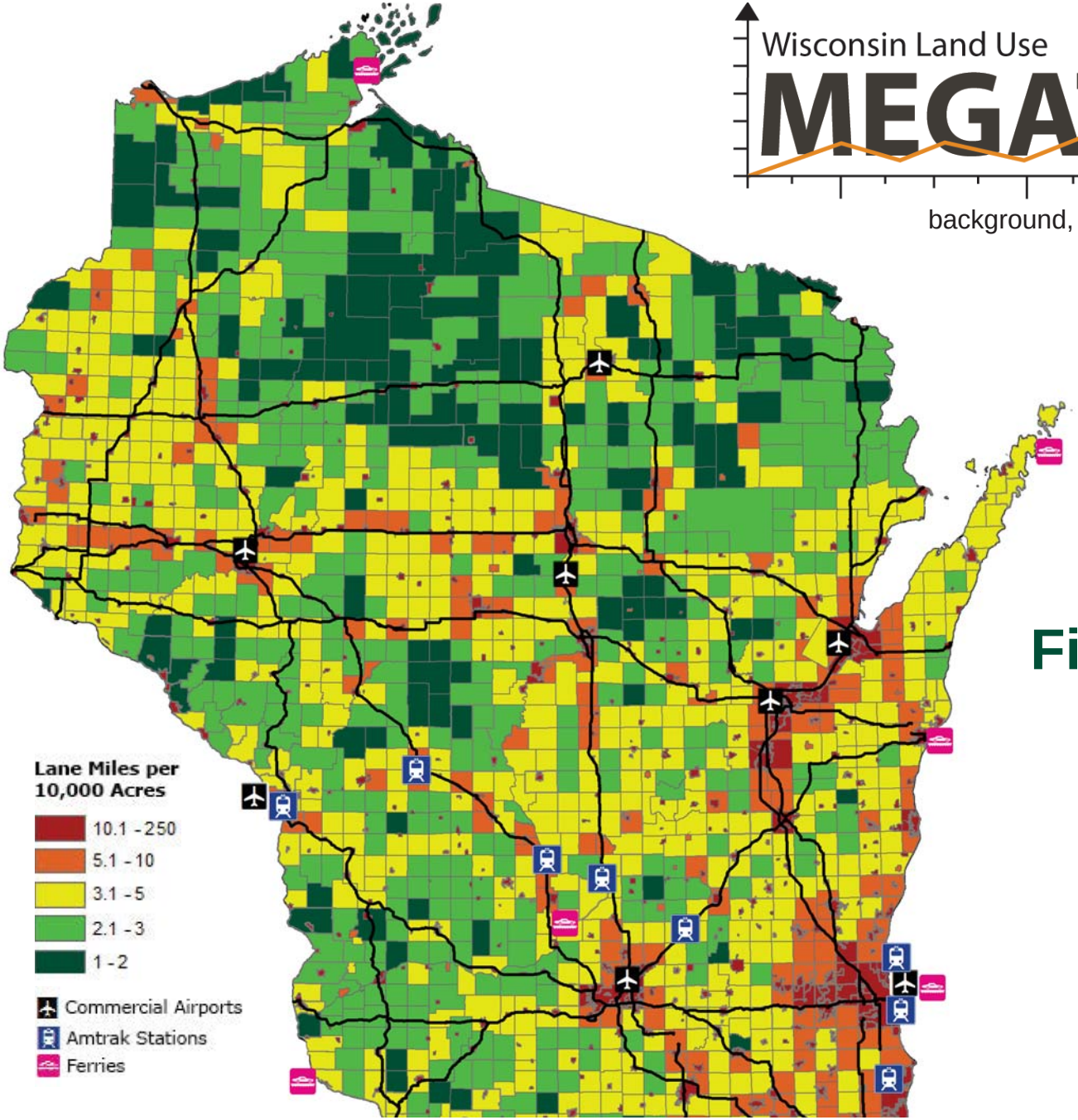
Winter 2017

Wisconsin Land Use

MEGATRENDS

background, impacts, policy...information you need to know



Find Your Community

How much of your community is covered by roads?

TRANSPORTATION

Introduction

How much time do you spend traveling to work, school, and recreational pursuits? How do you and other people in your community get from one place to another? How are goods transported in your community and throughout the state? What percent of your family budget is spent on transportation? How much does your community spend on road construction, maintenance, and snow removal? What is the impact of transportation on individuals, businesses, communities, the environment, and the state?

In this edition of Megatrends, we address these and other questions by taking a closer look at statewide land use and transportation trends. We provide a timeline of Wisconsin's transportation history and discuss how people and goods move around, how different users rely on the transportation system, and the impact of transportation on the economy, environment, and human health. Through case studies, we examine how land use and transportation policies can be used to shape local communities. Lastly, we look at emerging trends likely to take hold in the future.

Figure I1 illustrates the relationship between land use and transportation. State and local transportation policies affect our personal transportation experiences and local decisions about land use. Likewise, choices about where to live and how to build our communities impact how we invest in roads, highways, and transportation infrastructure. Transportation and land use work together to shape our communities.

Figure I1
Land Use and Transportation Relationship

History

How people travel and how goods are transported have changed throughout Wisconsin's history. In the 1600's French explorers used waterways to travel to and through Wisconsin. Rivers and the Great Lakes remain important modes for transporting goods – from logs in the 1800's to a variety of cargo today. The Northwest Ordinance of 1787 and the survey of Wisconsin that started in 1832 opened up Wisconsin to settlement from the eastern United States. Immigrants came by ship, steamboat, railroad, horseback, and wagon.[I1] In the early 1900's transportation expanded to include cars and planes. With these new technologies, community development patterns shifted to accommodate new roads, highways, and airports. Over a period of decades, heavy reliance on roads and automobiles led to more dispersed land use patterns and development of many small and mid-sized communities throughout Wisconsin. The ease of commuting to jobs and services from rural and suburban areas has left many cities grappling with disinvestment, a loss of affluent homeowners, and opportunities for infill and redevelopment. The timeline at right illustrates important milestones in Wisconsin's transportation history.

Figure C1
Wisconsin Transportation Routes

The cover map illustrates the density of transportation routes in Wisconsin and the location of major highways, airports, ferries, and rail stops. This analysis takes into account total lane miles and the length of those lanes. Not surprisingly, areas of the state with the densest population have the highest density of lane miles.

Transportation Timeline

1783
Transportation by trails and waterways

1834
Steamboats on the Mississippi and Great Lakes open Wisconsin to settlement

1836
Public petition to territorial legislature to start rail project for lead mining route

1844
Merrimac Ferry Service begins first river waterway crossing

1847
Stagecoach mail service begins

1851
First train on the Milwaukee-Waukesha line

1857
Lake Michigan to Mississippi rail line completed

1871
Wisconsin Central Railroad builds first line from Menasha to Stevens Point

1873
First steam powered vehicle designed and operated in Wisconsin

1890
Around 1,000 people own bicycles

1900
Gas stations begin to replace livery stables

1901
Legislature authorizes counties to construct bicycle paths along public roads

1902
Production of Ramblers begins in Kenosha

1903-4
Harley Davidson produce first 6 motorcycles

1911
Mitchell-Lewis Motor Co. becomes largest employer in Racine.

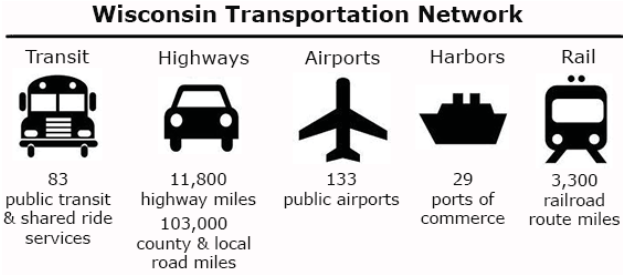
State Aid Road Law authorizes roads paved with gravel

Movement of People and Goods

Transportation Infrastructure

From roads and highways to airports and rail, Wisconsin has many forms of transportation. Figure M1 illustrates the extent of Wisconsin's transportation system in 2012. Excluding the construction of additional highway lanes, state highway miles have remained relatively constant since the 1950s. Meanwhile, county and local road miles have increased.

Figure M1[1]
Wisconsin Transportation Network



Evolution of the Street Network

As roads have been built, the pattern of those roads has changed to accommodate automobiles and suburban living. As shown in Figure M2, the rectilinear grid pattern common in most cities at the turn of the century has been replaced by fragmented, curvilinear streets and cul-de-sacs. Street patterns B and C emphasize cars and driving, which in turn increases traffic on major roads and decreases walking and biking.[M2] There has been much discussion to return to "traditional neighborhood design" with a focus on connectivity and human-scale design. Pattern D shows a grid-like pattern with access for cars through alleyways and pedestrians via sidewalks. Street patterns B and C continue to be used in new developments, despite their impacts on mobility, traffic and accessibility.

Figure M2
Evolution of the Street Network[M2]

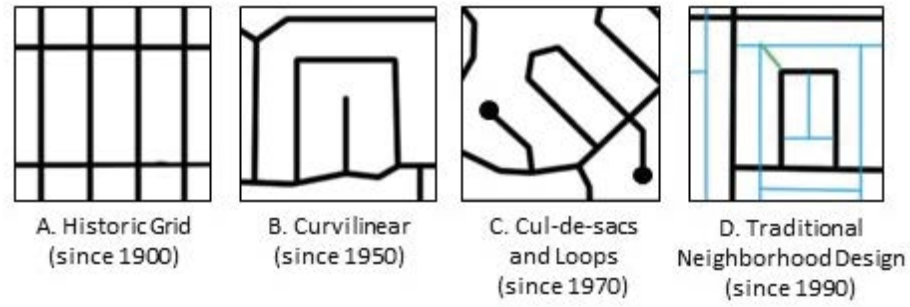
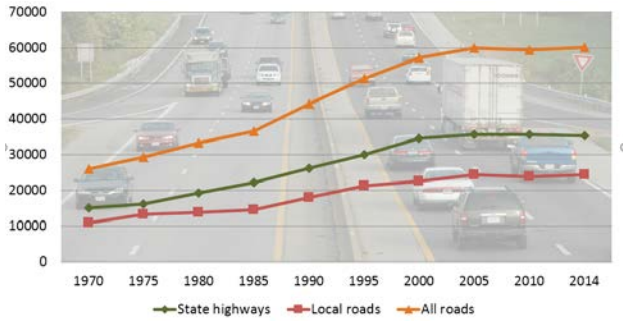


Figure M3
Annual Vehicle Miles Traveled 1970 - 2014[M3] (in millions)



Movement of People

One way to examine roads and driving is to look at vehicle miles traveled (VMT). VMT is an indicator of how much people drive. Figure M3 illustrates an increase in vehicle miles traveled from 1970 to 2014. Annual VMT increased by 40% from 1985 to 2005, while population increased by 23%.[M4] Since 2006 VMT has plateaued. VMT may continue to plateau or even decline in the future due to an aging population, saturation of the market for vehicles, and stabilization of alternate modes of travel.[M4]

1917
The 5,000 mile state trunk highway system established

1919
Butler Airport, first Wisconsin airport, opens in Milwaukee

1930
Kissel Kar closes due to the Depression

1942
250,000 bicycles used in Wisconsin

1947
State trunk highway system enlarged to 12,000 miles

1955
Nash and Hudson merge to form American Motors Co.

1965
Air Wisconsin, largest regional airline in US, founded by local investors in Appleton, WI

1950's-1970's
Bicycles become a major means of short trips and recreation in Wisconsin

1974-75
WISDOT and Phase II start rails to trails program with Elroy-Sparta trail

1988
Automobile assembly ends in Kenosha

2005
Milwaukee Airport Rail Station, first passenger rail-to-airport link in Midwest, opens at Mitchell International Airport

2009
Janesville GM Chrysler plant closes

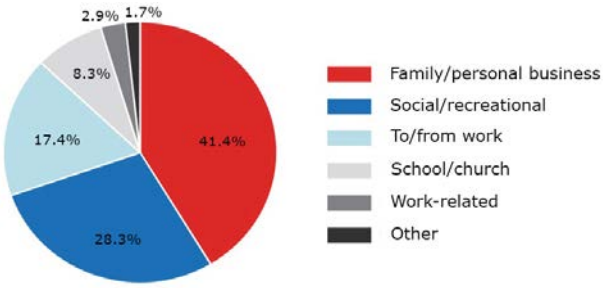
2013
Merrimac Ferry, the only WI river ferry, carries almost 271,000 vehicles annually

2016
Wisconsin Clean Cities announce first electric vehicle group buy, Rev Up Wisconsin

See references for photo credits

4 TRANSPORTATION

Figure M4
Percentage of Passenger Travel By Trip Purpose, 2009[M5]

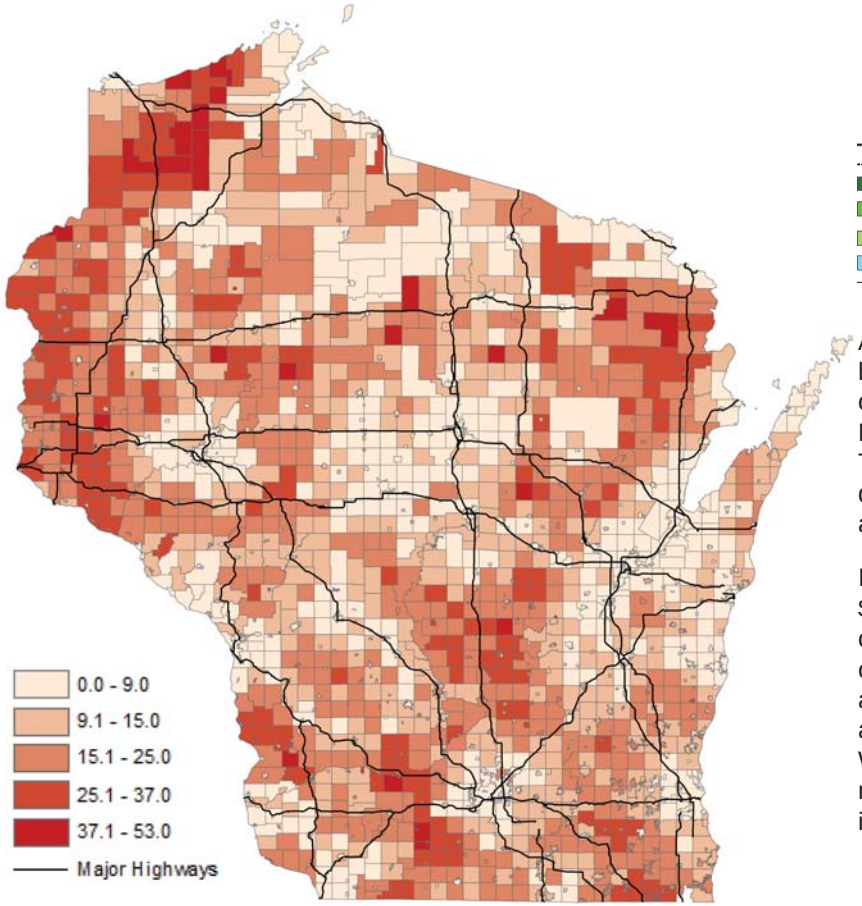


To understand travel behavior, transportation planners and others look at annual VMT in terms of the purpose of trips. Figure M4 shows the percentage of trips made in Wisconsin by purpose.[M6] Roughly two out of every three trips is made for personal, social or recreational purposes. Close to one in three is made for work or school.

Data is also available on how people travel to work. Four out of five Wisconsin workers (80%) use a personal automobile, which is slightly higher than the national average (76%). The remainder carpool (8%), walk or bike to work (4%), take public transit (2%), or work from home (4%).[M7]

Figure M5 shows the number of commuters that spend more than 45 minutes traveling to and from work. The dark red areas are places where residents spend from 37 to 53 minutes commuting to work. A higher percentage of people who live outside of cities in rural and suburban areas have commutes greater than 45 minutes. Most of these people are leaving the community where they live to work in another community.

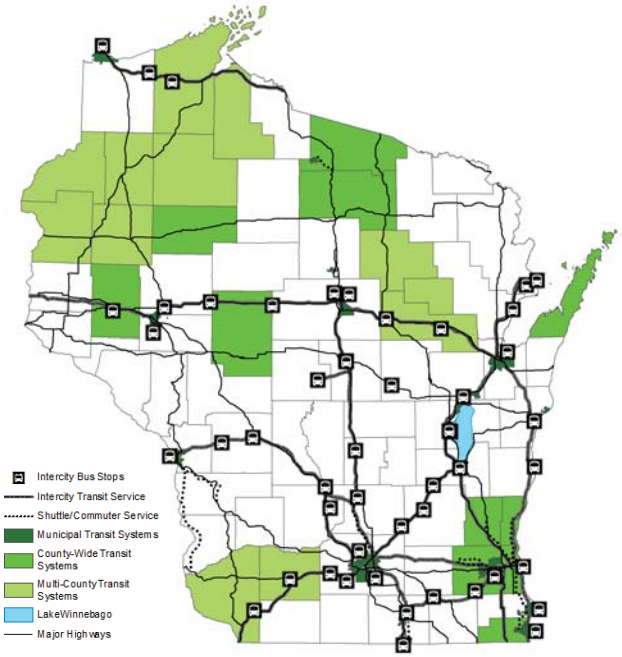
Figure M5
Percent of Population Commuting Greater than 45 Minutes



Public Transit

Federal, state, and local governments work together to plan, finance and operate a diverse array of transit services in Wisconsin. In 2015, there were 18 urban bus systems (population 50,000 or greater), 16 rural or commuter bus systems, and 49 shared-ride taxi services operating in Wisconsin.[M8] Seventy-four of these systems are publicly funded.[M9] Figure M6 shows where these systems are located.

Figure M6
Wisconsin Public Transit Systems, 2016



Approximately 48% of Wisconsin transit riders are headed to work, 23% to school, 18% to retail, tourism or recreational destinations, and 10% to health care.[M9] Many people are considered “transit-dependent.” These include the young and elderly, people with disabilities, low-income individuals, and people without a driver’s license or car.

In 2015, Wisconsin’s local transit systems cost over $300 million to operate. Twenty-eight percent of costs are covered by fares. The remaining costs are covered by federal grants (20%), state grants (35%), and local sources (17%).[M9] A study conducted in 2003 and updated in 2006 found that public transit saves Wisconsin riders and taxpayers an estimated $730 million annually. Every dollar a local community invests in public transit results in a three-dollar return.[M9]

Movement of Goods

While residents and visitors use Wisconsin's transportation infrastructure, businesses also rely on it. It is estimated that household travel accounts for 76% of all vehicle miles traveled on U.S. roadways, while public and commercial travel account for 14%, and movement of goods and freight accounts for 10%.[M10]

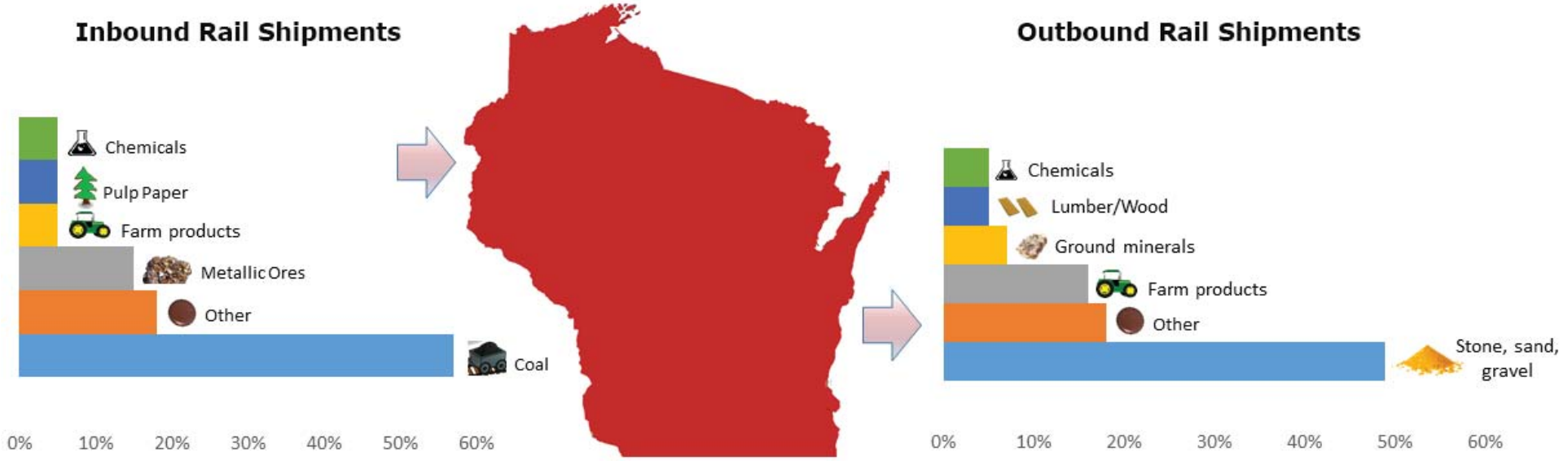
Figure M7 shows commercial shipping in Wisconsin by mode. Truck is the dominant mode of freight transportation, carrying nearly 60% of all freight by weight and 70% by value. Rail is second, carrying 36% of freight by weight and 28% by value. A small portion of freight is also transported by water, air and other means. Wisconsin DOT projects that freight shipments will nearly double over the next three decades. By 2040, over 1 billion tons of freight may be transported through the state at an estimated value of nearly $1.5 trillion.[M11]

Figure M8 takes a closer look at Wisconsin freight movement by rail. By weight, coal makes up nearly 60% of freight shipped into the state by rail. Roughly 80% of coal comes from Wyoming, and the majority is used for electrical power.[M12] Stone, sand and gravel account for nearly half of the freight shipped out of the state. This reflects that Wisconsin is the primary source of sand in the nation for hydraulic fracturing. As of 2014, there were 63 mining, 45 processing, and 27 rail loading facilities in Wisconsin, and most were involved in the frac sand industry.[M12] Given the decline of the sand industry as of 2016, the amount of sand shipped by rail has likely changed. Since 1985, total rail movement in Wisconsin has increased by roughly 23 million tons. Yet, total rail lines decreased from 7,500 miles in 1920 to 3,300 miles in 2016.[M13]

Table M7
Domestic Freight Shipments by Weight in Millions[M10]

Mode	Millions of Tons			Percent Change	
	2013	2021	2040	2013-2021	2013-2040
Train	206.9	249.8	351.6	21%	70%
Truck	341.1	421.9	613.9	24%	80%
Boat	28.3	30.1	34.3	6%	21%
Airplane	0.1	0.2	0.4	75%	253%
Other	0.1	0.1	0.2	29%	98%
TOTAL	**576.5**	**702.1**	**1,000.4**	**22%**	**74%**

Figure M8
Wisconsin Rail Shipments by Weight, 2012[M12]



Social Aspects

This section explores some of the social aspects of transportation, including the travel needs of different age groups and the challenges of providing transportation to rural and disadvantaged populations. Figure S1 highlights important modes of travel to each of these groups and some of their concerns.

Planning for All Ages

Wisconsin is facing an "age wave," meaning the number of adults over the age of 65 is expected to nearly double by 2040. In contrast, the number of children and working age adults is expected to remain relatively constant.[S2] By 2040, nearly one in four Wisconsin residents will be over the age of 65. Growth in the elderly population is concentrated in northern Wisconsin and parts of central Wisconsin.

Most older adults express a strong desire to "age in place," meaning they want to continue living in their own homes and communities. This will present a range of transportation, housing and human service challenges for local governments. If seniors do not have safe, convenient and affordable travel options, they may face isolation, reduced quality of life, economic hardship, and difficulty accessing services.[S3]

For most seniors, the use of a personal vehicle is the single most important factor in maintaining an independent way of life. Personal vehicles account for more than 80% of trips made by older adults.[S4] Seniors who no longer drive report making 15% fewer trips to the doctor, 59% fewer trips to shop or eat out, and 65% fewer trips to visit family and friends.[S3] Long before older adults stop driving, they often begin to "self-regulate," which means they change where, when and how frequently they drive.[S5] They also stop walking, avoid taking public transportation, and rely increasingly on family and friends to get around. Because safety and disability concerns increase with age, the demand for accessible transportation is expected to grow.[S4]

Figure S1
Different Users Rely on Transportation in Different Ways[S1]

Travel patterns and preferences vary by generation. Just over a quarter of Wisconsin's oldest and youngest adults (those ages 16-24 and 85+) do not hold a license. This compares with less than 10% of the total population.[S6] Young adults, which are part of the Millennial Generation, are more likely to live in urban areas[S7] and to opt for transportation alternatives such as walking, biking, car-sharing, public transit, telecommuting and shopping online.[S8] Reasons are varied but include low wages coupled with high debt, high costs of car ownership, availability of transportation alternatives, and concern for the environment.[S8]

Middle age groups, including Generation X and the Baby Boomers are the most auto-oriented of all generations. They tend to gravitate toward rural and suburban communities and are concerned with neighborhood safety, schools, and their ability to access work, recreation, and essential services.[S7] From a planning perspective, efforts focused on complete streets, safe routes to school, universal design, livability and accessibility can help to address needs across all ages.

Planning for Rural Communities

Where a person lives determines the amount of time and resources they spend on travel, and their ability to access public transportation. As shown in Figure S2, 56% of people live in an urbanized area, 14% in small and mid-sized urban communities, and 30%

in rural areas.[S9] Combined, urban areas take up just 4% of all land but contain 70% of Wisconsin's population. Figure M6 on page 4 shows the percent of Wisconsin workers that commute more than 45 minutes to work. Roughly 40% of Wisconsin's land area has high commute rates with more than 30% of the flow to an urbanized area.[S10]

Because of their lower densities, rural and suburban areas tend to be more automobile dependent than urban areas. Providing transportation services in rural areas presents barriers due to low population sizes, large service areas, and long travel distances.[S11] Over time, many rural communities have lost public facilities such as schools, healthcare centers, and stores. Providing regional transportation networks, including regional buses and shared ride taxis, is particularly important in order to provide rural and suburban residents with access to a full range of employment, medical, shopping, and recreational opportunities.

Planning for the Transportation Disadvantaged

Accessibility refers to a person's ability to reach goods, services and activities.[S1] Accessibility is a crucial need for all individuals, but it is especially important for those who are transportation disadvantaged due to age, disability or income.

Twelve percent of Wisconsin residents report having a disability and disability status increases with age.[S12] Twenty-two percent of those ages 65-74 and 47% of those over the age of 75 have a disability. Roughly half of people with a disability report having an ambulatory disability, meaning difficulty walking.[S12] Walking can become a barrier when required to connect with other modes of transportation.[S5] Improvements in the pedestrian network, including sidewalks, curb ramps, accessible bus stops, traffic signals, and snow removal can assist all travelers in getting around, regardless of physical ability.

"Some people who are willing and able to work cannot do so because of inadequate transportation. Others cannot shop, socialize, enjoy recreational or spiritual activities, or even leave their homes. And some individuals with disabilities who need medical services must live in institutions due solely to the lack of safe, reliable transportation."[S15]

The Americans with Disabilities Act and most federal and state funding sources require transportation programs to consider the needs of people with disabilities. This means providing safe and accessible walking, biking, rolling and public transportation options. If communities provide public transit, they are also required to provide complementary paratransit services designed to accommodate people with disabilities. However, even when public transit and paratransit services are provided, many individuals with disabilities report using a personal automobile to get around.[S5] This is particularly true for older adults.

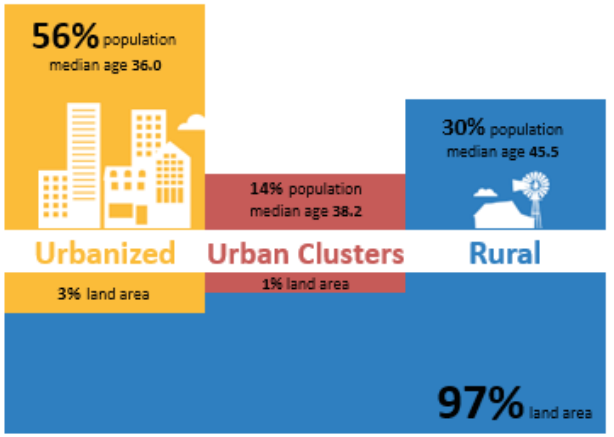
Transportation programs that receive federal funding are required to prepare a locally adopted coordination plan that is updated once every four to five years. The plan must address how transportation providers will coordinate with medical, educational, workforce development, and human and social service agencies to effectively respond to local accessibility needs. Wisconsin has developed a toolkit and model planning process for transportation coordination.[S13]

To support coordination efforts, Wisconsin has developed a network of about 40 mobility managers that teach people how to use public transit, coordinate trips between agencies, manage volunteer driver programs, and provide access to other services.[S11] Transportation coordination and mobility management help to meet the needs of all users by encouraging more efficient and effective use of existing transportation services and providers.

Creating Accessible Communities

Many communities are moving away from conventional forms of transportation planning, which place the automobile at the center of the transportation system, to accessibility-based planning which places people at the center. Accessibility varies by community but is generally defined by:

Figure S2
Population density and age varies throughout urban, suburban and rural areas of Wisconsin[S9]



- Local and regional transportation systems that serve rural, urban and suburban communities.
- Land use and transportation policies that consider the placement and connectivity of major housing, shopping, healthcare, and activity centers.
- Infrastructure and facilities that are designed to accommodate users of all ages, abilities, and modes of travel (i.e. bike, pedestrian, automobile and transit).
- A range of transit services appropriate for the size and needs of the community (i.e. fixed route, flexible, and paratransit services).
- Travel information and assistance appropriate for all users, including the elderly, low-income, and mobility impaired.

The U.S. EPA has developed a smart growth self-assessment tool to help communities evaluate how well their policies support the types of land use and transportation patterns they desire.[S14]

Land Use Policy

The connections between land use and transportation are complex. Land use patterns, including the density and placement of homes, businesses and other uses, and the connections between those uses, impact travel demand. In other words, how we build our communities impacts where we travel, how frequently we need to travel, and our mode of travel. Investments in the transportation system including roads, highways, parking, transit facilities and other infrastructure also influence development patterns, creating a feedback loop.

Figure P1
Highway 53 corridor in the City of La Crosse (top) reenvisioned as a green complete street (bottom).

Photos courtesy of SEH

As communities evolve, local governments can encourage the development of physical characteristics that accommodate the needs of all users throughout all stages of their lives. In urban areas, a livable community might mean high-density, mixed-use development in close proximity to public transit. In smaller communities, livability might be fostered by developing an interconnected network of streets and sidewalks that encourage walking and biking. In rural areas, greater access to regional transit and paratransit services may be needed to provide residents with access to essential services. The following case studies highlight communities that are actively investing in planning, design, infrastructure, and services as a means to create more livable and economically vibrant communities.

La Crosse Complete Streets

The City of La Crosse is located in western Wisconsin between the bluffs of the Mississippi River Valley. It is a great place to live, work and play, with many scenic hiking and biking trails, a lively downtown, historic neighborhoods, and an annual bicycle festival. Not unlike other cities of its size, walking and biking in many areas means crossing high-volume, multi-lane streets. In 2010, the city and county set out to make streets more accessible to all users. Using a grant from the Centers for Disease Control, the county hired a bicycle and pedestrian coordinator and began to educate local communities, businesses and residents about the benefits of complete streets.[P1]

Complete streets are designed to enable safe access for all users, regardless of age, ability, or mode of travel.[P2] In 2011, La Crosse County became the first county in the state to adopt a complete streets policy. Local cities and villages including Onalaska, West Salem and Holmen also adopted local policies. The City of La Crosse took it one step further by adopting a Green Complete Streets Ordinance. The ordinance requires that bicycle, pedestrian, and transit needs be considered when building or reconstructing streets. Stormwater best management practices must also be included when appropriate. As shown in Figure P2, the city reviews all projects across five categories and must provide justification if a project is unable to meet the criteria.[P3]

As part of its broader planning efforts, the city has documented baseline conditions and measures progress towards those goals. As a result of the county and city's complete streets efforts, bike counts doubled countywide, and 64 Share the Road signs, 100 bike

Figure P2
Review Criteria for La Crosse Green Complete Streets[P3]

Rublee Street from Onalaska Avenue to George Street

Description: Narrow 3 of 4 blocks from 32' to 28'. Widen N. Blvd so all 4 blocks will be 28'. Add 150' of sidewalk on south side of street. North side already has sidewalk. Restore boulevard.

Exemptions: Only adding sidewalk near trail. ROW width over rest of project is too narrow.

X - Existing A - Adding with project NA - Not applicable

Bike	
Designated bike lane	
Shared bike signage	
Bike boulevard	
Bike parking	
Low speed and volume	X

Pedestrian	
Sidewalks	A
Accessible ramps	A
Cross walks	
Bump outs/refuge island	
Raised intersection	
Signalized	
Adequate to use street	

Transit	
Transit facilities	NA
Transit signage	NA
Pavement thickness	NA

Traffic	
Bump-out	
Narrow lanes	A
Surface treatment	
Speed tables	
Chicane	
Meets functional group	

Storm water	
Bio-cell	
Porous pavement	
Narrow street and/or wide boulevard	
Swale	
Regional treatment	

Other	
Street furniture	
Street trees	
Planting strips	

"In order to protect and enhance our regional economy, quality of life, natural environment, aesthetics, human connections, and safety… the city envisions changing policies, practices, and the physical design of its streets, highways and parking infrastructure… to reduce dependency on the single occupant vehicle… and prioritize cycling, walking, public and private transit, and telecommuting".[P4]

City of La Crosse, Transportation Vision, 2015

parking spaces, and 17.5 miles of shared lanes and bike lanes were added by 2014.[P1] Partners in the complete streets efforts include local municipalities, the metropolitan planning organization, local non-profit and service agencies, two major health systems, and local schools, colleges and universities.

Multi-County Transit in Northern Wisconsin

Bay Area Rural Transit (BART) has been providing safe, convenient and affordable transportation to Chequamegon Bay residents for 35 years. Headquartered in Ashland, Wisconsin on the south shore of Lake Superior, the public transit commission operates in partnership with 17 local units of government. BART provides daily fixed route service in the City of Ashland, demand-response service in the cities of Washburn and Park Falls, and a 52-mile commuter route connecting the cities of Ashland, Washburn and Bayfield with the Bad River and Red Cliff Indian Reservations.[P5] Connections are also made to smaller communities throughout Ashland, Bayfield, and northern Price County. A certified mobility manager is available to provide training and connect riders with the most appropriate routes and services. BART coordinates services with county and tribal aging units, transportation departments, health and human service departments, hospitals, a non-profit developmental disabilities center, and the local university. A fleet of about a dozen small and mid-sized buses are equipped with wheelchair lifts and bicycle racks. Eighty percent of all residents live within walking distance of a BART route. Riders include students, adult commuters, seniors, and individuals with disabilities. BART's $1.4 million annual operating budget is funded using a combination of federal grants (43%), state grants (17%), local budgets (26%), and rider fares (14%).[P6]

Figure P3
Bay Area Rural Transit

Bay Area Rural Transit attempts to incorporate sustainability into its operations. In 2008, BART passed an Energy Independent Community resolution pledging to generate 25% of its electricity and transportation fuels from renewable resources by 2025. In 2010, it purchased the first hybrid bus in the state, and in 2013, it completed a new transit facility incorporating energy efficiency measures.[P7]

Regional Bicycle Network in Jefferson County

Jefferson County is a non-metropolitan county located within the Madison, Milwaukee and Chicago metropolitan triangle. It is home to the TREK Bicycle Corporation and is a regional destination for bicycling enthusiasts. Since at least the mid-1990s, Jefferson County has recognized bicycling as a major recreation, tourism, and economic development tool. The county's commitment to bicycling is expressed in three major plans: the County's Comprehensive Plan, Park and Recreation Plan, and Bicycle and Pedestrian Plan.[P8] Walking and biking trails also serve as key connectors in the DNR's Glacial Heritage Area Plan.[P9] A network of parks, natural areas, and historic and cultural sites are described in this plan as a series of "pearls on a string" connected to each other and nearby cities and villages through a network of multi-use trails and waterways. In 2005, UW-Madison researchers estimated that up to $32 million in total value-added income and 1,028 jobs could be generated from park and trail investments in Jefferson County.[P10] The County has used a combination of local, state, federal and private dollars on targeted planning, land acquisition and facility improvements to build this network. Key collaborators include county departments, UW-Extension, Wisconsin DNR and DOT, private consultants, local cities and villages, Jefferson County Economic Development Consortium, local bike clubs, and several major corporations including TREK, WE Energies, and Fort Healthcare.

Figure P4
Glacial River Trail, Jefferson County

The Glacial River Trail in Jefferson County got started in 1995 with 6.5 miles of paved trail on a former railroad site along Highway 26. It has since expanded to include 16 miles of paved, off-road trails and 17 miles of designated road routes.

"Jefferson County's system of large parks, extensive trails, and natural areas gives form to our communities and the rural landscape and integrates important cultural features. [It] is fundamental in creating special places to live with natural and rural character, vital and distinctive communities, and working farms."

Jefferson County Parks, Recreation and Open Space Plan, 2013

Economics

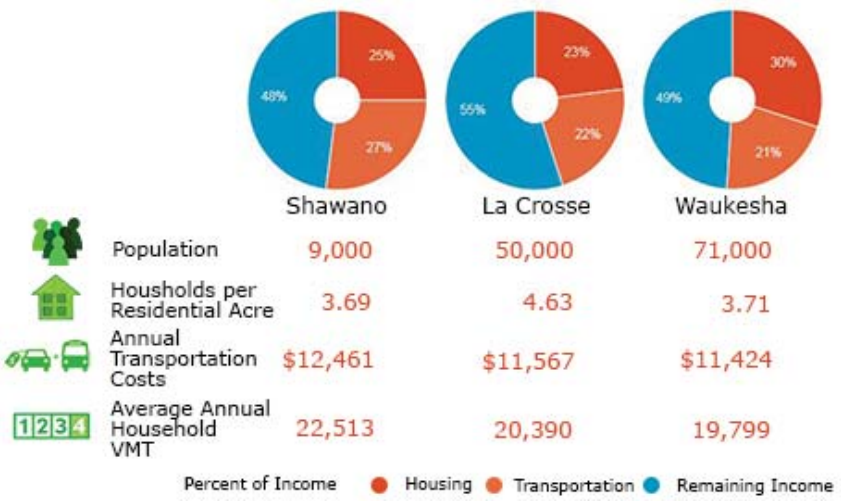
The vehicles and infrastructure that move people and goods have costs that are shouldered by households, businesses, and government agencies. We pay directly for our own transportation in the form of vehicle and fuel costs. The public also pays indirectly in the price of goods and services and taxes and fees that go toward public investment in public transportation. Local government spending on transportation includes the costs of building and maintaining roads, infrastructure and transit services. Given that capital investments in buildings and transportation have long lives and lasting impacts on accessibility and economic opportunity, coordinated planning for land use and transportation is important.

Household Costs

The average American household of 2.5 people owns 1.9 vehicles and spends roughly $9,000 on transportation each year.[E1] This equates to 17% of total spending and includes $3,270 on vehicle purchases, $2,610 on gas and oil, $2,580 on vehicle expenses, and $540 on public transportation. Americans spend more on transportation than they do on food ($6,600), personal insurance and pensions ($5,530), and healthcare ($3,630). Housing is the only category of spending that rivals transportation. In 2013, the average American spent $17,150 on housing, which equates to 33% of all spending. Together, housing and transportation account for more than half of all household spending.

Figure E1 shows sample housing and transportation costs for three Wisconsin cities. The Department of Housing and Urban Development recommends that housing costs not exceed 30% of household income. The Center for Neighborhood Technology provides an alternate measure of affordability based on the combined costs of housing and transportation.[E2] Compared to the nation, housing costs in Wisconsin are relatively low, but transportation costs are high. In choosing where to live, households must make trade-offs between housing costs and location, transportation options, access to jobs and services, and desired community amenities.

Figure E1
Housing and Transportation Costs as a Percent of Household Income[E2]



Choices about where to live and how a person travels are related. Some communities provide a range of transportation options including walking, biking, and traveling by car, bus or other means. Residents of rural and suburban communities tend to be more limited in their travel options and may need to travel longer distances to reach jobs and services. As a result, household transportation spending tends to be lowest in central cities and highest in suburban and rural communities. Rural and suburban households typically own one additional car and pay as much as $2,500 more in transportation costs than their central city counterparts.[E1]

Business and Commerce

Individuals, families, businesses and industries all rely on transportation. Transportation provides direct employment and is a key component in supporting employment. In Wisconsin, 208,000 people are employed directly in transportation and material moving occupations.[E3] An additional 1.4 million jobs in tourism, retail sales, agriculture, manufacturing, and other jobs depend on the state's transportation infrastructure.[E4]

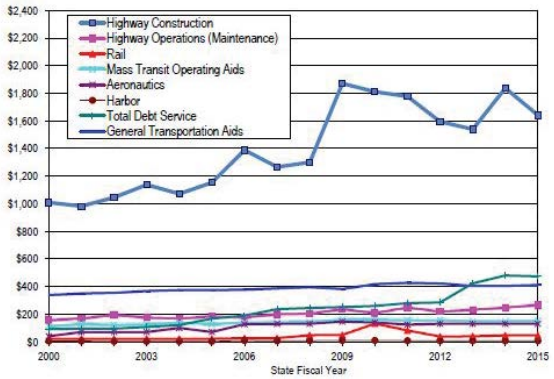
The U.S. Department of Transportation estimates that more than $1 out of every $10 produced in the U.S. is related to transportation activity.[E5] In 2012, nearly 235 million tons of freight valued at $312 billion originated within Wisconsin.[E6] By value, more than half of Wisconsin's freight comes from manufacturing (57%) and nearly a third from wholesale trade (30%). Mining contributes less than one percent of freight by value, but nearly a third by weight (29%). Page 5 takes a closer look at Wisconsin freight movement by mode.

Transportation costs associated with producing and distributing goods, including material shipment, product distribution, and employee travel make up 50 to 80% of supply chain costs.[E7] These are costs of doing business that companies pass on to consumers in the price of goods and services.

Public Infrastructure and Services

Federal, state, and local governments all play a role in maintaining transportation infrastructure. The current federal transportation act (FAST Act) authorizes the federal government to allocate roughly $40 billion per year over five years to states for highways and associated programs.[E8] In fiscal year 2014, Wisconsin received $711 million in federal funds for highways and $80 million for transit.[E9]

Figure E2
Funding for Various Transportation Modes 2000-2015 (nominal dollars, millions)[E9]



Wisconsin's 2015-17 state transportation budget is funded at $6.82 billion. State program revenues make up 56% of the budget and consist primarily of motor fuel taxes and vehicle registration fees. The remainder of the state transportation budget comes from federal grants (24%), bonds (13%), general purpose revenues (3%), and other funds (3%).[E10]

Figure E2 shows Wisconsin transportation funding by mode for 2000-2015.[E9] Modal programs receive roughly 90% of the state transportation budget and include highway construction, highway maintenance, mass transit, aeronautics, railroads, harbors, general transportation aids to local government, and debt service. Local road and bridge assistance is captured within and receives roughly 10% of highway construction funds. In recent years, general transportation aids have fallen flat, while highway construction costs and debt service have grown.

Not shown on this graph are multi-modal and non-modal programs. These include transportation assistance for the elderly and disabled, special aids to local units of government, and departmental operations including planning. Combined, these activities account for roughly 10% of the state transportation budget.

The task of keeping roads in good shape with limited funds is a constant struggle for many local governments. Wisconsin has 11,800 miles of state and Interstate highways, and 103,000 miles of county and local roads that must be maintained. Figure E4 shows the total number of road miles in Wisconsin compared to neighboring states. Wisconsin has less road miles than Minnesota and Illinois, but more road miles in poor condition. If you compare the percent of roads in poor condition in Wisconsin (21%) to other states, Wisconsin performs worse than Minnesota (11%), Iowa (12%), and Illinois (15%), and it is roughly on par with Michigan (22%).[E11]

Statewide, 19% of Wisconsin's major roads and highways are in good condition, 39% are in fair condition, and 42% are in mediocre to poor condition.[E4] Roads rated in mediocre to poor condition may show signs of deterioration including rutting, cracking and potholes. Some roads can be resurfaced, but those that are too deteriorated must be reconstructed.[E4]

According to the Transportation Development Association, 56 of Wisconsin's 72 counties replace their roads every 75 years. This is more than twice as long as the intended life span of 30 years.[E12] Roads that have fallen into poor condition are particularly expensive to repair, yet frequent maintenance to keep them in good condition may not be not possible due to lack of public funds.

Figure E3
County Highway M in Dodge County shows rutting and cracking

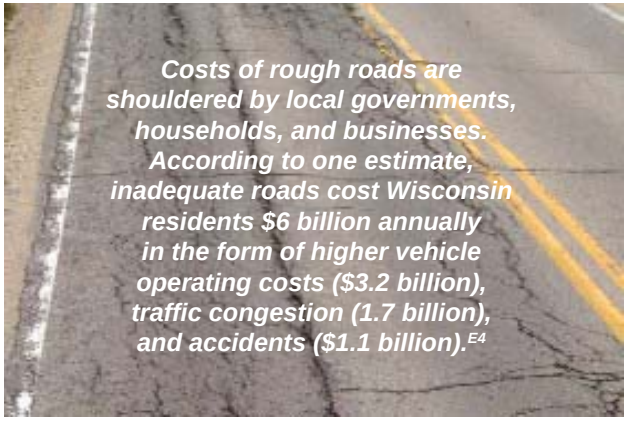
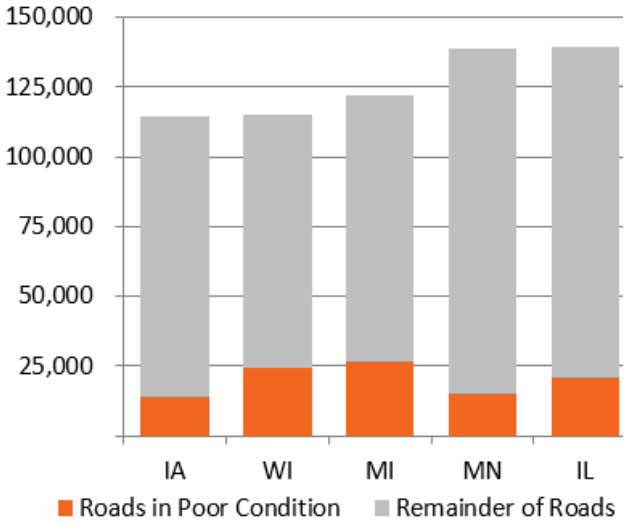


Photo courtesy TDA Wisconsin

Figure E4
Total Road Miles in Wisconsin and Neighboring States and Miles of Road in Poor Condition[E11]



During the past three decades, per capita spending on transportation by local Wisconsin governments has stagnated. Forty-three percent of local governments spent less per resident on transportation in 2012 than they did in 1987.[E13] During this same time period, highway construction costs increased. Between 1987 and 2003 highway project costs increased by 50%. They more than doubled by the time they reached a peak in 2006.[E14] Between 2005 and 2013, asphalt prices rose an average of 11 percent per year.[E15]

Increasing costs, declining state aids and limits on local property taxes means local governments are struggling to keep pace. In 2016, Wisconsin's local government associations joined together with the Transportation Development Association to create a "Just Fix It" campaign. To date, over 500 Wisconsin communities have signed resolutions urging state officials to invest in transportation and provide adequate funding for maintenance.[E12]

Human and Environmental Health

This section looks at some of the major human health and environmental health impacts resulting from transportation choices, including traffic deaths, traffic-related air pollutants, and impacts on fish, water quality, and climate change. Community options for minimizing negative impacts on human health are also described.

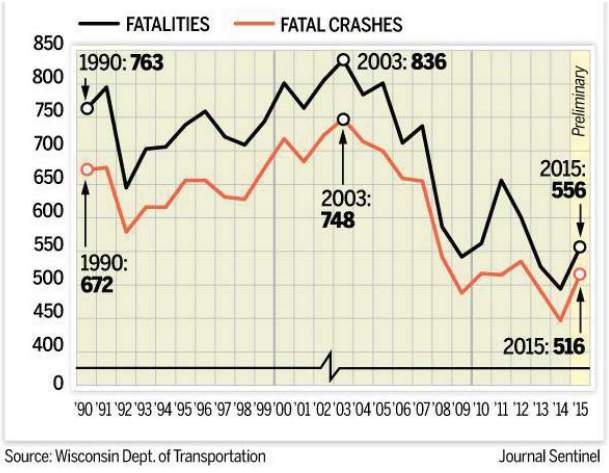
Direct Impacts on People

Traffic Deaths

Figure H1 shows traffic deaths and fatal crashes in Wisconsin from 1990-2015. Traffic deaths dipped in World War II when fuel-rationing restricted travel. They slipped again during the 1970s due to the oil embargo, a national speed limit of 55 miles per hour, and public pressure to make cars more crashworthy. With the recession of 2008 came a steep decrease in annual traffic deaths.[H1]

In the 12 months following Wisconsin's switch to 70 mph on interstate highways starting in June 2015, fatalities rose 37% on the interstate, injuries increased by 11% and the total number of accidents rose 12%.

Figure H1[H2]
Traffic Deaths 1990 - 2015



In that time 10 more people died, 208 more were injured, and 1,057 more accidents were reported than the previous 12 months on interstate roads, however, it is not clear that the higher speed limit is the reason behind the increase.[H3] Vehicle miles traveled in Wisconsin in 2015 were 3.5% higher than in 2014, which may have also contributed to increased deaths.[H4]

Major causes of traffic fatalities include unrestrained passengers, alcohol-impaired driving, and speeding. Each of these causes results in about 200 Wisconsin deaths per year.[H5] The Wisconsin Department of Transportation (WIDOT) and other organizations lead many transportation safety initiatives to improve safety and reduce fatalities.[H6]

Traffic-Related Air Pollution

Wisconsin's transportation sector accounts for 24% of the state's energy end use with an annual expenditure of $12 billion.[H7] Various modes of transportation depend on fossil fuels. The combustion of these fuels generates air pollutants including carbon monoxide (CO), nitrogen oxide (NO), volatile organic compounds (VOCs), and particulate matter (PM). Ground-level ozone, a harmful gas and respiratory irritant that causes symptoms like shortness of breath, coughing, wheezing, and chest tightness or pain for thousands of people each year, is formed when VOCs react with NO in the presence of sunlight especially during hot summer days.

Locally, automobiles contribute about 25% of all VOC emissions. Exposure to particulate matter can also cause serious health problems in humans, especially those with respiratory and cardiac diseases. The DNR monitors ambient concentrations of several pollutants throughout the state, including the two main pollutants likely to cause health problems in Wisconsin, ozone and particulate matter. AirNow[H8] provides a local air quality index. A recent report on air pollution shows that the overall air quality in Wisconsin continues to improve, building on a 15-year trend in the state (2001-2014).[H9]

Numerous studies have documented that concentrations of traffic-related air pollutants are highest near roads. A growing body of scientific research shows an association between residential traffic and adverse health outcomes, including asthma, respiratory symptoms and lung function, cardiovascular disease, and adverse reproductive outcomes.[H10] Recent studies have found:

- Children living near high traffic roads have a 50% increase in risk for leukemia.[H10]
- Exposure to traffic-related air pollution during pregnancy and during the first year of life is associated with autism.[H11]

Reduced driving, enhanced emission controls, use of alternative fuels, and more energy efficient vehicles can significantly reduce harmful emissions from the transportation sector. Local governments and residents can become more aware of the environmental impacts of automobiles, and take actions following other communities and organizational partners who are making a difference. Learn more at *Wisconsin Partners for Clean Air*[H12] and *SmartWay.*[H13]

Impacts on Fish, Lakes and Streams

Fish are indicators of lake and stream health. For example, if trout live in a stream, it is cold, clear and has high oxygen levels. If northern pike are eliminated, it may be because the water is too warm for them to survive. Other fish are eliminated if the water is so murky they can't find their prey, or if their spawning beds are covered in silt. This section focuses on the impacts of impervious surfaces, road salts, sealcoats and culverts on fish and water quality.

Impervious Surfaces

Development, which includes buildings, roads, parking lots, garages, culverts, and driveways consists of impervious (hard) surfaces that prevent rain and snow from soaking into the ground, causing runoff

that carries pollutants such as sediment, nutrients, gasoline, motor oil, antifreeze, heat, road salt, polycyclic aromatic hydrocarbons (PAHs), and heavy metals into our lakes and streams.[H14]

Wisconsin research has found more impervious surfaces result in less fish. In one study, when impervious surfaces exceeded 12% of a river's watershed in Wisconsin, the number of fish species plummeted, and largemouth bass, northern pike and a number of other fish species were eliminated.[H15]

The U.S. Geological Survey in Madison is doing research on surfaces for driveways and parking lots that let water soak in. They are determining how quickly these surfaces clog, and how they help to reduce runoff and pollutants.[H16]

In order to minimize impervious surfaces and their impacts on the health of fish, lakes and streams, one Wisconsin study[H17] recommends:

1. Reducing residential lot size, lot frontage and driveway length. Zoning and driveway ordinance can be used to set lot sizes, set backs and driveway lengths.
2. Reducing road width.
3. Considering surfaces such as permeable pavers, concrete, and asphalt that let the water soak into driveways and parking areas.

Road Salt and Chloride

In the winter of 2014-2015 Wisconsin applied 11.3 tons of salt per lane mile for a total salt cost of $26.9 million.[H18] Minnesota applied approximately half as much salt per lane mile, at 5.7 tons per lane mile.[H19] Road salt is a main source of chloride in Wisconsin, along with potash fertilizer, animal waste, wastewater treatment plants and septic systems.[H20] Chloride use increased dramatically in Wisconsin after 1950.[H21]

Salt readily dissolves in water, and is not removed when it soaks into the soil, so it ends up in the groundwater that feeds lakes, streams and wetlands.

Figure H2[H22]
Trends in flow-normalized concentrations of chloride at long-term river sites in Wisconsin measured over periods of 10-50 years.

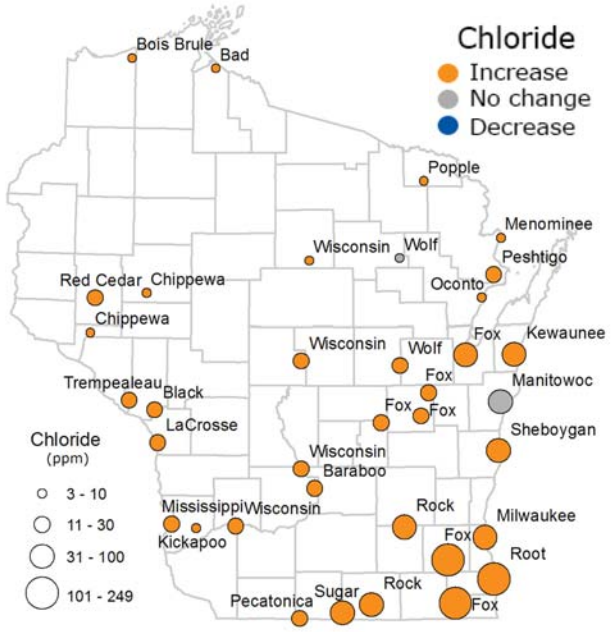


Table H1[H23]
Chronic and Acute Chloride Standards in Parts Per Million (ppm)

Organization	Chronic	Acute
Wisconsin Department of Natural Resources	395	797
U.S. Evironmental Protection Agency	230	860
British Columbia, Canada	150	600

As shown in Figure H2, nearly all of our major rivers in Wisconsin have increasing chloride levels. Sample results from major rivers do not indicate exceedance of Wisconsin or federal chloride standards. However, the Fox and Root Rivers in southeast Wisconsin already have average chloride concentrations over 100 ppm and continue increasing.[H22]

If chloride concentrations are high enough, a one-time spike will substantially decrease the population of fish and aquatic insects in the stream. Twelve Wisconsin counties have one or more smaller rivers and creeks on the impaired water list because they do not meet Wisconsin's chronic or acute standards for chloride. The counties with waters impaired by chloride are mainly in the southeast and south central part of the state. There are also two counties in the northwest, one in the Fox River Valley, and one in the northeast.[H24]

The extent of impervious surfaces draining to a stream matters. In a study of 19 stream sites in Wisconsin from 1990-2011, chloride concentrations increased at every site. Most stream sites with greater than 18% of the drainage area covered by impervious surface had average winter chloride concentrations exceeding the EPA chronic chloride standard (230 ppm), which was set to protect fish and other aquatic life. All sites with less than 11% impervious surface had average winter chloride levels below the federal standard.[H25]

Road salt can also dehydrate and kill trees and plants growing next to roadways. In some cases, salt attracts deer and other animals to busy roads, increasing their chance of becoming roadkill.[H26]

Since salt dissolves readily in water, settling and filtration practices will not remove salt from runoff. The only reliable way to reduce the impact of road salt on receiving streams is to reduce the amount of salt applied.[H27] There are ways to reduce road salt applications and maintain the same level of safety including:[H28]

- Anti-icing by applying a liquid salt brine to the pavement before the storm arrives so that snow and ice does not bond as well to the pavement. This makes plowing more effective and reduces the need for chemical deicers.
- Pre-wetting rock salt before it is spread on dry pavement. Studies show that as much as 30% of dry rock salt spread on pavement bounces off of the pavement. Wetting salt with brine before application can make 25% more salt hit the target rather than bouncing off of the pavement.
- New plow cutting edge designs make plowing more effective. After plowing, the pavement is cleaner, so less chemical deicers are needed.

Additional techniques are described in the report: *Strategies to Mitigate Impacts of Chloride Deicers on the Natural Environment*. The Transportation Information Center in Madison teaches courses about snow and ice control.

Coal Tar-based Asphalt Sealcoats

Asphalt sealcoats are used to improve the appearance and prolong the life of driveways and parking lots. Some sealcoat products contain coal tar. Coal tar is a complex chemical mixture that includes polycyclic aromatic hydrocarbons (PAHs), a class of chemical known to cause cancer. Types of cancer that may be caused by coal tar used in sealcoats, cited by the manufacturer, include: blood, kidney, liver, lung, scrotal, skin and stomach cancers. PAHs in coal tar-based asphalt sealants applied to driveways, parking lots or playgrounds can find their way into schools and homes, potentially exposing children and adults to toxic carcinogens via skin contact, ingestion or inhalation.[H29]

PAH contaminated runoff into lakes and streams contaminates aquatic life and can enter the food chain. When coal tar sealcoat particles collect in stormwater detention ponds, the contaminants can reach levels that require accumulated sediment to be disposed of in a licensed landfill. Minnesota enacted a statewide ban on coal tar sealcoats in 2014 after one city incurred $150,000 in disposal costs.[H30] The UW-Extension publication, *Avoiding Coal Tar-Based Asphalt Sealcoats and Finding a Coal Tar-free Sealcoat Applicator,*[H31] describes how to find appropriate applicators.

Figure H3
Chases Creek Flooding, Town of Blaine, Burnett County, July 2016

Photo by Shane Bucholz

Culverts, Flooding and Fish

Roads, bridges and culverts are expensive. Expected increases in large rainfall events will very likely increase the extent of flooding in Wisconsin streams and rivers. Road repair work after the July 2016 storms in northwest Wisconsin is estimated to top $15 million.[H32] Sizing culverts and bridges to accommodate the storms of today and decades to come will minimize disruptions and road repair costs.

In addition to impacting road budgets, culverts can cause major problems for fish, including preventing them from getting to their spawning grounds. The publication, *Fish Friendly Culverts*[H33] provides information for proper design, timing, installation and maintenance to protect both roadways and fish.

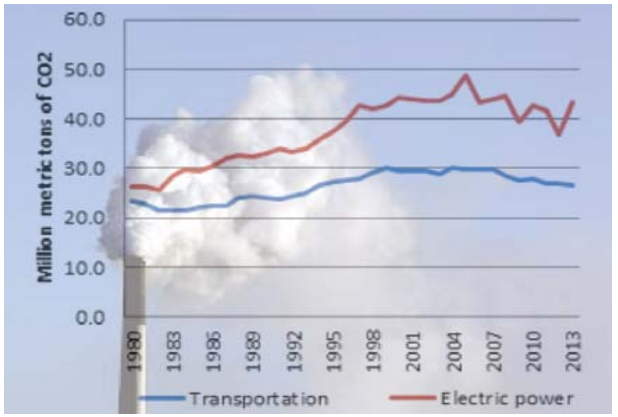
Impacts on Air Quality and Climate Change

The transportation sector is one of the largest sources of greenhouse gas (GHG) emissions in the United States. In 2016, U.S. carbon dioxide emissions from the transportation sector surpassed the top GHG emissions sector -- electric power plants, which has been the top GHG emitting sector since 1979.[H34]

In Wisconsin, transportation accounts for approximately 27% of total emissions. As shown in Figure H4, GHG emissions from transportation increased 16% in Wisconsin from 1980 to 2013.[H35] Since 1990, miles traveled in Wisconsin increased 40%.[H36] About 60% of transportation-related emissions comes from passenger cars and light duty vehicles including SUVs, pick-up trucks, and minivans.[H37]

An extensive analysis of nearly 50 transportation strategies found that the United States can significantly reduce greenhouse gas emissions if it aggressively employs a combination of strategies to reduce vehicle miles traveled, use more efficient modes of transportation, and improve transportation network efficiency. Strategies include investments in infrastructure and technology; pricing, taxes and incentives to encourage different travel behaviors; land use planning; and regulatory techniques. Under various scenarios, transportation-related GHG emissions could be reduced anywhere from 4% to 24% by 2050, with annual cost savings of $72 billion to $112 billion. If properly designed, investments in highways, public transportation, ride-sharing, and operations can benefit all user groups. Reductions in private sector vehicle operating costs also far outweigh public sector investments.[H38]

Figure H4
Wisconsin Carbon Dioxide Emissions



The U.S. Department of Transportation provides a clearinghouse of resources examining the connections between transportation, greenhouse gas emissions, and the impacts of a changing climate including increased flooding and temperature variations. Examples of state and local plans, policies and adaptation strategies are provided for communities looking to address climate change.[H37]

Emerging Trends

This section looks at some of the emerging trends in the transportation system, including alternative fuels, vehicle technologies and fuel efficiency, and how these transportation choices could reduce environmental and economic impacts. Options for local initiatives are described with several success stories, tools and resources.

Alternative Fuels

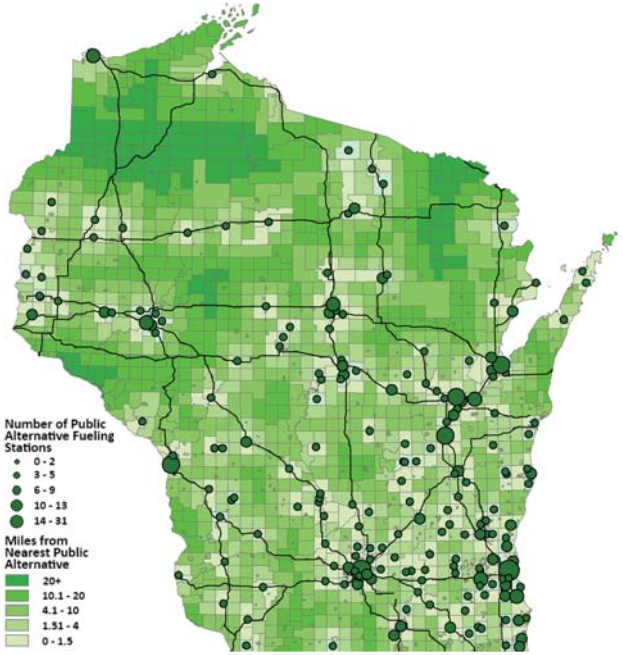
Wisconsin has no sources of petroleum or natural gas, so all transportation fuel is imported from other states and countries. In 2014, $12.5 billion left Wisconsin to pay for transportation fuel. This equates to 47% of state energy spending, or $5,455 per household per year.[E1]

Many alternative transportation fuels have emerged in the market within the last two decades and even more are in development. These include E85 (85% ethanol, 15% gasoline), biodiesel, electricity, liquid petroleum gas (LPG), compressed natural gas (CNG), liquid natural gas (LNG), and hydrogen.[E2]

Nationally, over 20,000 alternative fuel stations have been established.[E3] In Wisconsin, there are more than 500. Figure T1 shows the number and location of alternative fueling stations throughout the state. Many are clustered near high population areas such as Milwaukee, Madison and Green Bay.[E4] Electric and E85 fueling stations are most popular, comprising roughly 75% of all alternative stations.

More efficient and less polluting vehicle technologies are emerging that increase fuel economy and help the environment. The number of alternative fuel vehicles in use has been increasing steadily during the past two decades, largely due to federal policies and incentives. Those running on E85, propane, compressed natural gas, and electricity are in widest use today. The popularity of ethanol vehicles has grown widely since 1995 while the number of vehicles relying on other fuels has remained relatively constant. New models of electric vehicles (hybrid, plug-in hybrid, and all electric) and LPG and CNG operated vehicles are being developed with improved fuel efficient technology.[E5]

Figure T1
Alternative Fueling Stations in Wisconsin



Fuel Type	Number of Stations	Percent
Electric	207	42.4%
Ethanol 85	158	32.4%
Liquid Petroleum Gas	71	14.6%
Compressed Natural Gas	45	9.2%
Biodiesel	6	1.2%
Liquid Natural Gas	1	0.2%

Connected and Automated Vehicles

Progress is being made in connected vehicle (CV) technology[E6] and automated vehicle (AV) technology[E7] that would bring significant safety and efficiency improvements along with energy and environmental benefits. CV technology enables communication among vehicles, roads, infrastructure, and drivers' electronic devices to avoid accidents and to manage the transportation system efficiently.[E8] AV technology enables operating a vehicle without driver input in some control functions such as steering, throttle, or braking. Automated vehicles could use only vehicle sensors or they could use CV technology to operate safely. For both technologies, safety, privacy and data sharing remain as policy challenges to ensure the system functions optimally and securely.[E9] *Connected Counties: Tech Innovations in Transportation* describes how various counties are testing these technologies.[E10]

Fuel Efficiency and Idle Reduction

In addition to improvements in use of alternative fuels and advanced technology vehicles, more efficient and less polluting vehicles are emerging that increase fuel economy and help the environment. Today's cars and trucks are becoming more fuel efficient through various means including more efficient design, improvements to engines and tires, and weight reduction.[E11]

Local governments can use various strategies to reduce fuel consumption including encouraging the use of mass transit and active travel like biking and walking; making improvements in transportation system efficiency to reduce vehicle miles traveled; and encouraging private actions including idle reduction, regular vehicle maintenance, and use of more fuel efficient parts.[E12] *Wisconsin Clean Cities* are tracking smart ways to improve fuel economy.[E13]

Acknowledgments and References

On The Web

The Wisconsin Land Use Megatrends series is on the Web at www.uwsp.edu/cnr-ap/clue/Pages/publications-resources/LandUseMegatrends.aspx. Other topics include forests, housing, recreation, energy, climate change, agriculture and housing.

Acknowledgments

Prepared by Anna Haines, Rebecca Roberts, Lynn Markham, Shiba Kar and Karen Blaha of the Center for Land Use Education; and Nathan Sandwick, Portage County UW-Extension. Mapping work by Justin Johnson and Brewster Johnson.

The authors gratefully acknowledge the review and contributions of Nancy M Anderson and Michael G Han, Southeastern Wisconsin Regional Planning Commission; Steve Corsi, U.S. Geological Survey; Matthew Diebl, Wisconsin Department of Natural Resources; Jason Gilman and Lewis Kuhlman, City of La Crosse; Benjamin Jordan, Wisconsin Transportation Information Center; Joe Nehmer, Jefferson County; and Kassandra Walbrun.

The Center for Land Use Education is a joint venture of the College of Natural Resources at the University of Wisconsin-Stevens Point and the University of Wisconsin Cooperative Extension. Direct financial assistance for this project was provided by the University of Wisconsin Cooperative Extension.

Center for Land Use Education
College of Natural Resources
University of Wisconsin-Stevens Point

UW Extension

References

Cover

The cover map used the following sources: Lane Mile Data from the WI Department of Transportation 2013 Highway Performance Monitoring System; Airport, Ferry, and Amtrack Data and Major Highways Data from the WI Department of Natural Resources GEODISC 3.0 shared with the UW Stevens Point upon request; Wisconsin's Minor Civil Division Data from the 2000 Minor Civil Divisions (municipalities) in Wisconsin, derived from the US Census Bureau's 2000 TIGER line files.

Introduction

I1 www.wisconsinhistory.org/turningpoints/tp-018/?action=more_essay 19th-Century Immigration, accessed May 3, 2016.
I2 www.1kfriends.org/wp-content/uploads/2014/02/trans_network.png

Timeline

The Wisconsin Transportation Timeline includes several photos: 19th Century Wisconsin Steamship (Unknown Artist); Roper and Steam Carriage (Smithsonian Institution, On the Move Collection, Object 350); Pedestrians and Cyclists (Frederick Straubel, 1890); Gas Station (Hamblin Studio Service Station Photograph Collection, LVA09_1009_61); Harley-Davidson logo (Latrola); Wisconsin Central train (Sean Lamb); 1962 Rambler Ambassador 400 model (Christopher Ziemnowicz); Air Wisconsin BAe 146-200A (Eduard Marmet); Cyclists (Jereme Rauckman); Toyota Prius Hybrid recharging unit (Jebulon).

Movement of People and Goods

M1 1000 Friends of Wisconsin with modification www.1kfriends.org/wisconsins-transportation-system-in-crisis/
M2 www.cnu.org/our-projects/street-networks/street-networks-101
M3 wisconsindot.gov/Pages/projects/data-plan/veh-miles/default.aspx
M4 www.ssti.us/2012/02/motor-vehicle-travel-demand-continues-long-term-downward-trend-in-2011
M5 www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/wisconsin_11x17.pdf
M6 nhts.ornl.gov/introduction.shtml
M7 traveltrends.transportation.org/Documents/B2_CIA_Role%20Overall%20Travel_web_2.pdf
M8 Wisconsin Blue Book 2015-16. docs.legis.wisconsin.gov/misc/lrb/blue_book/2015_2016/875_transportation.pdf
M9 Wisconsin Public Transit. Briefing for the Wisconsin Congressional Delegation, Spring 2016. greenbaywi.gov/metrotransit/wp-content/uploads/2016/01/wis-packet.pdf
M10 wisconsindot.gov/Documents/projects/sfp/chap7.pdf
M11 www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/FF%26F_complete.pdf
M12 www.aar.org/Style%20Library/railroads_and_states/dist/data/pdf/Wisconsin%202012.pdf
M13 wisconsindot.gov/Documents/projects/sfp/chap7.pdf

Social Aspects

S1 Graphic adapted from accessibility for Transportation Planning. Todd Litman. Victoria Transport Policy Institute, 2016. www.vtpi.org/access.pdf
S2 2010 Census Chartbook: Demographic Trends in Wisconsin www.apl.wisc.edu/publications/2010_census_chartbook_wi.pdf
S3 Aging in Place, Stuck without Options. Transportation for America, 2011. t4america.org/docs/SeniorsMobilityCrisis.pdf
S4 Transportation in the New Millennium. Transportation Research Board, 2000. onlinepubs.trb.org/onlinepubs/millennium/00001.pdf
S5 Sandra Rosenbloom. Transportation Patterns and Problems of People with Disabilities. The Future of Disability in America. National Academies Press, 2007. www.ncbi.nlm.nih.gov/books/NBK11420
S6 Licensed drivers. Wisconsin Blue Book, 2015-16.
S7 America in 2015. Urban Land Institute. uli.org/wp-content/uploads/ULI-Documents/America-in-2015.pdf
S8 Wisconsin Urban & Rural Transit Association, 2014 Legislative Agenda. www.wurta.com/agenda.php
S9 American Community Survey, 2014-15, 5-year estimate.
S10 Wisconsin Divided Six Ways. Wisconsin Office of Rural Health. worh.org/sites/default/files/Wisconsin%20Divided%20Six%20Ways_1.pdf
S11 Mobility Management Practices in Wisconsin. WisDOT, 2015. wisconsindot.gov/Documents/doing-bus/local-gov/astnce-pgms/transit/mob-prac.pdf
S12 2013 Disability Status Report: Wisconsin. www.disabilitystatistics.org/StatusReports/2013-PDF/2013-StatusReport_WI.pdf
S13 Transportation Coordination and Resources, WisDOT. wisconsindot.gov/Pages/doing-bus/local-gov/astnce-pgms/transit/compliance/coord.aspx
S14 Smart Growth Self-Assessment for Rural Communities. U.S. EPA, 2015. www.epa.gov/smartgrowth/smart-growth-self-assessment-rural-communities
S15 9 The Current State of Transportation for People with Disabilities in the United States, National Council on Disability, 2005.

Land Use Policy

P1 La Crosse County: Complete Streets. www.dhs.wisconsin.gov/publications/p0/p00780c.pdf
P2 National Complete Streets Coalition. www.smartgrowthamerica.org/complete-streets
P3 2016 Green Complete Streets Project List. www.news8000.com/blob/view/-/37286436/data/1/-/o7jokuz/-/2016-Green-Complete-Streets-Project-List.pdf
P4 City of La Crosse Transportation Vision, 2015. www.cityoflacrosse.org/filestorage/593/844/3606/5145/Transportationvision.pdf
P5 Bay Area Rural Transit. www.bartbus.com.
P6 WisDOT 2014 Annual Transit Report. wisconsindot.gov/Documents/doing-bus/local-gov/astnce-pgms/transit/annual-report.pdf.
P7 Wisconsin Office of Energy Independence. 2008 BART Resolution and 2009 EI Report for Chequamegon Bay. www.stateenergyoffice.wi.gov.
P8 Comprehensive Plan (1999, 2010, 2012), Parks, Recreation and Open Space Plan (1997, 2005, 2013); Bicycle and Pedestrian Plan (1996, 2010). www.jeffersoncountywi.gov
P9 Wisconsin DNR, 2009. dnr.wi.gov/files/pdf/pubs/lf/lf0050.pdf
P10 Measuring the Economic Impact and Value of Parks, Trails and Open Space in Jefferson County, UW-Madison Graduate Planning Workshop, 2005. www.academia.edu/20929738

Economics

E1 www.bls.gov/cex/csxann13.pdf
E2 htaindex.cnt.org
E3 www.bls.gov/oes/current/oes530000.htm
E4 www.tripnet.org/docs/WI_Transportation_by_the_Numbers_TRIP_Report_May_2016.pdf
E5 www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/freight_in_america/html/nations_freight.html
E6 www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/commodity_flow_survey/2012/state_summaries/geographic
E7 www.tdawisconsin.org/1249/fixing-wisconsins-highways
E8 www.fhwa.dot.gov/fastact
E9 wisconsindot.gov/Documents/about-wisdot/performance/budget/trends2014-15final.pdf
E10 www.witransitriders.org/assets/2015/08/2015-17biennialbudget-final.pdf
E11 www.whitehouse.gov/sites/default/files/docs/economic_analysis_of_transportation_investments.pdf
E12 www.tdawisconsin.org/just-fix-it-wisconsin and www.wkow.com/story/31363408/2016/03/Wednesday/dot-wi-roads-are-4th-worst-in-the-us
E13 Based on Graphing Revenues, Expenditures and Taxes (GREAT) data compiled by UWEX. great.apl.wisc.edu
E14 www.fhwa.dot.gov/programadmin/pt2006q4.cfm and www.fhwa.dot.gov/policyinformation/nhcci/pt1.cfm
E15 www.localgovinstitute.org/potholes

Human and Environmental Health

H1 www.jsonline.com/news/traffic/crashes-traffic-fatalities-wane-in-wisconsin-b9967460z1-218257691.html
H2 archive.jsonlin.com/news/traffic/wisconsin-traffic-deaths-up-13-2015-weather-gas-prices-economy-cited-b99646732z1-364792451.html
H3 jsonline.com/story/news/2016/09/23/crashes-spike-after-70-mph-speed-limit/90416108/
H4 wisconsindot.gov/Pages/projects/data-plan/veh-miles/default.aspx
H5 www.nhtsa.gov/links/statedocs/FY15/FY15HSPs/WI_FY15HSP.pdf
H6 wisconsindot.gov/Pages/safety/education/default.aspx
H7 www.eia.gov/state/?sid=WI
H8 http://AirNow.gov
H9 15 year trend, 2001-2014. 2dnr.wi.gov/topic/airquality/trends.asp
H10 Boothe, V.L. et al. Residential traffic exposure and childhood leukemia: a systematic review and meta-analysis. American Journal of Preventive Medicine 2014 Apr;46(4):413-22. doi: 10.1016/j.amepre.2013.11.004
H11 Shekarrizfard M et al. An examination of population exposure to traffic related air pollution: Comparing spatially and temporally resolved estimates against long-term average exposures at the home location. Environmental Research. 2016 Mar 10;147:435-444. doi: 10.1016/j.envres.2016.02.039
H12 www.cleanairwisconsin.org/
H13 epa.gov/smartWay
H14 clean-water.uwex.edu/pubs/pdf/urban.pdf
H15 learningstore.uwex.edu/Impervious-Surfaces-How-they-Impact-Fish-Wildlife-and-Waterfront-Property-Values--P1637.aspx
H16 https://www.usgs.gov/science/evaluating-potential-benefits-permeable-pavement-quantity-and-quality-stormwater-runoff?qt-science_center_objects=1#qt-science_center_objects
H17 www.urbanclimate.gatech.edu/pubs/Paving%20Over%20Paradise.pdf
H18 wisconsindot.gov/Documents/doing-bus/local-gov/hwy-mnt/winter-maintenance/workers/2014-2015annualreport.pdf
H19 www.dot.state.mn.us/maintenance/pdf/wintermain20142015ataglance.pdf
H20 learningstore.uwex.edu/Assets/pdfs/G3582.pdf
H21 www.tandonline.com/doi/abs/10.1080/07438140809354055
H22 Map created by Matthew Diebel, Wisconsin DNR, August 2016
H23 dnr.wi.gov/topic/impairedwaters/2016IR_IWList.html; docs.legis.wisconsin.gov/code/admin_code/nr/100/105.pdf; www.env.gov.bc.ca/wat/wq/BCguidelines/chloride/chloride.html#app_tab1
H24 dnr.wi.gov/topic/impairedwaters/2016IR_IWList.html
H25 wi.water.usgs.gov/non-point/roadsalt/index.html
H26 www.smithsonianmag.com/science-nature/what-happens-to-all-the-salt-we-dump-on-the-roads-180948079/
H27 www.sciencedirect.com/science/article/pii/S0048969714017148
H28 Personal communication from Benjamin Jordan, Wisconsin Department Information Center, 8/19/2016.
H29 shwec.engr.wisc.edu/wp-uploads/2015/08/Sealants-health-and-envir-11-8-12.pdf
H30 shwec.engr.wisc.edu/wp-uploads/2015/08/Stormwater-Utilities-6-7-13.pdf
H31 shwec.engr.wisc.edu/wp-uploads/2015/08/Non-Coal-Tar-applicators-6-7-13.pdf
H32 fox6now.com/2016/07/20/transportation-secretary-announces-availability-of-4-15m-to-repair-roads-damaged-by-flooding-in-northerwn-wi/
H33 shwec.engr.wisc.edu/wp-uploads/2015/08/Non-Coal-Tar-applicators-6-7-13.pdf
H34 www.epa.gov/climatechange//ghgemissions/inventoryexplorer
H35 www.eia.gov/environment/emissions/state
H36 wisconsindot.gob/documents/projects/data-plan/veh-miles/vmt-hist.pdfH32
H37 www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/wisconsin_11x17.pdf; cta.ornl.gov/data/index.shtml
H38 www.transit.dot.gov/sites/fta.dot.gov/files/docs/MovingCoolerExecSummaryULI.pdf
H39 climate.dot.gov/index.html

Emerging Trends

E1 www.eia.gov/state/print.cfm?sid=WI
E2 www.afdc.energy.gov/fuels/; www.wicleancities.org/fuels_vehicles/index.php
E3 maps.nrel.gov/transatlas
E4 www.afdc.energy.gov/states/wi; www.wicleancities.org/fuels_vehicles/stations.php
E5 www.epa.gov/greenvehicles/alternative-vehicle-fuels.
E6 its.dot.gov/communications/media/15cv_future.htm
E7 its.dot.gov/automated_vehicle/index.htm
E8 its.dot.gov/communications/media/15cv_future.htm
E9 tti.tamu.edu/2015/12/01/roping-revolution-cvav-deployment-and-public-policy/; www.epa.gov/greenvehicles/transportation-down-road
E10 www.naco.org/resources/connected-counties-tech-innovations-transportation
E11 www.fueleconomy.gov/; www.epa.gov/greenvehicles/learn-about-green-vehicles
E12 www.afdc.energy.gov/conserve/
E13 www.wicleancities.org/fuels_vehicles/idle.php