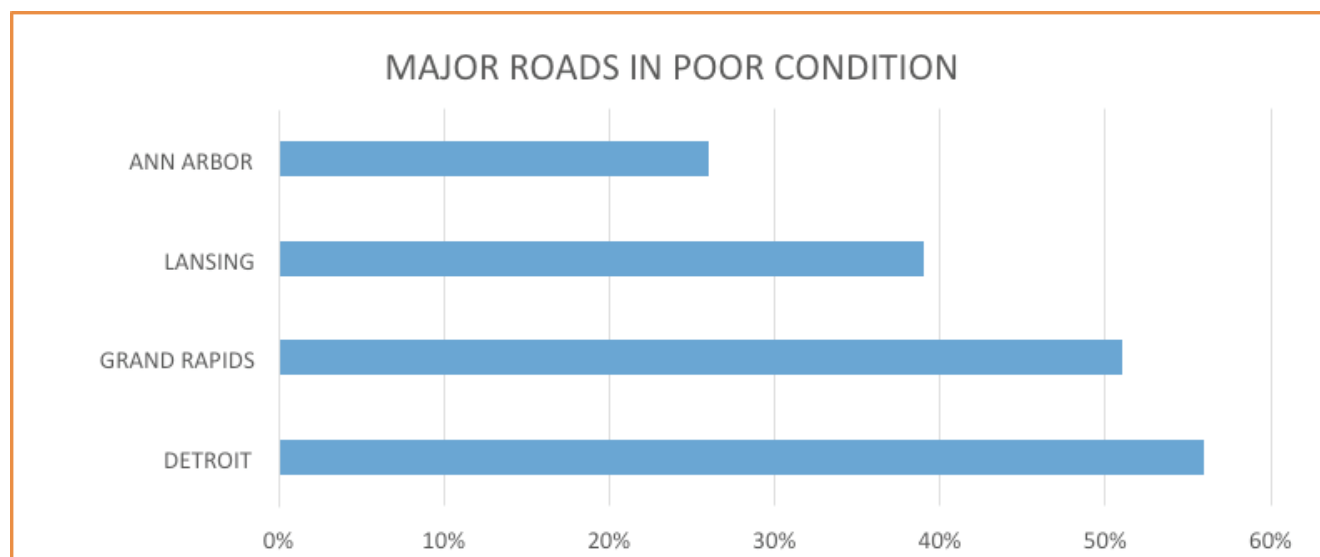
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An efficient transportation system is vital to successful commerce. Annually, \$520 billion in goods are shipped throughout Michigan, 78 percent of which are carried by trucks. A well-designed and highly accessible network of roads is more attractive for businesses to locate and expand. Numerous companies cite reliable access to the Interstate highway system and other major routes as a major factor in their choice. According to the national rankings from the 2016 Annual Report on the Performance of State Highway Systems, published by the Reason Foundation, Michigan is nationally ranked 35th worst in congested roads in urbanized area, 40th worst in rural interstate conditions and 41st worst in urban interstate conditions.

Consider this data published in 2015 by The Road Information Program (TRIP):



PUBLIC SAFETY

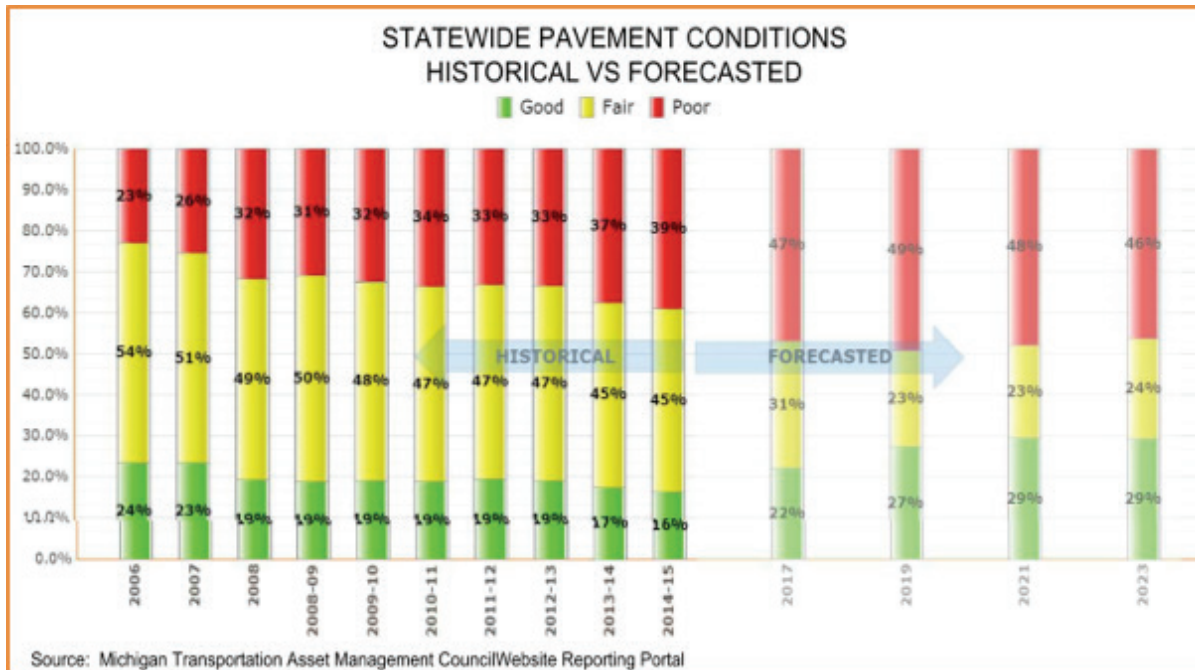
Safe and well-maintained roads provide residents access to work, home, vacation areas, medical facilities, schools, and businesses, and allows businesses access to suppliers and markets. In 2016, there were 312,172 recorded crashes on Michigan roadways and 1,064 traffic fatalities resulting from those crashes, according to the National Highway Traffic Safety Administration. The number of traffic fatalities on Michigan roadways has increased 22 percent since 2009, while over the same time period, the number of vehicle miles traveled on Michigan roads has only increased by 3.3 percent. The number of fatalities per 100 Million VMT in Michigan has increased from 0.91 in 2009 to 1.07 in 2016. The fatality rate in Michigan over this time period has held slightly lower than the national rate, which has ranged from 1.08 to 1.16 fatalities per 100 Million VMT.

Michigan's population has increased each year from 2011 to 2016 and is currently at 9.9 million residents. Michigan has about 7.1 million licensed drivers. It is challenging for the agencies responsible for managing roads to maintain and improve conditions due to the struggle of implementing a statewide-unified long-term asset management plan when faced with inadequate funding.



INVESTMENT AND FUNDING

According to forecasts by the Michigan Transportation Asset Management Council, the percentage of Michigan roads in good condition is expected to increase in the coming years, however, at the same time, the percentage of roads rated in poor condition is also expected to increase.



Even with recently enacted increases in transportation funding implemented at the State level over the next several years, funding levels will still not be sufficient to reverse the rate of deterioration of Michigan's roads. Additional funding is required to make necessary repairs to roads, to relieve current and future traffic congestion, and to improve public safety and the movement of freight. Inadequate investment in the transportation system today will mean not only accelerated deterioration of Michigan's roads, but also increased future maintenance costs.

According to the Michigan Governor's 21st Century Infrastructure Commission Report published in November 2016, Michigan's roads and bridges will require an estimated annual investment of:

- \$1 billion in State funds for Interstate and U.S. Route freeways and bridges
- \$600 million of State funds for other state highways and bridges
- \$600 million of State funds for other highly used roads and bridges under local jurisdiction

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Current mechanisms for state funding utilize vehicle-registration fees and motor-fuel taxes for the bulk of the State's transportation revenue. However, revenue from motor-fuel taxes has steadily declined from a high of \$939 million in 2002 to \$850 million in 2016, primarily due to increases in vehicle fuel-efficiency. Diesel fuel tax revenues have also declined, from a high of \$157 million in 2003 to \$135 million in 2016. Implementation of increases in fuel taxes and registration fees being phased in over several years starting in 2017 are anticipated to help boost revenues, however, it will not be sufficient to fully meet transportation needs. Other mechanisms for generating funds should be considered.

At the Federal level, motor fuel and other truck-related taxes that support the Highway Trust Fund, the major source of federal surface transportation funding, are eroding. Federal motor fuel tax rates have not increased since 1993, and drivers of passenger vehicles with average fuel efficiency currently pay about \$96 per year in federal gasoline taxes. Because of inflation, the 18.4 cent-per-gallon tax on gasoline enacted in 1993 is worth about 11.5 cents today. This trend will likely continue as demand for gasoline decreases with the introduction and adoption of more fuel-efficient and alternative fuel vehicles. To maintain spending levels of about \$50 billion a year for highway and transit programs and to cover revenue shortfalls, Congress transferred a total of about \$63 billion in general revenues to the Highway Trust Fund on six occasions between 2008 and 2014. This approach has effectively ended the long-standing principle of "users pay" in highway finance, breaking the link between the taxes paid and the benefits received by highway users. In August 2014, the Congressional Budget Office estimated that \$157 billion in additional revenues would be required to maintain current spending levels plus inflation between 2015 and 2024.

INNOVATION AND RESILIENCE

New technologies and materials are helping roads become more sustainable and resilient such as use of recycled materials in pavement and full depth reclamation. Michigan Department of Transportation (MDOT) is in the process of developing innovative techniques and delivery methods to improve the State's roadways. MDOT has also invested in Intelligent Transportation System strategies to help manage roadway congestion in addition to recent capacity improvements. MDOT has installed sensors, closed caption TV cameras along major highways/freeways, and dynamic message signs capable of disseminating travel time or alert information to motorists. Michigan is a leader in the development of autonomous/connected vehicle technology, with research and development at the Mcity facility on the University of Michigan campus and the American Center for Mobility, an autonomous and connected vehicle testing facility being constructed on the site of the former Willow Run bomber plant. These technologies are aimed at improving safety and mobility, reducing congestion, and supporting efficiencies and economic growth.

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RECOMMENDATIONS TO RAISE THE GRADE

A deteriorating and inadequate highway transportation system costs Michigan motorists billions of dollars every year in wasted time and fuel, injuries and fatalities caused by traffic crashes, and wear and tear on their vehicles. Making needed improvements to Michigan's roads is key to providing a safer, more efficient transportation system that will decrease fatalities, decrease the amount of wasted time and money spent by motorists, and improve the State's economic livelihood. Therefore, we recommend the following to raise the roads grade:

1. State leaders must acknowledge the roads crisis and provide substantial and sustainable funding and asset management programs to assist Michigan in continuing on the road to success.
2. Michigan is a national leader in the establishment and development of a statewide asset management approach to managing its diverse transportation investment for roads and bridges. It is vitally important to both continue, as well as expand, this effort at all jurisdictional levels in order to provide the most efficient and effective use of transportation investment.
3. Road designers and owners should review the total life cycle costs of the road to make strategic design decisions and prioritize maintenance and rehabilitation.
4. Fix the federal Highway Trust Fund by raising the federal motor fuel tax, creating a federal tax to replace the federal motor fuel tax, or studying and implementing mileage-based user fees.
5. Michigan receives a large amount of freight traffic and there should be a mileage-based user fee implemented for freight movement or fees for permits related to truck size and weight.

DEFINITIONS

Vehicle miles travelled (VMT) – The total mileage travelled statewide by all vehicles over one year.

SOURCES

Paying the Price for Inadequate Roads in Michigan by The Road Information Program (TRIP, a national transportation research group) published in May of 2007.

Michigan Road's in Crisis by the Highway, Bridge, and Roads Subcommittee of the Citizens Advisory Committee (commissioned by the Governor as part of the State Transportation Funding Task Force assembled in 2008), published in July 2008.

Transportation Solutions, A Report on Michigan's Transportation Needs and Funding Alternatives by The Michigan Transportation Funding Task Force, dated November 2008.

Five-Year Transportation Program 2008-2012 presented by Kirk Steudle, MDOT Director, to the State Transportation Commission on November 29, 2007.

Michigan Highway Performance Monitoring System (HPMS) – Ownership Report, dated 2015.

Information provided by the 21st Annual Report on the Performance of State Highway Systems (1984-2012) by David T. Hartgen, Ph.D., P.E. (Maine, Retired), M. Gregory Fields, Baruch Feigenbaum.

MDOT 2017-2021 Five Year Transportation Program – Approved by the State Transportation Commission on September 22, 2016.

21st Century Infrastructure Commission Report, Chapter 6, Transportation Recommendations, prepared by the 21st Century Infrastructure Commission, dated November 30, 2016.

Information provided by the U.S Government Accountability Office 2015 High Risk Report (Funding the Nation's Transportation System).

Information provided by the Reason Foundation 21st Annual Report on the Performance of State Highway Systems.

Modernizing Michigan's Transportation System: Progress and Challenges in Providing Safe, Efficient and Well-Maintained Roads, Highways and Bridges, prepared by TRIP (a national transportation research group), dated April 2017.

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SCHOOLS

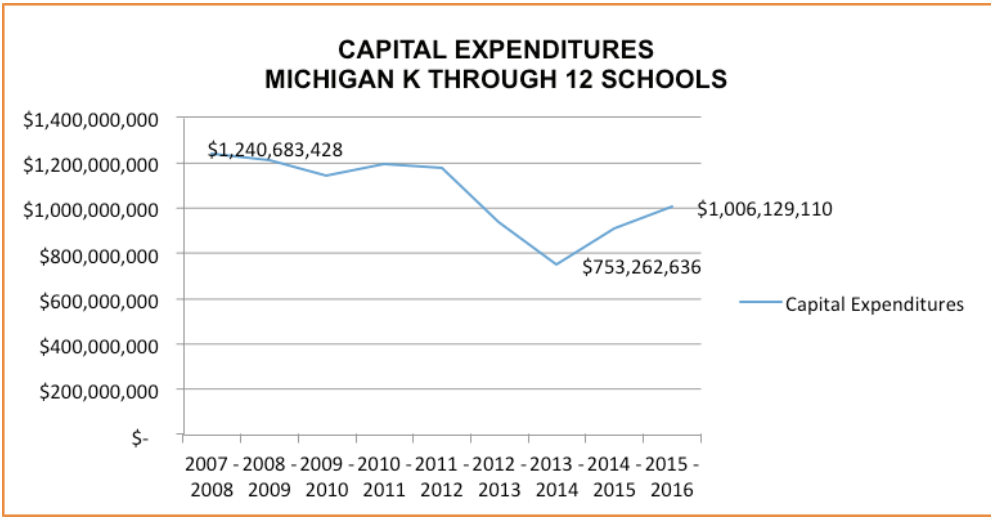
GRADE: D+

SUMMARY

The condition of Michigan's education facilities varies widely both across the state and within individual regions and districts. Nearly every district or organization has aging facilities, while some also have a mix of updated and newly constructed facilities. It is important to understand that access to funding for school facility improvements is largely based on the size of the local property tax base. The condition of Michigan's K through 12 schools varies based on a region's propensity to support property taxes for schools and the value of the region's taxable property. Overall, Michigan's schools have stabilized and shown slight improvements in enrollment numbers and facility funding. These improvements are driven by the improving economic conditions in Michigan and higher birthrates. As this trend continues, it is anticipated there will be less consolidation and closing of aging school facilities, and a movement will begin towards renovation, expansion, and construction to meet the future needs of Michigan's student population.

CONDITION

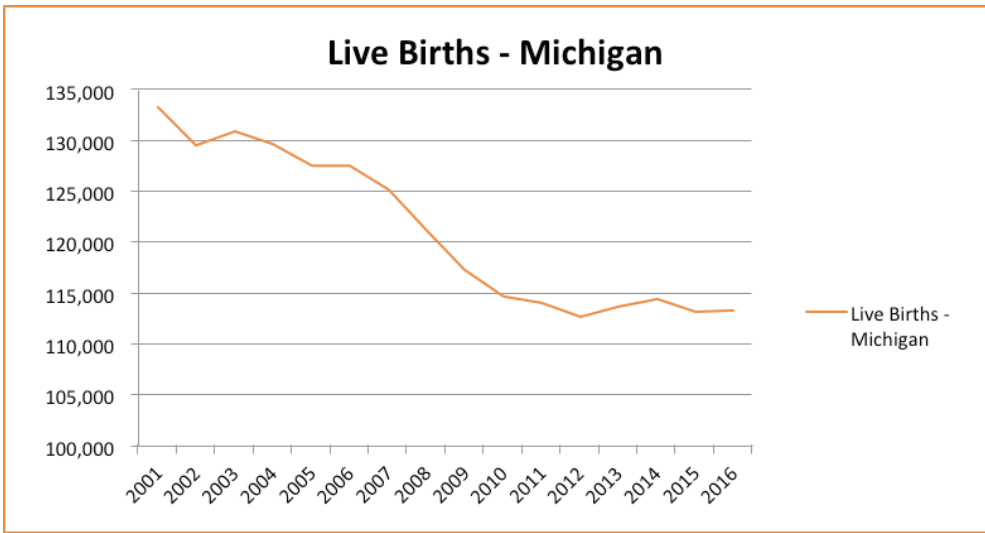
The condition of Michigan schools varies widely. While some districts have invested in significant renovations and some limited new buildings, many are utilizing structures and utility systems that are well beyond their design and useful life. Spending on capital expenditures by Michigan's schools declined from 2007 to 2014, but appears to be stabilizing, albeit at a level almost 30 percent below its average from the mid 2000's. In 2014, the US Department of Education published a report summarizing the overall surveyed condition of school facilities. The average reported number of years since the construction of the main instructional building in the Central Region (which includes Michigan) was 49 years with most recent renovation occurring 13 years ago. The condition of outdoor features such as parking lots, roadways, bus lanes, drop-off areas, sidewalks, playgrounds, athletic facilities, covered walkways and fencing was found to be rated as fair or poor at 39 percent of public schools, with the Central Region lagging all regions in nearly every outdoor feature category. Among public schools with permanent buildings, the environmental factors in permanent buildings were rated as unsatisfactory or very unsatisfactory in 5 to 20 percent of schools, depending on the system or characteristic rated. For example, indoor air quality rated unsatisfactory or very unsatisfactory in 9 percent of permanent school buildings, whereas heating systems rated poorly in 14 percent of schools. Given the limited capital expenditure funding in recent history, the condition of Michigan's school infrastructure continues to decline.



Source: Michigan Dept. of Education Bulletin 1011

CAPACITY

Based on the statewide declining enrollment of students, the capacity of Michigan schools continues to be adequate. The majority of capital expenditure in Michigan education has been focused on the renovation and replacement of existing facilities, rather than expanding space for students. As the population of Michigan remains stable, school enrollment projections are largely predicted by the birth rates in the state. Based on an analysis of birth rates for the last 16 years, the rate of births appears to be stabilized and may again be on the rise, predicting the need for additional facilities for future students.



Source - Michigan Dept. of Education

2018

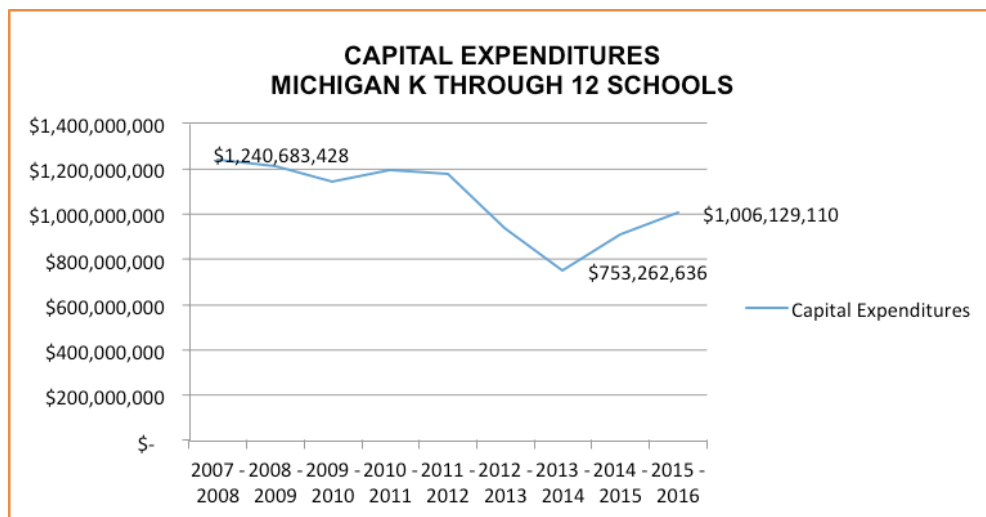
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INVESTMENT AND FUNDING

Very few dollars of state per-pupil funding for education in public schools remains available after paying basic educational staff and operational expenses. Instead, capital improvements in State of Michigan public schools are largely funded by local property tax millages. These millages require voter approval and have received mixed results in recent years. The average rate of passage of state qualified ballot questions from 2008 to 2017 was 61 percent. Districts with higher taxable values of property also required less millage to generate the same amount of funds, creating significant inequity between district facilities based on taxable value and propensity to approve additional property taxes.

While securing the funding for projects can be challenging, the need for funding is very apparent. The United States Department of Education (USDOE) survey indicated that 53% of respondents reported they needed to spend money on repairs, renovations and modernizations to put the school's onsite buildings in good overall condition. At a national level, the total amount needed was estimated to be approximately \$197 billion which equates to an average need of \$4.5 million per school.



Source - Michigan Dept. of Treasury

FUTURE NEED

The future needs of Michigan schools continues to point to renovations and upkeep bringing older facilities into the 21st century. Many districts are still utilizing facilities built in the 1950s and 1960s following the Baby Boom, in the condition they were originally constructed. Beyond utility and aesthetic renovations, teaching styles continue to evolve and favor team and project based environments with flexible spaces and technology rich environments. Older facilities typically do not support these teaching styles. While some new facilities have been approved and constructed in recent years, communities have largely only approved “use what you have” approaches rather than direct replacements. This has required creative approaches to modifying and adding to existing facilities to facilitate a new image and to incorporate 21st century teaching styles.

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OPERATIONS AND MAINTENANCE

The majority of school funds are used directly to educate students. Operation and maintenance funds are primarily used to maintain day-to-day building operations, with little money remaining for longer term maintenance, repair, and replacement. As discussed earlier in this chapter, funding for these activities largely falls to the levy of property tax millage for public schools. Schools also vary in their financial ability to set aside funds for replacement of property and plant (roofing, boilers, athletic fields, etc.) with defined lifespans and significant replacement costs. These projects tend to be delayed and often necessitate a larger program or community supported response.

PUBLIC SAFETY

Michigan schools continue to focus on improving safety both through facilities and policy. Many continue to implement single secure points of entry, guiding visitors through a staff checkpoint during the daytime operational hours. There's been an attempt to strike a balance between fortifying schools and maintaining open, community facilities. Significant progress has been made in securing many facilities in the last five years.

RESILIENCE

Michigan schools have in many cases “made do” with existing facilities and have been remarkably resourceful in consolidating where needed and shoe-horning modern technology in aging facilities. Often schools are repurposing space within aging structures to satisfy programming needs. While the minor changes allow for continuation of the education process, they do little to address the aging facility and infrastructure.

There are many districts that are considering adopting an “alternative calendar” that will lengthen the school calendar to year-round school thereby limiting the construction window in which facilities can be improved while unoccupied. Upgrading failing infrastructure is often invasive, loud, time consuming and presents many unique code challenges to maintain safety during construction. The pressure of the shortened construction window will only add to construction cost escalations experienced by material and trade shortages. Additionally, the alternative calendar will require that spaces used during summer are conditioned properly to ensure the educational process isn't impacted. This will increase the amount of infrastructure schools will need to maintain in the future driving long term maintenance costs higher.

SPOTLIGHT ON A MICHIGAN SCHOOL DISTRICT:

Zeeland Public Schools' Facility Analysis and Strategic Funding Plan

Zeeland Public Schools completed and continue to update a district-wide study of the condition of all their facilities including roofing, energy systems, interiors, pavements and athletic facilities approximately 10 years ago. The study has helped to make informed decisions for future funding and expansion/contraction as student population changes.

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RECOMMENDATIONS TO RAISE THE GRADE

1. Address facility funding inequity – While public schools receive very similar per pupil funding for education from the State of Michigan, major facility renovation projects are almost exclusively funded using local district or independent school district (ISD) wide property tax millages. Those with large property tax bases continue to have access to more capital than largely rural schools, who generally struggle to keep facilities operational. Additionally, schools with declining enrollment may struggle to secure funding to improve remaining facilities and continue to operate at a level similar to districts with growing student base. Adopt an equitable baseline facility funding source for districts across the state.
2. Development of Statewide Database of Condition of School Facilities – We recommend that documenting the current condition of school districts start with the Intermediate School Districts maintaining records and reporting to the State. Proper funding would be needed to support the collection and compilation of this information. If the State has a good understanding of the condition of its schools, it can make more informed decisions as to funding needs.

SOURCES

Information provided by the Michigan Department of Treasury

Information provided by the Michigan Department of Education

Information provided by Alexander, D., and Lewis, L. (2014). Condition of America's Public School Facilities: 2012–13 (NCES 2014-022). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved [1/5/2018] from: <http://nces.ed.gov/pubsearch>

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SOLID WASTE

GRADE: C+

SUMMARY

Solid waste disposed in Michigan totaled nearly 16 million tons in 2016, similar to the previous year. The estimated residential recycling rate was 15 percent, less than half the US average. Daily per capita waste generation is approximately 5.6 pounds, nearly 27 percent greater than the national average of 4.4 pounds.

Overall, Michigan's collection, transfer and disposal infrastructure is robust and the industry competitive, with approximately 27 years of landfill disposal capacity remaining. Michigan is beginning to actively shift its overall solid waste philosophy toward a sustainable materials management approach to create economic opportunities through waste diversion, beneficial re-use, and recycling programs

CAPACITY AND CONDITION

In 2016, over 15 million tons of waste was disposed in Michigan landfills. Waste imported and disposed in Michigan landfills was nearly 4 million tons, approximately 23.6 percent of the 2016 total. For comparison, in 2014, the total landfilled waste in the U.S. was 258 million tons. Michigan represented 6 percent of the total waste disposed in landfills nationally, a value impacted by imported waste streams.

As shown on Table 1, since 1996 the overall total waste disposed in Michigan increased by 12.1 percent, but yearly fluctuations occurred that appear to coincide with economic cycles and fluctuations in the volumes of imported wastes. Peak landfilling occurred in 2004 (21.4 million tons) and the greatest volume of imported waste occurred in in 2006 with 2.3 million tons from surrounding states and over 4 million tons from Canada, representing 30.9 percent of total landfilled waste in Michigan.



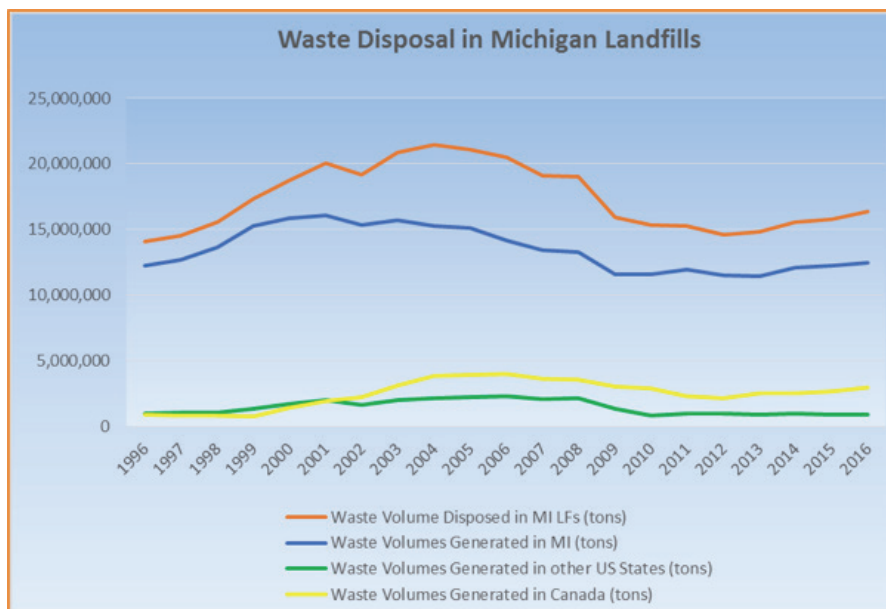
TABLE 1: OVERALL WASTE DISPOSAL FROM 1996 TO 2016

Year	Waste Disposed in MI LFs (tons)*	Waste Generated in MI (tons)*	Waste Generated in other US States (tons)*	Waste Generated in Canada (tons)*
1996	14,094,134	12,225,765	1,011,731	884,858
1997	14,556,547	12,698,550	1,025,504	834,960
1998	15,580,411	13,649,043	1,062,117	849,605
1999	17,319,155	15,260,745	1,344,031	780,930
2000	18,717,437	15,884,131	1,738,705	1,405,605
2001	20,083,537	16,087,345	1,992,590	1,964,913
2002	19,180,307	15,348,826	1,628,862	2,202,619
2003	20,871,810	15,689,023	2,026,456	3,144,343
2004	21,429,085	15,260,221	2,192,468	3,852,966
2005	21,098,372	15,145,748	2,204,076	3,959,364
2006	20,501,110	14,155,926	2,316,882	4,028,302
2007	19,129,356	13,411,074	2,057,287	3,660,995
2008	19,039,965	13,304,545	2,161,365	3,574,055
2009	15,945,906	11,583,788	1,343,994	3,018,124
2010	15,374,312	11,600,955	854,352	2,919,005
2011	15,242,667	11,952,640	962,318	2,327,709
2012	14,629,515	11,495,178	970,917	2,170,741
2013	14,867,088	11,411,053	928,567	2,531,572
2014	15,575,820	12,093,906	943,412	2,546,389
2015	15,805,947	12,287,504	890,966	2,686,981
2016	16,363,089	12,504,839	896,931	2,961,319

 From DEQ's 2005 Annual Report of Solid Waste Landfilled in MI
 From DEQ's 2016 Annual Report of Solid Waste Landfilled in MI
 * Annual Report from DEQ report in cubic yards. Numbers shown in this table have been converted using a 3:1 conversion factor



FIGURE 1: TREND OF ANNUAL WASTE DISPOSAL IN MICHIGAN LANDFILLS



As depicted on Figure 1, 2005 marked the beginning of a trend in declining annual waste disposal in Michigan landfills that extended to 2012. During this period, which roughly coincides with the national economic recession, the amount of solid waste landfilled in Michigan fell from 21 million tons to 14.6 million tons, an overall decrease of 30.7 percent. In the last four years, total landfilled waste increased slightly, with imports from other states and Canada remaining relatively stable, averaging 6 percent and 16.8 percent, respectively.

SOLID WASTE COMPOSITION

Michigan licensed landfills are categorized based on the type of waste disposed. These include: Type I (hazardous waste), Type II (residential, commercial, and institutional waste), which can also dispose of C&D and IW waste, and Type III (C&D and industrial wastes). Excluding hazardous waste facilities, there are 69 active Type II and Type III landfills (including all subcategories).

REMAINING LANDFILL DISPOSAL CAPACITY

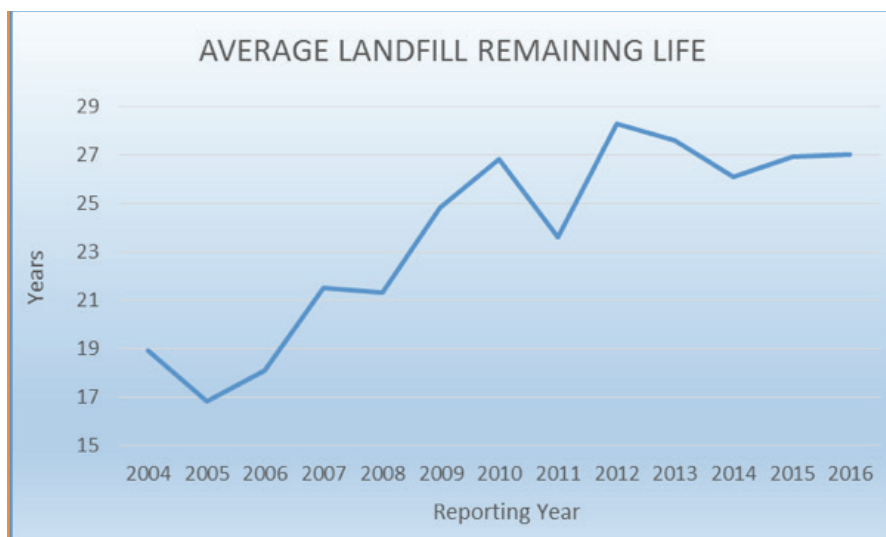
Michigan law requires each county prepare a solid waste management plan to demonstrate waste disposal capacity of at least 10 years or submit annual reports to certify compliance. Any county that reports capacity less than 66 months is subject to automatic siting criteria enforced by MDEQ.

At present, all Michigan counties have access to disposal capacity in excess of 10 years, available in-county or via inter-county agreements. Based on MDEQ's 2016 database, the capacity of individual landfills varies widely (1 to 494 years); however, the total available capacity of Michigan's 47 non-captive Type II landfills located within the state's 83 counties is nearly 500 million cubic yards (166.5 million tons). At existing disposal rates, this equates to approximately 27 years of remaining disposal capacity.

As indicated in Figure 2, the overall remaining capacity trend of non-captive landfills has generally increased since 2004 when MDEQ began tracking this statistic.



FIGURE 2: AVERAGE LANDFILL REMAINING LIFE



Michigan's substantial landfill capacity results in lower disposal rates than elsewhere in the Great Lakes Region. The Recycling Partnership's 2016 report indicates that within the U.S. Environmental Protection Agency (EPA) Region 5 states (i.e., Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin), the average landfill tipping fee ranges from \$28/ton (Indiana) to \$51/ton (Minnesota); Michigan's average is \$31/ton.

Combined, the abundant landfill capacity and low disposal fees, which result in lower rates for customers, are often cited as the primary factors contributing to Michigan's relatively low residential recycling rate. Landfill diversion and related sustainability issues will be addressed as part of pending county solid waste plan updates, many of which have not been revised for more than 10 years.

MSW RECYCLING FACILITIES

Based on available information, MSW recycling operations occur primarily at material recovery facilities (MRFs) owned and operated by both public and private sector organizations. There are 65 MRFs located in Michigan, seven located in the Upper Peninsula (UP), and 58 in the Lower Peninsula (LP). These facilities process the majority of traditional recyclables materials (e.g., metal, plastic, paper, and glass) generated in the state and sell to end-users in Michigan and elsewhere in the country. At present, due to recent facility fires and low-commodity pricing, only a few single-stream MRFs operate in southeast Michigan.

Although Michigan's current recycling rate is relatively low, existing infrastructure appears adequate to support increased activity and participation, especially if education programs are developed and implemented.





INVESTMENT AND FUNDING

Michigan's solid waste program is funded by a combination of fees and legislative appropriations that cover MDEQ staff salaries, expenses, and various grants distributed to local communities for recycling and pollution prevention activities. In 2016, the total budget allocated to MDEQ to administer the solid waste program was \$11,042,400. The MDEQ solid waste program employs 51 staff, or full-time equivalents (FTEs). The budget also included a \$1 million special legislative appropriation to support the Governor's recycling initiative. The initiative is a 15-point plan focusing on public education and technical assistance, convenient access to recycling for Michiganders, and better benchmarking and tracking of recycling rates. The state hopes to see results from the initiative in the upcoming years.

Nearly half of MDEQ's funding source is a \$0.12/cubic yard (\$0.36/ton), surcharge from all non-captive MSW landfills, which totaled nearly \$4.5M in 2016. Other major user fee-based funding sources include facility construction permits and operating licenses, as well as scrap tire, medical waste, and e-waste program registration and surcharge fees.

Approximately one-third of MDEQ's solid waste program budget is allocated to pollution prevention and recycling grants, with scrap tire pile cleanup and market development projects the major recipients. Michigan also charges a \$0.75/ton perpetual care fund surcharge for non-captive landfills, capped at \$2M per facility, for use to manage facility environmental protection systems during the 30-year post closure period or in the event of site abandonment.

Similar to Michigan, each of the six USEPA Region 5 Great Lakes states uses a variety of financial mechanisms to fund their respective solid waste programs. Each state collects a waste disposal surcharge, which ranges from \$0.36/ton to \$13.00/ton, with Michigan charging the least and Wisconsin the most. However, only slightly more than half of Wisconsin's surcharge directly supports their solid waste program. Ohio, compared to other Great Lakes states, is most analogous to Michigan with respect to solid waste management infrastructure and population, and appropriated nearly \$20.7M for their solid waste program in 2016 compared to Michigan's \$11.7M. This translates to \$1.78 per capita/year in Ohio and \$1.11 per capita/year in Michigan spent on solid waste management programs administered by the Ohio EPA and MDEQ, respectively.

RECOMMENDATIONS TO RAISE THE GRADE

Based on available data, Michigan's solid waste infrastructure (including: collection, transfer, and disposal) is robust and competitive. Michigan's solid waste infrastructure provides the means necessary to effectively manage residential, commercial, and industrial waste streams compliant with environmental standards at a reasonable cost. However, to increase Michigan's overall recycling rate and reduce landfilling, Michigan should take the following steps to raise the grade:

1. Follow Governor Snyder's "Michigan's Recycling Plan of Action" that includes increasing recycling from 15 to 30 percent by: developing a reliable measurement tracking and reporting system; increasing education, outreach, and technical assistance programs; marketing development and innovation support; updating county solid waste plans; and, continued state-level leadership and funding to enact the plan.
2. Complete on-going joint efforts between the MDEQ, industry, and other stakeholders, to revise Part 115 of Michigan's PA 451 (1994) that shifts current solid waste policy towards a material management approach less reliant on landfilling.

These initiatives, if fully-supported and funded, will place Michigan on path to improve its overall solid waste infrastructure performance and associated grade.

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STORMWATER

GRADE: D-

SUMMARY

Michigan's stormwater management system provides flood protection, improves the quality of life for residents, allows our businesses to operate safely and efficiently, provides for safe transportation, improves agricultural production, and extends the service life of roads, streets, and highways. Stormwater management impacts the water quality of streams, rivers and the Great Lakes which are a key component of Michigan's economy. Currently, Michigan lacks a systematic approach to inventorying, operating and maintaining our stormwater infrastructure, and few communities have dedicated funding sources for stormwater systems. Recent implementation of asset management programs are exposing the deterioration of our stormwater infrastructure, and unless a funding source is dedicated, Michigan's stormwater infrastructure/grade will continue to decline.

BACKGROUND

Michigan is home to more than 11,000 inland lakes, 51,000 miles of rivers, 6.5 million acres of wetlands, and more than 3,288 miles of freshwater coastline (the longest in the world). Additionally, Michigan has over 1,200 public beaches and over 1,400 public boat launches that support nationally recognized recreational opportunities. Stormwater management systems, by managing runoff and the associated pollutants from rainfall and snow melt, play an integral role in protecting and restoring these water resources. In fact, one in five of Michigan jobs is directly related to water resources. The state is increasingly reliant on freshwater resources to achieve economic development, tourism, and recreation opportunities.

Historically, design criteria focused on conveying stormwater from developed areas quickly and efficiently downstream through large infrastructure systems. Stormwater best management practices become more prevalent in the 1980s to provide greater flood control and to improve stormwater runoff quality. Modern design criteria, by contrast, focuses on opportunities to manage rainfall where it lands through green infrastructure systems (e.g. infiltration, filtration, and volume reduction) while also addressing flood control and conveyance alternatives.

Stormwater systems can include any combination of enclosed and open conveyance systems, underground and aboveground detention basins, and green infrastructure. Systems are owned and operated by cities, villages, townships, county road commissions, county drain commissioners, state and federal agencies, and a multitude of private entities. Michigan also has combined sewer areas, which are designed to collect everything from domestic sewage, to rainwater runoff, to industrial wastewater in the same pipe. Many lack adequate controls for wet-weather overflows, which result in untreated wastewater discharging to nearby bodies of water. To date, the total investment in eliminating uncontrolled Combined Sewer Overflows (CSOs) is estimated at \$4 billion.

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Patterns in precipitation have also been changing across the Great Lakes Region and are evident in the increased frequency of extreme precipitation events that have occurred over the last decade. In August 2014, more than 6-inches of rainfall occurred in southeast Michigan over an 8-hour period resulting in over \$1.8 billion in damages and a federal disaster declaration. Since 1900, total annual precipitation has increased by approximately 11 percent in the Great Lakes Region. Since 1958, the amount of precipitation falling in the heaviest 1 percent of storms has increased by 37 percent (Source: Great Lakes Integrated Sciences and Assessments).

CAPACITY AND CONDITION

MUNICIPAL AND PRIVATE SYSTEMS

Local municipalities are commonly the first line of defense regarding stormwater issues that arise within their jurisdictional boundaries; however, the majority of local governments lack adequate financial means to address these issues. Recent condition assessments for several Michigan communities revealed that up to one third of storm sewer systems require structural rehabilitation to maintain their function in future years.

Based on an urban population of 7.4 million (U.S. Census, 2010) and typical per-capita quantities of storm sewer assets in Michigan communities, our estimate for the total urban stormwater infrastructure in Michigan is as follows:

- 38,000 miles of storm sewer pipe
- 725,000 manholes
- 1.6 million inlets and catch basins

Using the industry standards of storm sewers and manholes being replaced, on average, every 120 years, and inlets/catch basins being replaced, on average, every 40 years, the approximate annual statewide cost to cycle out old stormwater infrastructure with new will likely range from \$400 to \$500 million per year. This includes only conventional infrastructure within urban systems and does not include privately-owned stormwater assets.

While much of the stormwater infrastructure described is focused on separate storm sewer systems, CSOs and the reduction of stormwater entering these CSOs are still high priorities in Michigan. Green infrastructure now plays a major role in addressing uncontrolled CSOs in Michigan because it leads toward multiple outcomes including: reduced treatment costs, basement backups, street flooding and untreated overflows into local waterways. Green infrastructure also beautifies and stabilizes neighborhoods. Focusing on reducing stormwater runoff volume into CSOs enhances the capacities of these systems and increases the CSOs ability to achieve water quality standards.

PRIVATE DRAINAGE SYSTEMS

Private stormwater systems include catch basins and storm sewers under parking lots, minor storm sewers in residential areas outside of the right-of-way, and stormwater detention and retention ponds that are constructed to control peak flow rates. There is no asset management system in place to identify, track, and determine private stormwater system functionality or maintenance needs. This is largely due to lack of funding at the local level.

In many cases, both public and private storm sewer systems do not have the capacity to safely convey rainfall for the 5-year or 10-year rainfall event.

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COUNTY DRAINAGE SYSTEMS

There are approximately 35,000 regulated county drains in Michigan, and more than 50 percent of the drains are open drains. More than 50 percent of the drains are over 75 years old, and more than 30 percent are over 100 years old.

Open drains are estimated at 65 percent of the total mileage, with the remaining 35 percent representing enclosed (pipes and culverts) systems. Replacement value of open drains is assumed to be about \$100/foot, and about \$200/foot for enclosed systems.

Current maintenance practices for County Drainage systems are impacted by antiquated funding limitations set by the State's Drain Code. Currently, only \$1,400 on average is invested per mile of County Drain per year. However, estimates suggest that this is an underinvestment of 80 percent to 90 percent.

The limited resources that County Drain Commissioners have are often dedicated to basic maintenance only, such as open drain mowing and service calls.

STATE AND COUNTY ROAD SYSTEMS

According to MDOT, 9,668 miles of road are state owned, 21,200 miles are owned by municipalities, and 89,444 miles are under the jurisdiction of County Road Commissions. It's estimated that approximately 80,000 miles of Michigan roads have linear drainage infrastructure. Typically, the drainage component of roadway projects is 5 to 15 percent of the total project cost.

Limited transportation budgets result in challenges when addressing the underinvestment in Michigan's transportation infrastructure, including stormwater management. Continued underinvestment in stormwater infrastructure for the transportation network exacerbates the challenges in improving the quality of the state's water resources.



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OPERATIONS AND MAINTENANCE

ASSET MANAGEMENT

Asset management provides an opportunity to manage infrastructure in a more cost-effective manner, based on condition assessment and desired outcomes. While Michigan is a national leader with a statewide asset management program for roads, stormwater infrastructure is typically left out. Michigan is now leading a program to align underground infrastructure with roads in a more comprehensive asset management program, something no other state is doing.

Between 1982 and 2012, the total urbanized area in Michigan increased by nearly 50 percent. During the same time-period, the population increased by only 8 percent. This reveals that we are expanding the size of infrastructure without increasing revenue. In other words, land is being developed quickly, with a focus on subdivisions in urban fringe areas at the expense of urban cores. These newly developed communities require additional lane miles, drinking and sewer pipes, but lack the density of population to fully pay for the needed infrastructure expansion. Finally, with the addition of stormwater quality and quantity rules applying to urbanized areas, we have added more Best Management Practices (BMPs) to the developments. Adding these components to a development requires more inspection, maintenance, and system management in order to provide a well-functioning system. Maintaining these assets in the future will be more complex than it has been in recent decades.

RESILIENCE AND INNOVATION

Michigan has been a leader in development watershed management plans and programs that identify goals, objectives and actions to work towards achieving water quality standards and removing beneficial use impairments (BUIs) in local water resources.

Managing stormwater on a watershed basis to achieve local, regional and state environmental outcomes is critical to improving the state's stormwater infrastructure systems. Opportunities may include simple policy changes within codes and ordinances to more elaborate partnerships that seek to align resources through principles of asset management for construction of stormwater management systems.

Joint action and collaboration among jurisdictions to manage stormwater on a watershed basis is critical to strategically aligning financial and environmental objectives.

Michigan is behind other states with innovative materials and practices in stormwater infrastructure. Performance based specifications for new infrastructure are not required, which can shorten the actual service life of stormwater infrastructure.

INVESTMENT AND FUNDING

STORMWATER ENTERPRISE FUNDS IN MICHIGAN

Michigan is far behind its neighbors in the development of enterprise funds (i.e. "utilities") for municipal stormwater systems. This is largely due to legal precedent (*Bolt v Lansing* and *Jackson County v City of Jackson*) where stormwater utilities have been deemed "illegal taxes" under the Headlee Amendment of Michigan's Constitution. This has prevented the spread of stormwater utilities in Michigan. Currently, over 1,600 cities in the U.S. have a stormwater utility, while in Michigan, fewer than ten cities have one. Our neighboring states are far ahead of Michigan in establishing funding sources for stormwater: Ohio has 125 cities with a stormwater utility, Wisconsin has over 100, and Indiana has nearly 80.

Although there is proposed legislation to enable the creation of stormwater utilities in Michigan, it will be necessary for that legislation to be fully enacted before there is a mechanism to provide a dedicated funding source for this vital component of our infrastructure.

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SAW GRANT PROGRAM

The State of Michigan, through the Michigan Department of Environmental Quality (MDEQ), has committed \$450 million to allow communities to develop Asset Management Plans for stormwater and wastewater systems. Nearly 280 individual applications were received for Stormwater Asset Management Plans, totaling over \$115 million in potential grant funding. Communities began developing these plans in early 2014, and the program should last through at least 2020 before the available funding is expended. Although the first round of Asset Management Plans were not due until May 2017, many communities are in the final stages of developing their Asset Management Plans; they have learned the following about their stormwater systems:

- Alarming budget gaps currently exist for stormwater systems since the vast majority of Michigan cities have no dedicated funding source. Current funding for stormwater often comes from the General Fund or the Road/Street Fund, both of which have other priorities. The funds are frequently diverted away from stormwater unless an emergency arises.
- Communities do not have funding or staffing to regularly inspect their storm sewer systems (as they do their wastewater collection systems). Because of this, public works staff are often unaware of where the next emergency will surface. Many communities have no rehabilitation/replacement programs for storm sewer systems.
- Deterioration forecast modeling for numerous Michigan communities has revealed that systems will begin to fail with increasing frequency unless more investment is made to systematically rehabilitate aging sewers (i.e. fixing cracks, replacing structurally deficient pipes, etc.). This problem is more acute for older communities where the average asset age is over 60 years. Although younger communities (recently-developed suburban areas) do not yet require immediate attention, they will age. Proactive asset rehabilitation and replacement programs will benefit all cities by reducing the frequency and cost of emergency repairs.

Several Michigan communities are exploring the concept of creating a stormwater utility as part of their SAW Grant budgets. These efforts have revealed that local property owners and businesses are generally amenable to a dedicated funding source for stormwater if that cost can be linked to demonstrated need and if property owners are charged based on their relative demands on the system.

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RECOMMENDATIONS TO RAISE THE GRADE

Michigan is home to more than 11,000 inland lakes, 51,000 miles of rivers, 6.5 million acres of wetlands, and more than 3,288 miles of freshwater coastline (the longest in the world). However, the state and local jurisdictions lack a coordinated and collaborative approach to strategically invest in infrastructure improvements that support achieving sustainable state-wide high quality water resources. Michigan should take the following steps to raise the stormwater grade:

- 1. Establish a dedicated source of funding for stormwater systems.** This funding source needs to support collaborative planning, design, construction and long-term maintenance. Without a consistent, reliable source of funding, stormwater systems and the quality of our water resources will continue to deteriorate.
- 2. Integrate flexibility into regulatory programs for public agencies to address local stormwater challenges across jurisdictions.** Stormwater systems are owned by multiple jurisdictions that lack integrated and collaborative planning mechanisms. Regulatory programs are also structured by jurisdiction, further reducing collaboration. Changing precipitation patterns also warrant a more holistic approach when addressing water resource challenges.
- 3. Amend the County Drain Code to increase the statutory spending limit.** The limited resources that County Drain Commissioners have are often dedicated to basic maintenance only. Underinvestment is driven by a statutory spending limit of less than \$1 per foot of drain per year without a petition meeting the requirements of the Drain Code or a resolution to exceed the maintenance limits from a municipality.
- 4. Align infrastructure improvements to achieve a sustainable future for our water resources.** These improvements should include adopting principles of asset management across all infrastructure sectors, evaluating use of innovative materials, using performance based specifications, and securing multiple funding mechanisms.
- 5. Strengthen collaboration and partnerships across multiple agencies and jurisdictions.** Partnerships and collaboration are the cornerstone of integrated water resource management. While many partnerships were initially formed to address specific silo-based topics or permit requirements, it is important for existing and new partnerships to strategically address all elements of water resource planning objectives.

SOURCES

The storm water grades are based on information provided by a variety of sources including:

- A survey of 54 different Michigan communities including City, County, State and local government councils
- Governor's 21st Century Infrastructure Commission
- Michigan Water Strategy
- Southeast Michigan Council of Governments
- County Road Commissions
- County Drain (Water Resource) Commissions
- Cities, Towns and Villages
- Urban communities
- Rural communities

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TRANSIT GRADE: C-

SUMMARY

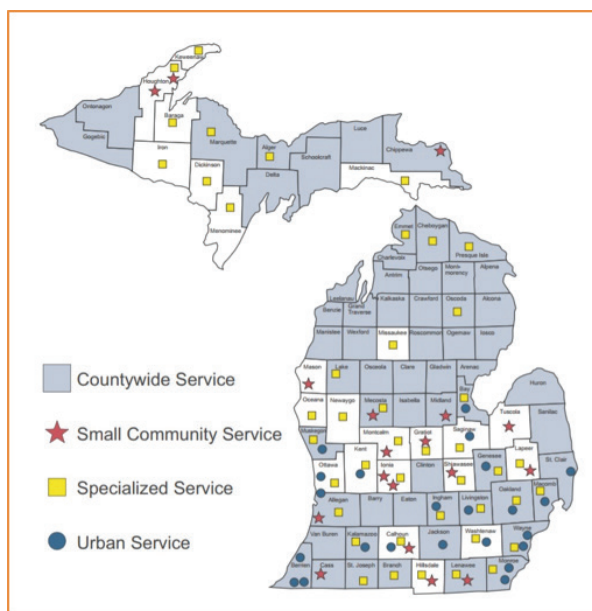
The 78 public transit agencies in Michigan provide 88.4 million passenger trips annually. While a majority of Michigan's residents have access to some form of public transportation, the reliability and availability of these services to many areas is inadequate, and some of the urban systems are unable to adequately meet transit demands. Existing fleets are aging, and some are already past useful life. Fortunately, the state and localities are making strides in addressing transit gaps and are investing in the existing infrastructure. In 2012, Detroit and the surrounding counties established the Regional Transit Authority (RTA) of Southeast Michigan, which oversees new bus routes, and improves transit safety, viability, and reliability. Since establishment of the RTA of Southeast Michigan there has been increasing ridership in these counties. The state will continue to experience significant challenges and opportunities as millennials and seniors, who view transit as the preferred mode of transportation, make housing choices in urban areas.

BACKGROUND

The State of Michigan has 78 public transit agencies, which provide transit services to the general public within their local service areas (Figure 1). Twenty-one of those public transit agencies serve urbanized areas. Service areas range from a single community to several counties. In addition, MDOT provides financial support to 38 specialized providers whose services focus on people with disabilities and senior citizens. Often these people are also part of specific social service programs. All 83 counties in Michigan have some form of transit service through the public transit agencies and specialized providers. However, transit may be limited in some areas in both terms of the service area and/or the individuals served.

Michigan transit has made significant improvements in recent years, including in the following areas:

FIGURE 1. LOCAL TRANSIT AGENCIES IN MICHIGAN



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SILVER LINE BUS RAPID TRANSIT (BRT) – THE RAPID

Grand Rapids' transit partnership, The Rapid, opened the first BRT in Michigan in August of 2014, called the Silver Line. Since opening, this corridor has seen a 40 percent increase in ridership, with the Silver Line serving approximately 70,000 riders per month.



LAKER LINE BRT – THE RAPID

The Rapid is currently at a 90 percent design phase for the second BRT route, which will be called the Laker Line. This east-west BRT covers 13.1 miles along Lake Michigan Drive (M-45), connecting Grand Valley State University to downtown Grand Rapids' Medical Mile and to the existing Silver Line BRT. This will make The Rapid a true BRT network. The Laker Line is expected to open in 2020.

RTA OF SOUTHEAST MICHIGAN

The RTA was established via Public Act 387 of 2012 and is comprised of Wayne, Oakland, Macomb, and Washtenaw counties. The RTA has been charged with coordinating transit services within these four counties and recently completed a single Master Transit Plan. The RTA is also responsible for coordinating the operating and capital plans of all transportation agencies and authorities in southeast Michigan.

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Q-LINE - DETROIT

The Q-Line is a light rail system which runs a 6.6-mile loop along Woodward Avenue from Grand Boulevard to Jefferson Avenue. Q-Line operations began in May 2017, and fare collection started in September 2017. Ridership on the Q-Line is expected to reach 5,000 riders per day after one year of operation.



In addition, there are multiple studies taking place within Michigan that are looking to bring additional enhancements to the existing transit network, which include:

CAPITAL AREA TRANSPORTATION AUTHORITY (CATA) BRT

CATA has developed preliminary plans for Bus Rapid Transit along the Michigan/Grand River Avenue corridor between Lansing and Meridian Township, which would connect downtown Lansing and the state capital area to the campus of Michigan State University and retail areas to the east. As of April 2017, planning for this project has been suspended “until such time as CATA has reasonable assurances as to the availability of adequate federal funding to support the BRT.”

THE CONNECTOR IN ANN ARBOR

This is an alternatives analyses evaluation that recommends a hybrid light rail/streetcar system be constructed that connects northeast Ann Arbor to south Ann Arbor. Specifically, this system would likely connect the following: the University of Michigan campuses, downtown Ann Arbor, the medical center, the train station, and commercial areas. The alternatives analyses have been completed, and the next steps are the conceptual design and environmental review. A timeline has not been set for design.



FLINT'S MASS TRANSPORTATION AUTHORITY (MTA) CORRIDOR STUDY

This evaluation is currently in the study phase and is looking at the I-75 corridor between Bay City and Detroit, which will also include the I-69 corridor from Lansing to Port Huron. The MTA would like to consider a “Bus on Shoulder” program operating on I-75 and I-69 along with a major hub being placed near these two corridors.

BRT CORRIDOR SELECTION AND REFINEMENT STUDY – THE RAPID

The Rapid has teamed with the Grand Valley Metropolitan Council to conduct a study to select the next feasible corridor for a third BRT route. The study will focus on the urbanized areas of Grand Rapids and is expected to come up with a list of possible corridors. The study is expected to be completed in early 2018.

INVESTMENT, FUNDING, AND FUTURE NEED

Michigan’s transit agencies are funded through multiple sources, including federal and state funds, local millages, local general funds, farebox revenues, service contracts, and the sale of advertising. Federal funding is provided by the FAST Act, which is a five-year authorization bill that expires in FY 2020. Federal funds for urban transit are awarded directly to, and programmed by, the individual transit agencies (listed in Table 1 below). Federal funds for rural services are awarded to Michigan and programmed by MDOT.

TABLE 1: URBAN TRANSIT AGENCIES

Ann Arbor	Holland (Macatawa Area Express)
Battle Creek	Kalamazoo
Bay County (Bay City)	Jackson
Benton Harbor	Lansing
Detroit Department of Transportation (DDOT)	Livingston
Monroe County (SMART Lake Erie Transit)	Midland
Detroit Metro SMART	Muskegon
Detroit Transportation Corp.	Niles
Flint	Port Huron (Blue Water)
Grand Haven, Spring Lake, and Ferrysburg (Harbor Transit)	Saginaw
Grand Rapids (The Rapid)	



State funds for transit come from the Comprehensive Transportation Fund (CTF), which receives gas tax revenue and vehicle registration revenue from the Michigan Transportation Fund as well as a small portion of Michigan's sales tax on automobile related sales. The largest Michigan program supported by the CTF is state operating assistance to local transit agencies, most commonly called the Local Bus Operating (LBO) Program. LBO funding is provided to agencies in the form of reimbursement, as a percentage of their eligible operating expenses. The amount of CTF appropriated for the LBO program remained relatively static from FY 2006 to FY 2016 at approximately \$167 million per year and then increased about 11 percent in FY 2017 to approximately \$186 million, as a result of the new transportation revenue package.

In November of 2015 Michigan passed a series of surface transportation funding bills that included raising the gas tax to 26.3 cents per gallon, indexing the gas tax with inflation beginning in 2022, raising vehicle registration fees by 20 percent, and adding an annual surcharge to all electric or hybrid vehicles. When the plan is fully implemented in 2021, the CTF should increase by approximately \$59.5 million. This increase is a positive step forward, especially with the 11 percent increase of CTF appropriated for the LBO program in FY 2017, it may help reverse the trend of service cuts in some areas of Michigan.

The revenue increase in the CTF in FY 2017 also allowed for a 50 percent increase in the CTFs appropriated to match federal transit capital grants awarded to MDOT and individual transit agencies. Federal funds are needed to keep the current transit infrastructure in a state of good repair. Additionally, being able to provide the match allows Michigan to remain competitive in accessing available formula and discretionary grants from the Federal Transit Administration (FTA), including the FTA's Capital Improvements Grant program, which is a critical source of funding for BRT. However, the CTF increase is insufficient to fully support future expansion for local transit as well as all the other modes of transit that are dependent on the CTF. The revenue package, while creating a substantial one time increase to the LBO program in FY 2017, will not be able to keep pace with growth in demand for state operating assistance under the LBO program. This will be especially true if transit services expand in the southeast Michigan area under the leadership of the RTA.

CAPACITY AND CONDITION

Since 2009, local transit in Michigan has seen a 13 percent decrease in overall ridership numbers, as shown in Table 2 below. The ridership decline reflects decreases in both miles and hours of service (i.e., service cuts; however, ridership has declined more than service levels). Service cuts have been seen throughout Michigan, but cuts in southeast Michigan have the most significant impact on the overall decline.

TABLE 2: RIDERSHIP OF MICHIGAN'S 78 TRANSIT AGENCIES

YEAR	RIDERSHIP	OPERATING MILES	NUMBER OF VEHICLES	HOURS OF SERVICE
2009	99,640,358	99,256,007	2,979	6,378,746
2010	95,937,865	95,294,701	3,011	6,154,248
2011	96,306,968	91,597,572	2,968	6,097,452
2012	96,776,930	90,399,467	2,992	5,941,723
2013	94,847,672	88,026,144	2,968	5,747,478
2014	88,080,757	87,586,843	2,980	6,389,201
2015	87,012,000	90,208,209	2,980	6,062,619
2016	88,430,031	91,939,437	2,933	7,920,646

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Although this recent history shows negative trends, the trend is reversing. With the formation of the RTA, and more stability in local revenues (including the resolution of the Detroit bankruptcy and a significant millage increase for the SMART service area), ridership in the greater Detroit area is increasing. Specifically, the Detroit Department of Transportation (DDOT) has seen an increase in ridership of about 10 percent in the last quarter of 2015. With additional BRT routes coming on line, including in places like Grand Rapids, transit is becoming an increasingly viable and reliable transportation option, and is providing services to customers that five years ago was not available.

Michigan's transit agencies continue to utilize and maintain an aging fleet of vehicles to provide transportation services. The percentage of rural and specialized fleets that are past useful life has increased from 15 percent in 2014 to 35 percent in 2016. In urban areas, approximately 45 percent of transit agencies reported in 2016 the need to replace at least a few vehicles.

OPERATIONS AND MAINTENANCE

MDOT uses the Public Transportation Management System (PTMS) to collect service data as well as an inventory of local transit assets. Based on PTMS data, MDOT's Rural and Specialized fleets reported 35 percent of the fleets being past useful life as defined by the FTA. MDOT's goal is to keep less than 20 percent of the rural and specialized fleets past FTA useful life. Therefore, more work needs to be done. Urban agencies reported on average 27 percent of their fleets are past FTA useful life. Urban agencies set their own goals for fleet condition.

SAFETY

The MAP-21 federal transportation funding package requires FTA to develop safety performance criteria for all modes of public transportation (rail, bus, etc.). Both MAP-21 and the FAST Act require all recipients of FTA funding to develop agency safety plans that include performance targets, strategies, and staff training. The FTA has been issuing rulemakings in response to MAP-21 and the FAST Act's provisions. It will be several years before the impacts of these new requirements on Michigan's transit providers are fully realized.

Michigan's transit agencies experience about 10 collisions per million vehicle miles of bus transit travel, which is very low when compared to the national average. According to PTMS Safety Data from 2012 to 2015, there was a 30 percent decrease in property damage only (PDO) accidents, and PDO accidents greater than \$25,000 in damage stayed about the same at an average of about 11 percent.

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RECOMMENDATIONS TO RAISE THE GRADE

1. Continued investments in transit for rural areas and increased investment in urban transit systems is needed to continue properly serving the transportation needs of Michigan's citizens.
2. Increase the use of asset management principles by transit agencies, as required by MAP-21 and the FAST Act, with the specific requirements yet to be defined by the FTA.
3. Transit systems need funding to continue to improve reliability and to provide a wider range of service, especially as Michigan's population continues to grow. Additionally approximately 35 percent of existing fleets are past useful life as defined by the FTA. Therefore, in order to meet future growth and demand, Michigan's transit systems will require a combination of local, state, federal, and private investments, as well as financing strategies.

SOURCES

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WASTEWATER

GRADE: C

SUMMARY

Michigan is a water wonderland. It is surrounded by four of the five Great Lakes, and the state's 3,288 miles of shoreline are fed by 11,000 inland lakes, 51,000 miles of river systems and 6,500,000 acres of wetlands. It is essential that these valuable assets are protected, and our \$15 billion water economy is sustained by proper operation, maintenance, and rehabilitation of our wastewater infrastructure. Most wastewater facilities and infrastructure are buried, leading to lower priority of both funding and maintenance. The old cliché out of sight, out of mind is too often the approach to managing wastewater infrastructure.

Michigan has been making great strides in asset management through their Stormwater, Asset Management, Wastewater (SAW) grant funding, but should allocate additional funding for secondary treatment and conveyance system repairs, according to the 2012 EPA Clean Water Needs Survey. The EPA estimates \$690 million is needed for Michigan's secondary treatment, and \$702 million is needed for conveyance system repair/improvement needs. Additionally, the Michigan Infrastructure Commission (MIC) Report suggests that public health and safety could benefit by providing a uniform, statewide sanitary code that helps ensure safely operating septic systems. A statewide sanitary code does not currently exist in Michigan as it does in most other states.

BACKGROUND

On average, wastewater treatment facilities in Michigan are operating within their legal regulatory requirements. Operations and maintenance (O&M) staff are diligent in servicing and replacing equipment when needed. Effluent permit conditions are regularly met. However, many Water Resource Recovery Facilities (WRRFs) and virtually all the secondary treatment facilities in Michigan were built soon after implementation of the 1972 Clean Water Act. Many of these facilities are reaching their design 50-year service life and will require significant rehabilitation.

Approximately 30 percent of Michiganders are on septic systems and 130,000 (10 percent) of the State's 1.3 million septic systems are likely experiencing operational problems. Septic system failures often lead to untreated wastewater leaking into our soil and potentially into our groundwater. In 2015, according to MDEQ data, there were 4,138 septic failures reported to local Michigan health departments.



Historically, below-ground wastewater collection systems have received less attention than WRRFs and have only recently become a focus, particularly as sinkholes receive front page attention. Municipalities are beginning to increase their condition assessments of sewer systems and assign a standardized rating.

The estimated number and type of wastewater conveyance treatment facilities located in Michigan include:

MICHIGAN WASTEWATER INFRASTRUCTURE INVENTORY	
Municipal WRRF	247
Total WRRF	1,080
Lagoon System	232
Septic System [3]	1,300,000
RTB/CSO Facilities [8]	47
Miles of Sewer:	150,000

CONDITION

Several sanitary sewer condition data sets were consolidated to create the sample table below, which follow the NASSCO Pipeline Assessment and Certification Program (PACP) rating method. The miles of sewer analyzed in the table compose approximately 8 percent of the total miles of sewer in Michigan.

		LENGTH OF SANITARY SEWER	
		Length	Percentage
PACP SCORE:	Good - 0, 1, 2	1,630	81
	Fair - 3	253	13
	Poor - 4	70	3
	Failing - 5	53	3
		TOTAL LENGTH: 2,006 MILES	

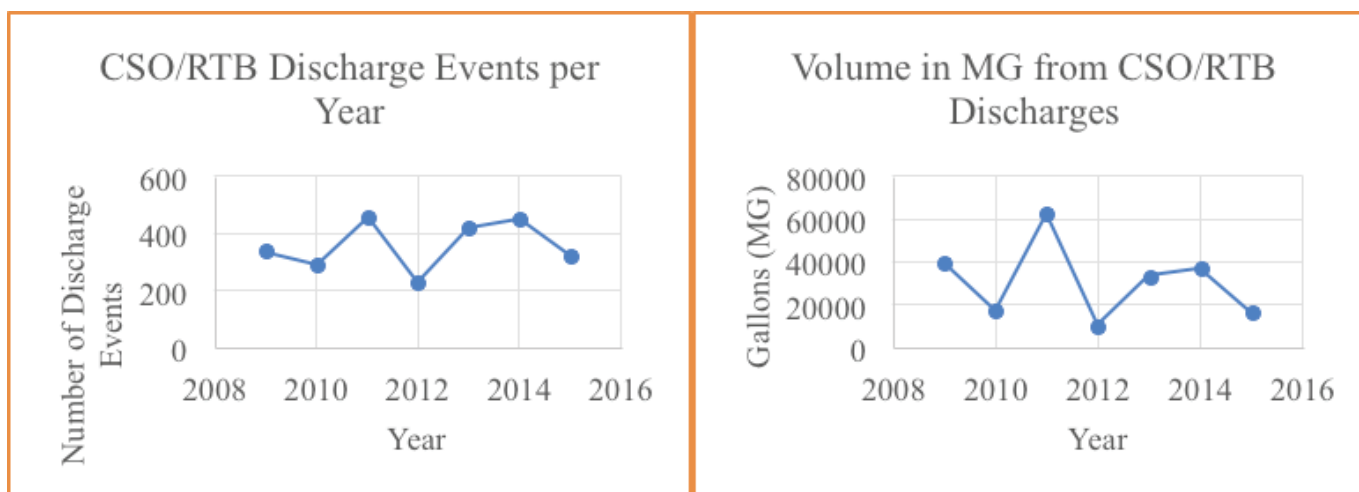
While the data from this small sample size indicates that 81 percent of the sewers inspected were in acceptable condition, many wastewater operators have not incorporated proper asset management practices into their public works activities. Asset Management Plans are an effective and increasingly utilized means for evaluating the condition of infrastructure. For those communities with a WRRF, Asset Management Plans are now a requirement of their National Pollutant Discharge Elimination System (NPDES) permit. As these assessment plans are prepared, actual conditions will become more apparent.



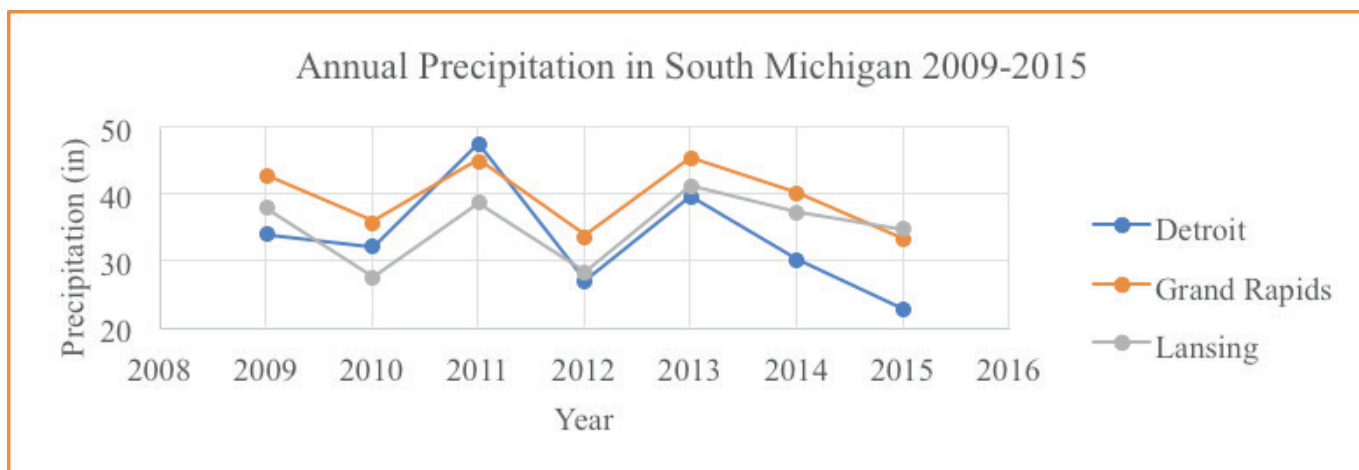
CAPACITY

Capacity is the amount of liquid (hydraulic capacity) and waste constituents (treatment capacity) the infrastructure can safely convey and treat. Almost all WRRFs in the state can effectively convey and treat dry weather flow. However, the same is not true for peak flow capacity when rainwater migrates into the collection system during wet weather events via infiltration and inflow.

According to the Michigan Department of Environmental Quality (MDEQ) CSO, SSO, and RTB 2015 Annual Report, Michigan has seen some varying amounts of CSO/RTB events from 2009-2015, with a peak occurring in year 2011, the year coinciding with the most rainfall. Combined sewer overflow (CSO) events occur when wastewater and stormwater drain into the same treatment system. Many of the state's sewer systems can experience capacity issues following heavy rain events, resulting in overflows. Deficient capacity has the potential to discharge untreated wastewater into our waterways, which makes it a key objective for the MDEQ to reduce these discharge events.



Source: MDEQ CSO SSO RTB 2015 Annual Report



Source: MDEQ CSO SSO RTB 2015 Annual Report



The total number of basement flooding events, which may also indicate capacity restriction, are occurring more frequently. Tens of thousands of basements flooded in Southeast Michigan during storms on May 26, 2011 and again on August 11, 2014. The frequency of extreme rain events, defined as greater than two inches in a single day, have increased by 89 percent between 1964 and 2013 and brings with it the increased risk of public health and safety concerns due to untreated wastewater discharges.

In recent years, an average of 5,750 Olympic sized swimming pools of untreated sewage flowed into Michigan waterways. Sixty-four rivers that drain 84 percent of Michigan's Lower Peninsula tested positive for human sewage. Nearly 25 percent of beaches experienced closures in 2015 and 20 percent of beaches in Michigan do not meet public health protection standards. In 2015, there were 324 reported CSO events discharging 16,205 million gallons of partially treated sewage. NPDES permit violations can result from facilities operating outside of their permit limitations. Within the last three years, there were 1,770 NPDES permit violations in the state of Michigan.

PERMIT VIOLATIONS WITHIN LAST 3 YEARS		PERMIT STATUS					TOTAL
		Admin. Continued	Effective	Expired	Not Needed	Terminated	
Permit Type:	Associated Permit Record:	--	--	2	--	--	2
	General Permit Covered Facility:	1	577	371	--	34	983
	NPDES Individual Permit:	1	299	232	1	252	785
TOTAL:		2	876	605	1	286	1770

Source: EPA Echo 1-17-2017

INVESTMENT AND FUNDING

Inadequate and inconsistent information on the condition of wastewater infrastructure and resources prevents system managers from developing sustainable funding models. In most cases, utility rate revenues do not adequately provide enough funding for all cost considerations of those utilities, most notably capital improvement and asset replacement costs. Investing in water and sewer infrastructure leads to lower maintenance and operation costs and supports the economy. According to the 21st Century Infrastructure Commission Report, every dollar spent on water and sewer assets can return up to \$2.03 in revenue.

Between 2010 and 2014, Michigan had the lowest national average annual state and local capital spending, which was an average of 6.4 percent of total expenditure annually between those years. Currently, Michigan has an estimated \$800 million annual gap in water and sewer infrastructure needs, compiled from decades of deferred maintenance and a lack of knowledge on the condition of our wastewater-related assets. Furthermore, it is estimated that \$25 million of state funds should be allocated annually for immediate public health risks and environmental emergencies due to failing wastewater infrastructure and \$780 million annually to upkeep failing septic systems that are approaching their 25-year design life.

The State Revolving Fund (SRF) program awards approximately \$200 million annually in low interest loans for renovation projects. The five-year SAW grant program, initiated in 2013, is providing \$450 million in grant funding of up to \$2 million per community to help fund the development of Asset Management Plans and the resulting facility replacement expense. As the SAW program closes, it is estimated that another \$400 million should be invested at a rate of \$8 million a year for five years to revamp the SAW grant program, by providing additional funding to assist wastewater utilities that have not yet established asset management plans. These

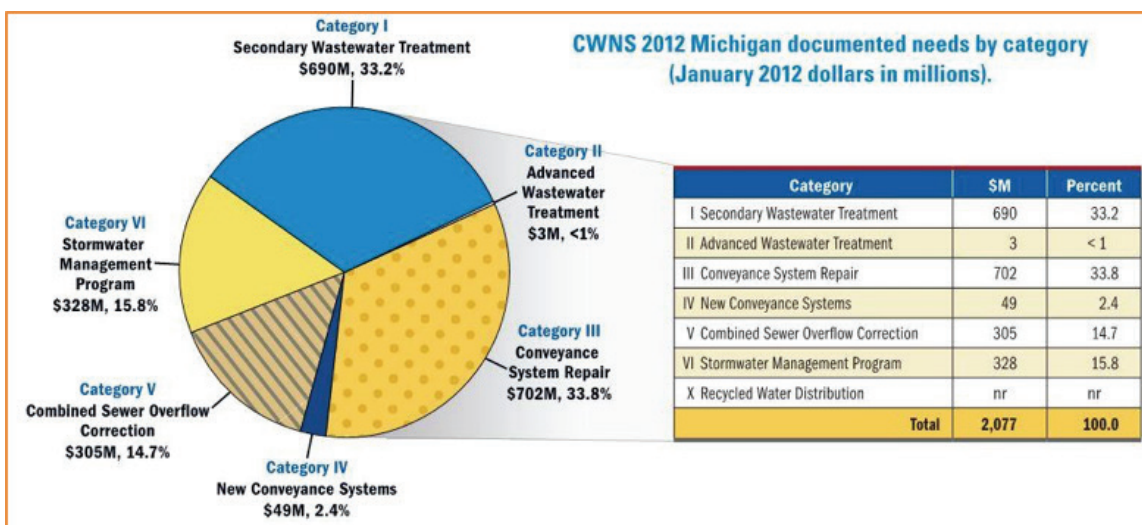


updates should ensure the condition assessments and asset management plans are developed in a manner that enables consistent reporting in a statewide asset management database system.

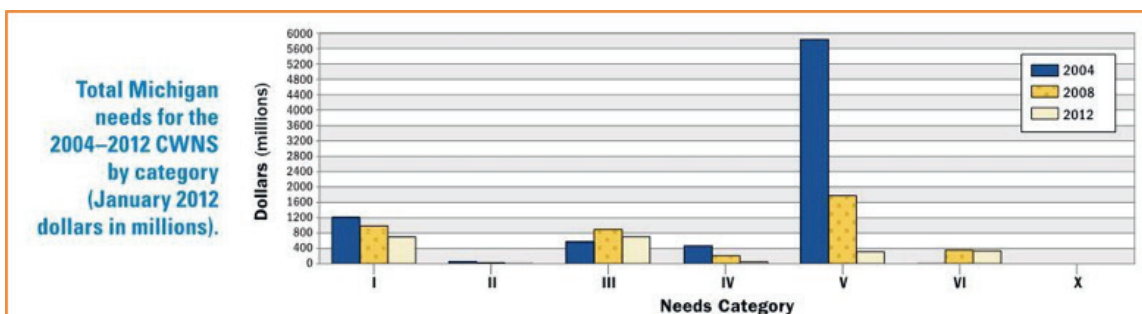
FUTURE NEED

Future need of wastewater collection and treatment systems can be represented as the projected amount of capital and rehabilitation investments which are needed to provide a safe, efficient, and dependable level of service. This can include wastewater treatment plant expansion and upgrades, sanitary sewer rehabilitation or replacement, expanded sanitary sewer service areas, and repair of failing septic systems.

According to the Clean Water Needs Survey for 2012 published by the EPA, Michigan has a projected need of \$2.077 billion to bring its wastewater collection, wastewater treatment, and stormwater systems to a dependable level of service. This equates to about \$208 per person.



Source: CWNS 2012



As indicated in the 2012 CWNS, essentially one third of the need is for treatment facilities and two-thirds for collection/conveyance systems. As permit required condition assessment continues, wastewater infrastructure needs and funding requirements will become much more apparent.

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INNOVATION

In response to aging facilities, retiring workforce, reduced funding, and other factors, the National Association of Clean Water Agencies (NACWA), Water Environment Federation (WEF), and Water Environment & Reuse Foundation formed a joint work group to assess how to address these problems. The concept of Water Resources Utility of the Future (UOTF) grew from that effort. A UOTF focuses on the potential products that can be produced or resources that can be recovered. The most common are nutrients, energy, and water. These organizations worked with wastewater agencies to create the Leaders Innovation Forum for Technology (LIFT), which is conducting technology evaluations and many other activities to promote and implement innovation.

Within the State of Michigan, the Water Resources Division of the MDEQ issued a grant to the Michigan Water Environment Association to assist with the development and implementation of recycling metrics for the wastewater community. This effort resulted in a one of a kind summit to introduce the UOTF concept, establishing benchmarks, and conducting the state's first energy survey of wastewater treatment plants.

More wastewater treatment facilities in Michigan are now utilizing cutting edge technologies, such as biogas energy generation and combined heat and power, to re-use wastewater and bio-solids to promote energy reduction and recovery.

RESILIENCE

Resilience of wastewater treatment facilities and collection systems is imperative to public health and safety as these systems protect the environment and are relied upon daily by millions of users.

In Michigan, resilience is mandated statutorily and built into each WRRF located within the state. This includes: process and equipment redundancy, dual power source or back-up emergency power generation, and construction of pumping and treatment facilities above the 100-year floodplain elevation. Each of these measures are part of the design process and/or the construction permit review process. Additionally, materials resilient to wear and corrosion, such as stainless steel, ductile iron, HDPE, polyethylene encasement, and similar measures are commonplace.

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RECOMMENDATIONS TO RAISE THE GRADE

1. Create a uniform, statewide sanitary code that helps ensure safely operating septic systems.
2. Ensure that condition assessments and asset management plans are developed in a manner that enables consistent reporting in a statewide asset management database system.
3. Allocate \$25 million of state funds annually for immediate public health risks and environmental emergencies due to failing wastewater infrastructure.
4. Allocate \$780 million annually to upkeep failing septic systems that are approaching their 25-year design life.
5. Invest another \$400M at a rate of \$80M/year for five years to revamp the SAW grant program by providing additional funding to assist wastewater utilities that have not yet established asset management plans.

DEFINITIONS

Combined Sewer Overflow (CSO) – An event resulting from combined storm and sanitary sewers being unable to accommodate the flow because of an exceeding of their capacity and untreated sewage is discharged into the environment prior to reaching sewage treatment facilities.

Sanitary Sewer Overflow (SSO) – An event where untreated sewage is discharged from a sanitary sewer system into the environment prior to reaching sewage treatment facilities.

Water Resource Recovery Facility (WRRF) – Traditionally known as a wastewater treatment plant; facility that provides physical, biological, and chemical treatment of wastewater to remove contaminants prior to discharging waters into the environment.

Clean Water Act of 1972 – The primary federal law in the United States governing water pollution; establishes the basic structure for regulating discharges of pollutants into waterways and regulating quality standards for surface waters.

Retention Treatment Basin (RTB) – Facility that receives excess combined sewage flow during wet weather events where the sewage is stored, screened and/or settled, and disinfected prior to discharge.

National Association of Sewer Service Companies (NAASCO) – Organization that set industry standards for the assessment, maintenance, and rehabilitation of underground infrastructure.

National Pollutant Discharge Elimination System (NPDES) – Permit program created in 1972 by the Clean Water Act that helps address water pollution by regulating point sources that discharge pollutants to waterways.

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