4.1 Vision

The first three chapters have outlined the need for a long-range plan and its place in the overall planning and programming process; the current characteristics of Iowa's people and economy and the trends likely to shape their future; the inventory, planning efforts, trends, and planning issues for multimodal transportation system; and passenger and freight trends showing how the transportation system is utilized to get people and goods where they need to go.

This basis helps form the background for developing a vision for what Iowa's transportation system needs to look like to successfully function into the future. Iowa's multimodal transportation system is one of the foundations of Iowa's economy and society. The decisions made today regarding how to construct, operate, and maintain the system will significantly affect the state's future. This makes it important to have an overall vision for how the current and future transportation system should be managed and operated. The transportation system vision of the Iowa DOT and Iowa Transportation Commission is:

A safe and efficient multimodal transportation system that enables the social and economic wellbeing of all Iowans, provides enhanced access and mobility for people and freight, and accommodates the unique needs of urban and rural areas in a sustainable manner.

This vision captures the overall intent of what the Iowa DOT is aiming to provide its customers, the traveling public. It is strategic and meant to be specific enough to help target limited financial resources, but it is also adaptable, because change is inevitable and can occur quickly.

The outcome of successful implementation of this vision is what we are calling **mobility**. In this context, mobility means the ability to utilize the transportation system to get where you want to go or to transport something from one place to another. While the department's focus tends to be on the infrastructure and services that facilitate transportation, the value those elements bring to society is the ability to use them as a means to an end – so individuals can get where they need to go.

The vision forms the foundation for the rest of this chapter, which will define how we can achieve it (system objectives) and other important factors (planning considerations). The way the Iowa DOT and Iowa Transportation Commission work towards the vision for the transportation system is ultimately through where investments are made – the activities of the Iowa DOT workforce, the maintenance work and construction projects that the Iowa DOT oversees, the way the system is managed and operated, and the funding that the Iowa DOT and Iowa Transportation Commission passes through or allocates to others for investments in non-primary highways or other modes. The system objectives described next will help guide those investments and activities.

4.2 System Objectives

As noted, the ultimate purpose of the transportation system is to get people and goods where they need to go – mobility. To know whether or not we are meeting or making progress towards that goal, we need to be able to define outcomes that can be measured. Through this State Long Range Transportation Plan (SLRTP), mobility is being defined through four outcomes – safety, sustainability, accessibility, and flow – which are all critical elements for a well-functioning transportation system. These ***mobility outcomes*** can also be thought of as ***system objectives***, or what we are trying to achieve with the system – that it is the safest, most sustainable, most accessible, and smoothest flowing that it can be for users.

The system objectives help form a framework for decision-making, shown in Figure 4.1. By defining what we are trying to achieve and how to measure whether we are achieving it, we can make better decisions about what projects to fund or which activities to undertake to make progress. This can be applicable at the broad level of the Five-Year Program or the relatively narrow scope of a grant program. The objectives can be woven into activities across the department, including other planning efforts, project evaluation criteria and tools, grant application scoring, and other business units' efforts.

The objectives are being established as part of the SLRTP because this document's role in guiding investment helps formalize them as part of the department's decision-making framework. They are system objectives for the long-term, analogous to the single-year objectives in the Business Plan that help achieve shorter term goals to build towards the vision outlined here. One of the strategies identified in Chapter 5 is integrating these objectives throughout the department's other planning efforts and processes. Chapter 5 helps summarize modal needs identified in other plans and highway needs and risks determined through various tools and analyses. The system objective framework outlines what areas decision-makers should be focusing on to help them prioritize among those needs and risks.

The objectives were developed through extensive work by an internal performance management working group, and they were refined by the Internal Planning Steering Committee that guided SLRTP development. The work was focused on which objectives to include, how to define them, and what areas to identify for monitoring progress. The committees chose not to develop overarching performance measures, but rather to allow business units to do so as they work to integrate the objectives into their work, so that the most appropriate measures can be identified and monitored for the specific function.

Figure 4.1: Iowa DOT system objectives

Source: Iowa DOT

Relationship to Federal Legislation

The current federal surface transportation bill, the Infrastructure Investment and Jobs Act (IIJA), maintained the ten transportation planning factors that were included in the prior bill, the Fixing America's Surface Transportation (FAST) Act. Each state is required to carry out a continuing, cooperative, and comprehensive statewide transportation planning process that provides for consideration and implementation of projects, strategies, and services that will address the planning factors. The system objectives and planning considerations discussed in this chapter are closely aligned with the ten federal planning factors, which are listed to the right. Table 4.1 shows how the system objectives tie to the planning factors.

1. Support economic vitality, especially by enabling global competitiveness, productivity, and efficiency.
2. Increase the safety of the transportation system for motorized and nonmotorized users.
3. Increase the security of the transportation system for motorized and nonmotorized users.
4. Increase the accessibility and mobility of people and for freight.
5. Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and state and local planned growth and economic development patterns.
6. Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight.
7. Promote efficient system management and operation.
8. Emphasize the preservation of the existing transportation system.
9. Improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation.
10. Enhance travel and tourism.

Table 4.1: Relationship between system objectives and federal planning factors

	Safety	Sustainability	Accessibility	Flow
Economic vitality				
Safety				
Security				
Accessibility and mobility				
Environment, energy, quality of life, and consistency				
Connectivity				
Efficient system management and operation				
System preservation				
Resiliency and reliability				
Travel and tourism				

Source: Iowa DOT

Public Input

In 2021, public input was sought on the system objectives relative to various transportation modes and types of infrastructure. The aim was to identify whether individuals felt positive, neutral, or negative towards each transportation element relative to how **safe** they felt using it, how good of condition it was in (**sustainability**), how easy it was to **access**, and how much delay they expected (**flow**). The survey results, while only representing a small portion of Iowans, help show that feelings regarding these attributes vary significantly by mode/infrastructure. This is something to consider as system objectives are implemented across planning efforts. Table 4.2 shows the percentage of positive (green), neutral (yellow), and negative (red) responses for feelings related to the system objectives for the various modes/infrastructure.

Table 4.2: Public input survey results related to system objectives by mode/infrastructure

	Safety	Sustainability	Accessibility	Flow
Airports				
Amtrak				
Bicycle facilities				
Intercity bus				
Park and ride lots				
Pedestrian facilities				
Public transit (bus)				
Roadways				
Taxi service				
Transportation Network Company (Uber, Lyft, etc.)				

Note: green is the portion of respondents with a positive response; yellow is neutral; red is negative.

Source: Iowa DOT

4.3 Planning Considerations

The vision and system objectives help define the transportation planning decision-making framework and the core areas against which progress will be measured. Chapter 5 will transition to discussing needs across the transportation system and strategies to help implement the plan. Prior to defining needs and strategies, there are many planning considerations that merit discussion. Some of them share a name with a system objective, though all objectives relate to more than one of the planning considerations. Many of them also relate to the ten federal planning factors. These topics have been included based on their importance to the statewide transportation planning process and input from stakeholders. Several are also emerging planning areas that may not have standalone plans or may have relatively new plans.

- Asset management and stewardship
- Economic vitality
- Energy
- Environmental planning
- Equity, accessibility, and civil rights
- Land use, livability, and quality of life
- Resiliency and sustainability
- Safety
- Security
- Technology
- Travel and tourism
- Transportation systems management and operations

Asset Management and Stewardship

Transportation asset management (TAM) is a strategic, comprehensive, and proactive approach to managing transportation infrastructure. The overall goals of asset management are to minimize long-term costs, extend the life of the transportation system, and improve the transportation system's performance.

The Iowa DOT has been implementing TAM across its business practices and processes with increasing emphasis over the past several years. In the past, a combination of preventive maintenance and worst-first approaches were used to manage bridges and highways. In a worst-first approach, agencies rank their assets from worst to best condition and then work down the list repairing assets until they exhaust available funds. Often, the assets in the worst condition require expensive reconstruction. This approach is costly and leaves limited resources for preserving and maintaining other parts of the network. This issue is not confined to roads and bridges – managing assets applies across infrastructure and modes, as well as to capital assets such as transit buses, snow plows, and other equipment.

Asset management provides an alternative approach in which agencies strike a balance between reconstructing poor assets and preserving good assets so that they do not become poor. This balanced approach extends the useful lives of assets and is more cost-effective in the long run. Faced with budgetary constraints and an overwhelming need for investment in infrastructure, Iowa DOT's executive leadership determined that TAM was necessary for the successful long-term operation of Iowa's transportation system.

In recent years, especially in light of limited funding and increasing costs, the efficient management of Iowa's existing transportation system has been identified as the priority investment path. Iowa's citizens have overwhelmingly expressed their support of this stewardship philosophy and keeping the existing system in a state of good repair before pursuing expansion needs. Some expansion of the existing system is needed, but it will only occur when and where careful planning efforts have identified the need to do so. Yet even with minimal expansion, funding limitations will make maintaining and preserving the existing system at an acceptable level a challenge.

It is important to note that stewardship of the transportation system is more than just highways and the maintenance of those highways. All modes of transportation have critical maintenance and preservation needs. In addition to including all modes, maintenance and preservation also addresses more than the infrastructure components of these modes. The transportation system involves the services and support functions keeping it operational. Examples of these functions (some of which involve entities other than the Iowa DOT) include air traffic control, construction materials testing, driver's license renewal, highway patrol duties, intelligent transportation systems (ITS), lock and dam operation, planning support, transit fleet dispatching, and weight-restriction enforcement. Iowa has a comprehensive transportation system that involves many functions and roles, and good stewardship of all these elements is essential to keep the system operational.

Transportation Asset Management (TAM)

TAM is defined by the American Association of State Highway and Transportation Officials (AASHTO) as "a strategic and systematic process focused on business and engineering practices for allocating resources to assets throughout their lifecycles." Given the challenges posed by issues such as aging infrastructure and escalating construction and operating costs, tools such as asset management are increasingly valuable when seeking to balance funding realities with public needs and expectations.

According to the Federal Highway Administration (FHWA), an effective asset management program can:

- Track system condition, needs, and performance.
- Clearly identify costs for maintaining and preserving existing assets.
- Clearly identify public expectations and desires.
- Directly compare needs to available funding, including operating and maintenance costs.
- Define asset conditions so decisions can be made on how best to manage and maintain assets.
- Determine when to undertake action on an asset, such as preservation, rehabilitation, reconstruction, capacity enhancement, or replacement.

Asset management provides insights and tools to help transportation professionals make wise investments that result in improved service and greater cost-effectiveness. Within the context of transportation planning and programming, asset management can positively influence every phase of the process.

Asset Management Planning

While a variety of asset management activities occur across the Iowa DOT, two specific asset management plans are required by federal law – transit asset management plans and a TAM Plan for National Highway System pavements and bridges.

Transit Asset Management Group Plan

While large urban transit agencies develop their own TAM plans, Iowa DOT oversees a group TAM plan for the other 23 transit agencies in Iowa. The plan was initially developed in 2018 and will be updated every four years. The Iowa DOT sponsored the group plan to aid in the following.

1. Assessing of the current condition of capital assets.
2. Determining the condition and performance of assets.
3. Identifying unacceptable risks.
4. Providing guidance and technical assistance to group participants to balance and prioritize reasonably anticipated funds towards improving asset condition and achieving a sufficient level of performance within those means.

All group plan participants follow Federal Transit Administration (FTA) guidance for buses and bus facilities to ensure they are maintained in good condition and are safe to use. All systems have adopted vehicle maintenance policies that outline the necessary steps to follow.

Most federal assistance for bus replacements comes to the state level, necessitating a process for determining which vehicle replacements to fund across the state. The Iowa DOT uses the Public Transit Management System (PTMS) prioritization process. The Public Transit Bureau maintains an inventory of all existing transit revenue vehicles in the state, which is updated annually. The Iowa DOT prioritizes vehicle replacement and rehabilitation/remanufactured projects annually on a statewide basis based on age and mileage of existing vehicles compared to useful life standards for the specific type of equipment.

Transit facility assessments were also conducted as part of the asset management planning process. The Iowa DOT developed a tablet-based application to collect facility data and automatically calculate the condition assessment based on the Transit Economic Requirements Model (TERM) scale.

Transportation Asset Management Plan (TAMP)

Recent transportation reauthorization bills have included the requirement for states to develop transportation asset management plans for roads and bridges on the National Highway System. The Iowa DOT formed a steering committee in 2014 to oversee the development of the Iowa DOT's first TAMP. The initial TAMP was finalized in 2016, followed by versions in 2018 and 2019. The TAMP will be updated in 2022.

The TAMP describes how the Iowa DOT manages the existing highway system. Preserving and improving this system is critical for achieving the system vision discussed at the beginning of this chapter. The TAMP also helps connect this SLRTP and system/modal plans to the Five-Year Program, which identifies specific investments over the next five years. The TAMP has a 10-year planning horizon and helps align investments in the Five-Year Program to be consistent with Iowa DOT's longer-term vision.

The TAMP outlines the following information.

- **Asset inventory and condition data**: These are the foundation for managing transportation assets, and are needed for supporting asset management processes such as life cycle planning, projecting funding needs, developing projects, and monitoring asset performance.
- **Life cycle planning (LCP)**: This is the process of developing a strategy for managing an asset class to achieve a target level of performance while minimizing life cycle costs. LCP is a network level analysis intended to help lower costs and improve condition. Using its bridge and pavement management systems, the Iowa DOT can estimate the cost of managing its bridges and pavements and determine the optimal mix of treatments to achieve condition goals at the lowest cost.
- **Performance measures and gap analysis**: These are included to measure the current condition of assets, estimated benefits from asset treatments, forecast future asset conditions, and review budget constraints to assist in determining how to best manage bridge and pavement assets over time.
- **Managing risk**: This is an integral part of asset management. By anticipating, identifying, and planning for potential scenarios, the Iowa DOT can reduce uncertainty and mitigate the effects of risks.
- **Financial plan**: This presents the funding picture at the Iowa DOT, identifies revenues needed to maintain asset conditions today and into the future, and identifies any gaps between funding needed to meet condition targets and funding available. Investment strategies shape the DOT's spending to maximize return on investment and make progress towards state and national goals and targets.
- **Process improvements**: These are discussed since TAM is a process of continuous improvement. Each process used to develop the TAMP, whether it be LCP or risk management, needs to be reevaluated on an ongoing basis to keep practices current.

Iowa DOT's TAMP is not a fix for an emergency. It represents a way of doing business. When used effectively, the TAMP will assist Iowa DOT in preventing major problems by prolonging the life of Iowa's most critical assets and by planning for future replacements.

TAM Governance

The Iowa DOT has also established a TAM governance structure, which was identified as a need during the initial TAMP development. A team was assembled to design a process and governance structure for highway program development with the objectives listed below.

- Add transparency to the programming process, align associated tools and plans, and incorporate appropriate stakeholders.
- Define roles and responsibilities of the associated stakeholders.
- Create a process that is adaptable over time as technology, initiatives, and priorities change.
- Oversee the incorporation of risk management into the prioritization process.
- Provide input to critical plan development efforts, including the TAMP and long-range transportation plan.
- Propose performance targets, propose funding levels to achieve those performance targets, and coordinate the associated monitoring and reporting.

The TAM governance structure includes system teams for the topics of pavement management, bridge management, safety, and traffic operations; a TAM Technical Committee that brings together the leads from those teams and others in the department to work on asset management initiatives; a TAM Implementation Team that helps guide implementation of initiatives across the department, and a Program Team that incorporates the Executive Leadership Team.

Economic Vitality

The transportation system provides significant value to Iowa's economy, and has great value in and of itself. For example, the amount of funding that would be needed to replace all existing Iowa DOT highways and bridges is estimated to be over $36 billion, and that represents only a small portion of the state's overall multimodal transportation network.

Throughout Iowa's history, economic growth has occurred along transportation networks of all forms, from rivers to railroads to highways. While transportation networks and economic growth have a clear relationship to each other, it is not straightforward in terms of causality and importance. It is important that the potential economic impacts of transportation projects are considered during the planning process; likewise, it is important that areas planning for new developments of any type consider the transportation needs and impacts.

Economic considerations are integrated into the transportation planning process. For example, the Five-Year Program identifies several transportation policies, the first of which is to promote a safe transportation system that addresses user needs and maximizes economic and social benefits for Iowans. As part of the programming process, economic development impacts are considered as candidate projects are identified and evaluated, though these aspects must be balanced with limited resources and various transportation needs, such as safety, condition, connectivity, operations, and accessibility, just to name a few. The following items are a few specific economic-related initiatives the Iowa DOT is involved with.

RISE Program

The Revitalize Iowa's Sound Economy (RISE) program promotes economic development in Iowa through the establishment, construction, and improvement of roads and streets. The RISE program is targeted towards value-adding activities that feed new dollars into the economy and provide maximum economic impact to the state. The RISE Program has funded more than 840 city and county transportation projects and provided nearly $500 million in assistance to support the creation and retention of over 90,000 jobs over the program's 36-year existence.

Freight Network Optimization

This was a joint effort with the Iowa Economic Development Authority (IEDA) completed in 2016. The goal of this project was to effectively identify and prioritize investment opportunities for an optimized public and private freight network to lower transportation costs for Iowa's businesses and to promote business growth in Iowa. The optimization strategy outlined in the report Development of Iowa Statewide Freight Transportation Network Optimization Strategy will assist in improving the effectiveness and performance of the multimodal freight transportation network. It is expected that, over time, the optimization strategy will lower or stabilize transportation costs for Iowa businesses, make Iowa's transportation system a more valuable and efficient asset in economic development, and enhance freight mobility.

Certified Sites

The Iowa Certified Site Program was launched by the IEDA in 2012 to address the lack of project-ready industrial sites in the state. It is an independent, third-party certification program that considers a combination of national site location standards as well as Iowa's natural assets and industry needs. Certified sites must meet certain minimum requirements related to infrastructure availability (including transportation networks), environmental clearances, and other items related to being development-ready. Locations certified through this program may be eligible for higher RISE participation in local development projects.

Energy

Energy issues are another important consideration in transportation planning. Areas where energy and transportation overlap include the cost and availability of fuel, the production and movement of different types of fuel, and the impact of alternative fuel vehicles on transportation.

Iowa Energy Plan

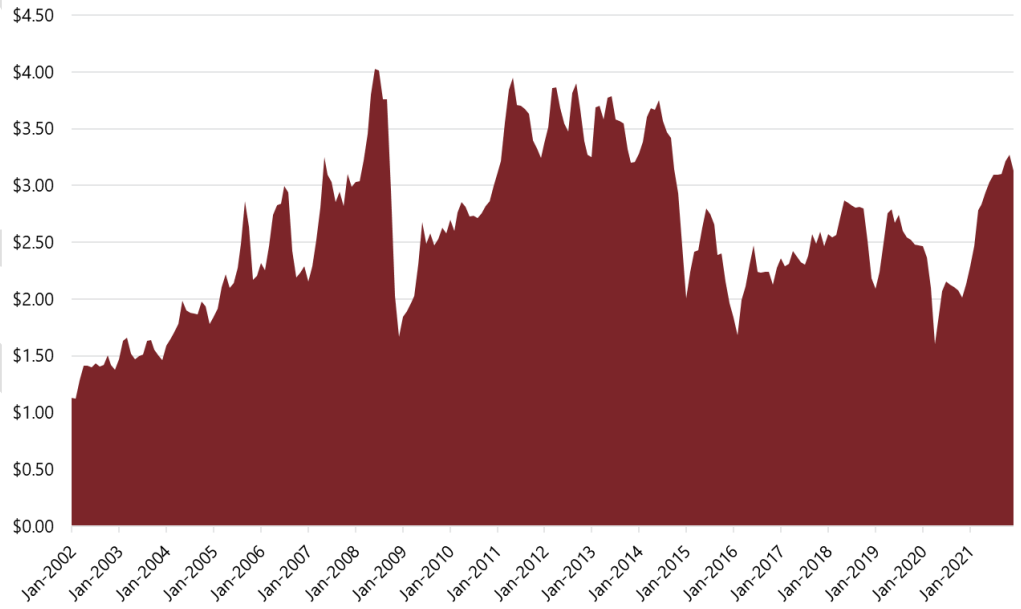
The Iowa Energy Plan was developed in 2016 as a joint initiative between the Iowa DOT and the Iowa Economic Development Authority (IEDA). Iowa's energy plan is a means to set state priorities and provide strategic guidance for decision-making while working to encourage energy, economic, and environmental benefits through goals and recommendations. It includes an assessment of current and future energy supply and demand, examines existing energy policies and programs, and identifies emerging energy challenges and opportunities. The plan synthesizes the existing state energy goals and strategies that are beneficial for the state, and outlines new objectives and strategies to position Iowa for the future.

The plan was built on four foundational pillars, one of which is transportation and infrastructure. The other three are economic development and energy careers, Iowa's energy resources, and energy efficiency and conservation. Several of the plan's strategies relate specifically to transportation, including expanding the use of alternative fuel vehicles in Iowa and optimizing the movement of freight and people to reduce energy use.

Fuel Supply and Cost

Both the supply and cost of fuel can directly affect many facets of the transportation industry. For example, when the cost of fuel fluctuates noticeably, driving behavior can change and create an immediate impact on the transportation system through variations in number of miles driven and changes in mode of travel. Such changes in behavior can also have more far-reaching impacts, as notable increases or decreases in travel can affect transportation-related revenues such as those derived from fuel taxes. Figure 4.2 shows the average monthly price for gasoline in the Midwest from 2002-2021. The lowest price during that time was $1.13 per gallon in February 2002, the highest price was $4.03 per gallon in June 2008, and the average during the 20-year time period was $2.59 per gallon.

Figure 4.2: Gasoline price per gallon, 2002-2021



Note: based on the Midwest retail average monthly gasoline price per gallon for all grades, all formulations

Source: U.S. Energy Information Administration

The fuel market can also affect transportation construction costs. In recent years, many state transportation departments have experienced unprecedented construction cost increases. The escalation of global fuel prices is one of several factors that has contributed to higher bid prices. As construction cost inflation continues, the buying power for all revenue sources decreases. In addition to construction costs, the supply and cost of fuel affects the operational costs associated with maintaining Iowa's expansive and aging public roadway system. Volatility in fuel prices can make budgeting difficult, particularly if coupled with extreme weather, such as severe winter storms, which can compound impacts on operational budgets. Increased fuel costs reduce funding available for maintenance, resulting in further deterioration of the system and loss of useful life.

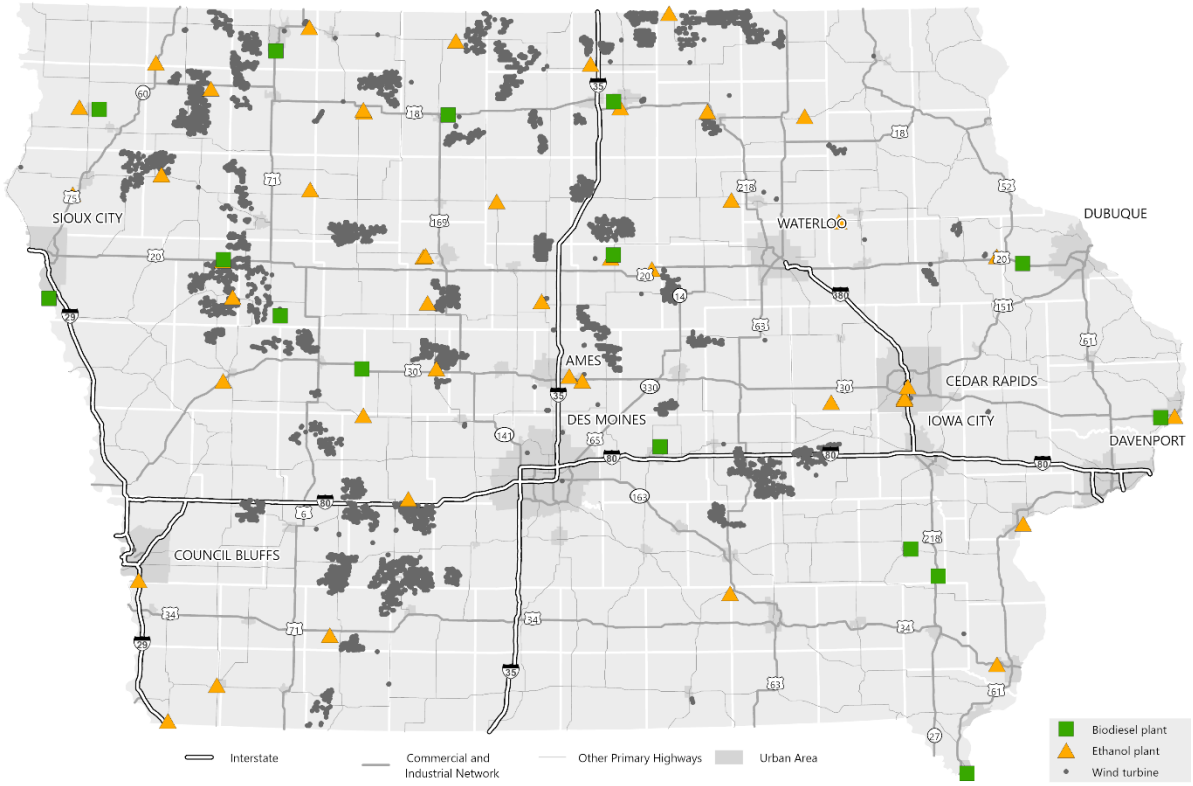
Energy Production and Movement

Biofuels and Wind Energy Industries

Iowa has emerged as a national leader in both the biofuels and wind energy industries, resulting in physical and financial impacts. An example of these impacts is increased large truck traffic during the construction of wind turbines or a biofuels plant; with the latter, traffic remains relatively high after construction to support plant operations. Increased rail traffic is also common on the lines that service these plants. This traffic growth leads to accelerated infrastructure deterioration and increased maintenance costs. Figure 4.3 shows the locations of Iowa's biofuel plants and wind turbines.

Ethanol and biodiesel fuels have become significant value-added products for Iowa's agricultural economy over the past few decades. Iowa produced over a quarter of the nation's ethanol and biodiesel in 2019, the most of any state, with a production capacity of 4.479 billion gallons of ethanol and 445 million gallons of biodiesel.

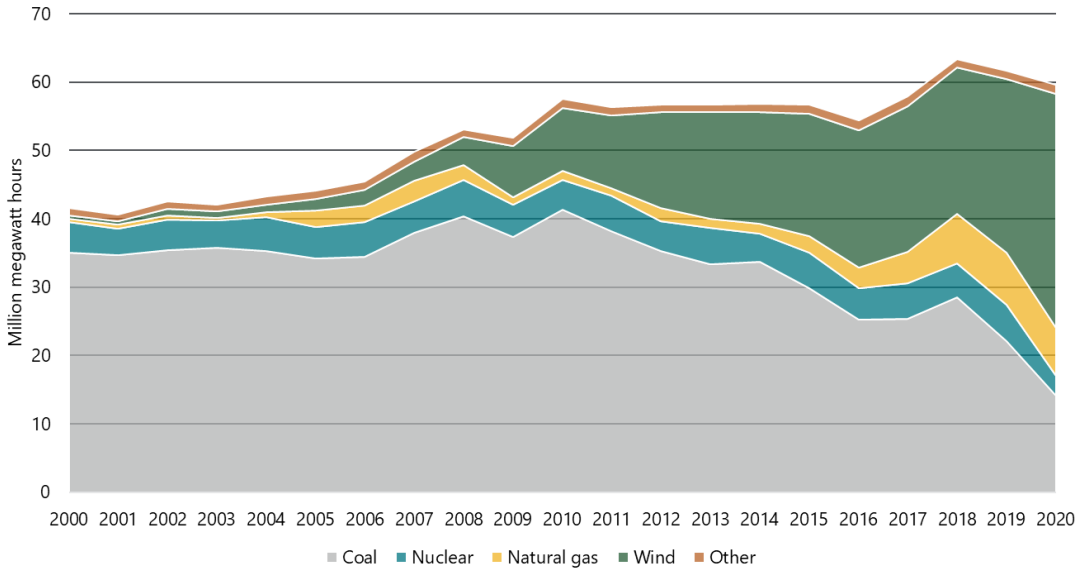
Figure 4.3: Iowa biodiesel plants, ethanol plants, and wind turbine locations



Source: Iowa DOT; U.S. Wind Turbine Database

Iowa has also become a leader in wind energy with 5,590 turbines operating statewide in 2020. A higher percentage of Iowa's electricity is generated by wind than any other state. Figure 4.4 shows trends in Iowa's electricity production since 2000. While overall electricity production has remained fairly level for the past decade, wind has overtaken coal as the source for the majority of Iowa's electrical power. Several manufacturing facilities in Iowa produce parts for the wind industry. The movements of the raw materials to make these components, the finished products, and the construction equipment to install the turbines have a significant impact on Iowa's transportation system. This requires coordination across modes and planning for the movement of oversize/overweight loads. If the transportation infrastructure supporting these movements deteriorates, costs to move the materials and products associated with these industries will increase. If this happens, the state could lose its competitive edge in these growing economies. The increase in wind energy production also corresponds to a decrease in coal energy production, which results in less coal being shipped into the state, which is typically done via rail lines.

Figure 4.4: Iowa electricity generation by source, 2000-2020



Source: U.S. Department of Energy

Crude Oil Movements

Energy production in the U.S. has been growing significantly since the turn of the century. One of the largest growing sectors, and perhaps the one with the largest impact on the national freight network, is hydraulic fracturing of rock or "fracking." This process allows for the recovery of deep sources of gas and petroleum products. Fracking has resulted in large amounts of gas and oil being extracted, particularly from the Bakken Shale formation region of North Dakota, Montana, and parts of Canada. This can have major transportation impacts, including increased freight traffic (product being shipped from the region and materials used for fracking being shipped to the region) and the potential for lower fuel prices.

Much of the freight movement to and from the Bakken region is by rail due to production increasing at a rate that exceeds the capacity of the nation's pipelines, and a significant portion of that is shipped through Iowa. Iowa DOT completed the Iowa Crude Oil and Biofuels Rail Transportation Study in 2016. The study considered both the physical characteristics (i.e., people, facilities, environment) in the vicinity of the crude oil and biofuels rail routes, as well as the insight of representatives from all sides of this industry. The study recommended improvement strategies in the areas of prevention, preparedness, response, and recovery.

Alternative Fuel Vehicles

In addition to the use of ethanol to make E85 and other fuel blends, and the use of biodiesel, other fuel sources are becoming common options for alternative fuel vehicles. The use of natural gas as a transportation fuel is being explored and adopted by some trucking and railroad companies. When used as transportation fuel, natural gas comes in the form of either compressed natural gas (CNG) or liquefied natural gas. The use of natural gas as a fuel in the trucking industry has increased substantially in the past several years. Despite the relatively low cost of diesel fuel, the price of natural gas has remained even lower, and future projections show prices remaining steady. Typically, trucking companies will add CNG vehicles to their fleets allowing for greater diversification and the ability to switch between diesel and natural gas for higher-mileage routes depending on the lower-cost option.

Electric vehicles have also become increasingly popular. Hybrid electric vehicles are powered by a combination of an internal combustion engine and an electric motor that uses stored battery energy. These vehicles do not receive energy from plugged charging; typically, the battery is charged by either regenerative braking or by the internal combustion engine. Plug-in hybrid electric vehicles can be powered through plug-in sources, and may or may not have an internal combustion engine for charging and/or operating. In 2021, there were 3,200 battery electric vehicles and 3,183 plug-in hybrid electric vehicles registered in Iowa. While still a relatively small number, electric vehicle registrations have increased significantly over the past several years.

Iowa's Energy Plan outlines several strategies for expanding the use of alternative fuel vehicles in Iowa. Implementing the strategies will be key to ensuring the transportation system is able to evolve along with changes to the vehicle fleet. The strategies include:

- Plan for electric vehicle charging corridors
- Alternative fuel vehicles station code education
- Business model development for the electric vehicle market
- Incentives for alternative vehicle fueling infrastructure

In coordination with the Iowa DOT, the IEDA also led a study in 2019 titled Charging Forward: Iowa's Opportunities for Electric Vehicle Infrastructure Support. The report investigated the infrastructure support needed for electric vehicles, evaluated costs and benefits, and made several recommendations related to clarifying and updating state policies and procedures, advancing planning and development of charging stations, and maximizing benefits for consumers.

Infrastructure has been developing across the state to support alternative fuel vehicles. According to the U.S. Department of Energy's Alternative Fuels Data Center, there are now over 1,000 charging stations in Iowa with alternative fuels. Most are for electric vehicles or ethanol, but there are also stations with biodiesel, CNG, and propane.

The growth in alternative fuel vehicles has several implications for transportation planning. They provide air quality benefits by aiding in the reduction of greenhouse gases. While many of these technologies require a higher up-front investment, the fuel sources tend to be a lower-cost option over the life of the vehicle. Some of these fuel sources require retrofitting equipment or providing new infrastructure, such as storage tanks for CNG and charging stations for electric vehicles. If alternative fuel vehicles continue to grow in popularity, they will also have significant implications for traditional transportation revenue sources, such as the fuel tax. To help address that, in 2019 the Iowa legislature passed changes in fees for electric vehicles. These include supplemental annual registration fees for passenger electric vehicles, a hydrogen fuel excise tax, and a per kilowatt hour excise tax for charging at non-residential charging locations.

Environmental Planning

National Environmental Policy Act (NEPA)

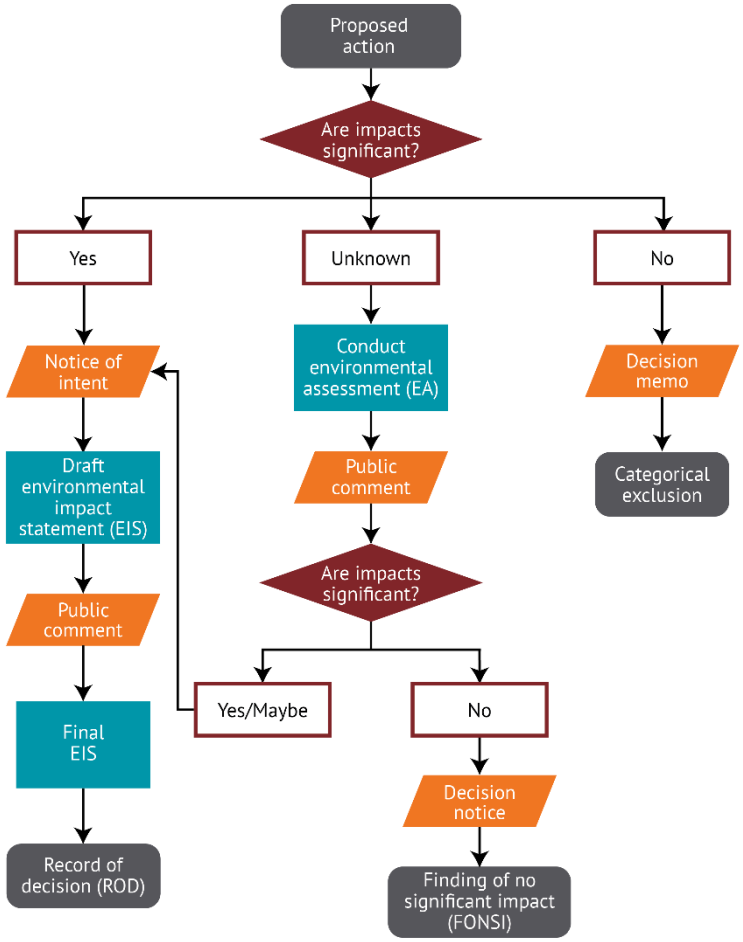
NEPA defines the process used by decision-makers to make informed decisions on proposed federal actions, which includes federally funded Iowa DOT actions. The NEPA process is an approach to balanced transportation decision-making that accounts for the potential impacts on the human and natural environment and the public's need for safe and efficient transportation. For recipients of federal funds, this means that before proceeding with a project, the project sponsor must first disclose any environmental consequences and evaluate alternatives that would avoid or lessen the project's impacts. In addition to evaluating the potential environmental effects, transportation needs of the public must also be taken into account when reaching a decision that is in the best overall public interest.

Levels of Environmental Analysis

Transportation projects vary in type, size, complexity, and potential to affect the environment. Their effects can range from minor to significant impacts on the natural and human environment. To account for the variability of project impacts, three basic "classes of action" are allowed, which determine how compliance with NEPA is carried out and documented. This decision-making process is shown in Figure 4.5.

- An environmental impact statement (EIS) is prepared for projects where it is known the action will have a significant effect on the environment.
- An environmental assessment (EA) is prepared for actions for which the significance of the environmental impact is not clearly established. Should environmental analysis and interagency review during the EA process find a project to have no significant impacts on the quality of the environment, a finding of no significant impact (FONSI) is issued. If significant issues are found, an EIS is prepared.
- Categorical exclusions are issued for actions that are not individually or cumulatively significantly affecting the environment.

Figure 4.5: NEPA document decision process



Source: U.S. Environmental Protection Agency

Planning and Environmental Linkages (PEL)

When possible, it is important to create an early linkage between planning and NEPA to develop early analysis and preliminary decision-making that can be incorporated into the project-level NEPA process. The Federal Highway Administration (FHWA) defines the use of PEL as "a collaborative and integrated approach to transportation decision-making that considers environmental, community, and economic goals early in the transportation planning process and uses the information, analysis, and products developed during planning to inform the environmental review process." This helps provide a solid foundation of information for the environmental review process, and enables early analysis, public input, and decisions to help streamline the environmental review. This process allows all parties the opportunity to get involved in the early stages of planning to help shape transportation projects and minimizes duplication of work in the planning and NEPA processes for large projects.

During the environmental review process, known environmental constraints are identified and potential and known impacts are (to the extent practicable) quantified and avoided, minimized, or mitigated so that a project can proceed towards further development. Within this process, feasibility studies can be used to outline the environmental setting and define the vision, goals, and strategies for a study area. Analysis at this stage of planning can include a range of possible engineering solutions, traffic analysis, cost analysis, and a review of potential project-stopping issues within the human and natural environment.

PEL feasibility studies provide the benefit of allowing planning-level decisions to be made for a larger study area and subsequently adopted into the NEPA process for smaller projects within the study area as those needs arise. However, for these planning-level decisions to be used in the NEPA process, the planning study must include public input and (among other conditions) be approved or validated no more than five years prior to the date on which the information is adopted. Also, FHWA notes that "To be viable in NEPA, a PEL study must involve interested State, local, Tribal, and Federal agencies as well as the public, document relevant decisions in a form that is identifiable and available for review during the NEPA scoping process and can be appended to or referenced in the NEPA document, and be accepted by the NEPA lead agencies."

In order to maintain these planning-level decisions, the Iowa DOT intends to review and update/reaffirm active feasibility studies in conjunction with the state transportation plan update, which is on a five-year cycle. This section serves as documentation of active feasibility studies that have been vetted through this review process.

Completed PEL studies include:

- I-80 – rural portions statewide
- I-380 – from south of Cedar Rapids to just north of the I-80/380 system interchange
- US 30 – from just east of Lisbon to just west of DeWitt
- US 18 – from Garner to Spencer

Underway PEL studies include:

- US 34 – from Albia to Union County
- US 63 – from west junction of US 6 to Hudson
- US 150 – from I-380 to Oelwein

Environmental Mitigation

Environmental mitigation proceeds differently at the planning and project development levels. At the broad, long-range planning level, it is primarily achieved through the inclusion of environmental resource inventories in the planning process and a comparison of transportation planning inputs and outputs to any environmentally sensitive resources. This is done to determine possible conflicts or benefits. Types of efforts typically conducted during this process include the development of inventories of environmentally sensitive resources, consultation with agencies at various levels of government that are responsible for environmental resources and oversight, and discussion of mitigation activities at the policy and strategy level.

The project development level involves the NEPA process outlined previously. Depending on the type of project and its potential environmental impacts, it may require a detailed environmental review. Should there be potential for major environmental impacts, mitigation measures will likely be required. Mitigation occurs in the following sequenced approach.

- Avoid the impact altogether by not taking a certain action or parts of an action.
- Minimize impacts by limiting the degree or magnitude of the action and its implementation.
- Rectify the impact by repairing, rehabilitating, or restoring the affected environment.
- Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action.
- Compensate for the impact by replacing or providing substitute resources or environments.

Example mitigation activities could include:

- Replace impacted wetlands at a 1:1 or 1:1.5 ratio.
- Replacement of parkland at 1:1 ratio or equivalent usage ratio.
- Avoid parking and/or storing construction equipment in the vicinity of potential groundwater contamination.
- Preserve trees along watercourses to protect aquatic life and prevent streambank erosion.
- Construct noise and/or visual barriers.
- Physically move the impacted resource while maintaining the structural integrity and historic qualities.
- Document the historical nature of a structure prior to demolition.

The mitigation activities highlighted above have the potential to be very costly. However, these expenses should be considered as a cost of doing business and should be reflected in the overall project cost estimates. Ultimately, the planning and coordination described in this section involves approaching a project area as one functioning ecosystem, which has the potential to be impacted by any planned activity.

Equity, Accessibility, and Civil Rights

Equity, particularly having equitable access the transportation system, is an important component of the transportation planning process. Civil rights laws exist to help ensure there is not intentional discrimination or barriers to system accessibility and use, but achieving a fully accessible and equitable system requires more than just meeting the minimums defined by law. This section will cover these closely related topics.

Equity

Equity is a topic that relates strongly to accessibility and civil rights. Accessibility is required to be able to use the transportation system, but accessibility may not be equitably available to all individuals. In a general transportation planning sense, equity means that the benefits and burdens of transportation are distributed fairly, and individuals have access to affordable and reliable transportation options that help them meet their needs. Fairly does not necessarily mean equally, as there may need to be additional consideration for underserved groups to be able to achieve the same level of access to and benefit from the transportation system as other groups.

Transportation policies and investments can directly or indirectly contribute to disparities; conversely, they can also help reduce the negative effects of existing inequities and improve quality of life. Thus, it is important to consider the ways transportation policies and investments impact equity and develop strategies and tools to support an equitable transportation system. While achieving full equity will require many community-specific and project-level actions, it is an important topic for system-level and long-range planning. Transportation infrastructure can have a lifetime that lasts decades and a significant impact on the land uses that surround it. Inequities that exist today are often the legacy of decisions that were made decades ago; it is important that decisions being made today do not contribute to these inequities or create new ones, but rather help us move towards a fully equitable system.

By necessity, system-level planning is typically conducted at a broad scale, and how the system is functioning is often distilled into singular performance metrics that are highly aggregated and may not accurately represent how the system functions for specific groups or users. It can be more straightforward to focus on the system and usage of it rather than users and their needs for it or access to it. Enhancing the emphasis on user and community perspectives on equity, accessibility, and mobility is an important step to take in order to more effectively integrate these views and needs into planning efforts and projects.

Accessibility

Accessibility can be thought of as an end goal of transportation – being able to get somewhere that you need or want to go – which is part of why it is so strongly related to equity. There are many different ways to view and measure accessibility, and questions such as the following can help in understanding whether a particular transportation mode, infrastructure, or service (all referred to generically as "system") is truly accessible.

- Is the system physically available and accessible by users with different ability levels?
- Is the system easy to use, safe, comfortable, affordable, and timely?
- Are there barriers that make the system more difficult or less desirable to use, such as limited service hours, winter weather, or congestion?
- Does the system provide access to desired destinations?
- Are mobility substitutes available, like telework or obtaining services via the internet?
- Do underserved populations have similar levels of access to the system as other populations?

Accessibility planning at a statewide level can be challenging, as the feasibility of using various modes, infrastructure, and services varies depending on the area being considered. A densely populated metropolitan area with hundreds of thousands of people differs significantly from a rural county with only a few thousand people. In Iowa, the vast majority of travel is conducted by personal vehicle, often with those vehicles only having a single occupant. This fact is unlikely to change in the near future. However, when considering the full population of Iowa (including children), more than 1 in 4 individuals are not licensed drivers. Taking a more people-oriented view, as opposed to traffic-oriented, and continually evaluating multimodal transportation options and including them in planning and project development is essential to continuing to improve accessibility.

These considerations can be implemented through a wide variety of planning efforts and policies. The Complete Streets Policy helped formalize accessibility considerations by requiring consideration of other modes. The policy notes that the Iowa DOT "shall view all transportation improvements as opportunities to improve safety, access, and mobility for all transportation users." In the area of automated transportation, as technology evolves and more use cases develop, it will be critical to ensure that these types of services are equitably accessible. They may be able to help with some commonly cited transportation challenges in Iowa, such as a lack of transportation options for older Iowans in rural areas and the challenges low-income workers that lack personal vehicles face in commuting to work. A recent initiative to improve accessibility of Iowa DOT rest areas has been to install adult changing tables, which helps meet a need for individuals that require assistance attending to their personal care in a restroom. In addition to accessing the transportation system, accessibility of transportation-related services, particularly those offered through the Iowa DOT's Motor Vehicle Division (MVD), is another important consideration. This will be discussed later in this section.

Accessibility/Mobility Analysis

An accessibility/mobility analysis was undertaken as part of SLRTP development. As previously noted, there are several ways to measure accessibility. The approach taken for this analysis was to focus on factors that may limit mobility, ability to access transportation infrastructure, and/or travel via a personal vehicle. The aim was to identify populations that may be more likely to have mobility challenges than the general public. While transportation planning should be conducted through a multimodal lens by default, these populations may be particularly in need of or best served by alternatives to driving. These populations may also be better served by non-traditional public outreach techniques. Future analysis efforts may work to integrate other accessibility considerations, such as availability of different transportation options and how many essential destinations can be reached by them.

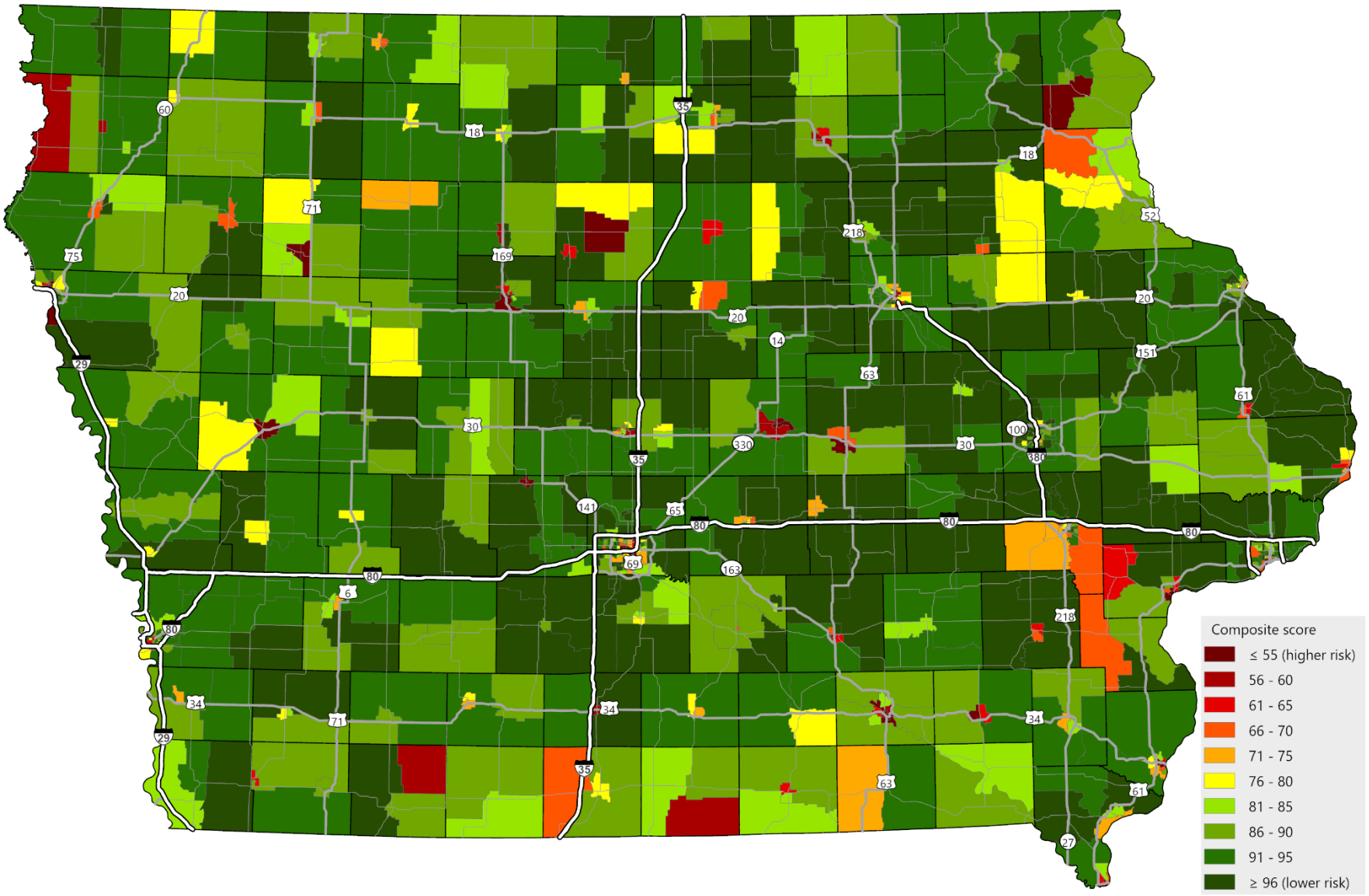
Analysis was conducted by using 2015-2019 American Community Survey data from the U.S. Census Bureau at the census tract level. The following ten attributes were included in the analysis.

- Youth – under 18
- Older adults – 65 and over
- Minority (non-White and/or Hispanic/Latino)
- Foreign-born
- Limited English proficiency
- With a disability
- Households below poverty level
- Zero vehicle households
- College enrolled
- Single parent households

The percentage of a tract's population for each attribute was used in the analysis, which was divided into a rural and urban analysis based on metropolitan planning organization boundaries. For each tract, the value for each attribute was normalized on a 1 (worst) to 10 (best) scale. The ten normalized values were then added together to determine a composite rating for the tract. The composite score had a maximum value of 100, which would mean the highest possible score was assigned for each factor. The higher a tract's score, the fewer mobility challenges its population has relative to other tracts in the state; lower composite scores indicate the most 'risk'.

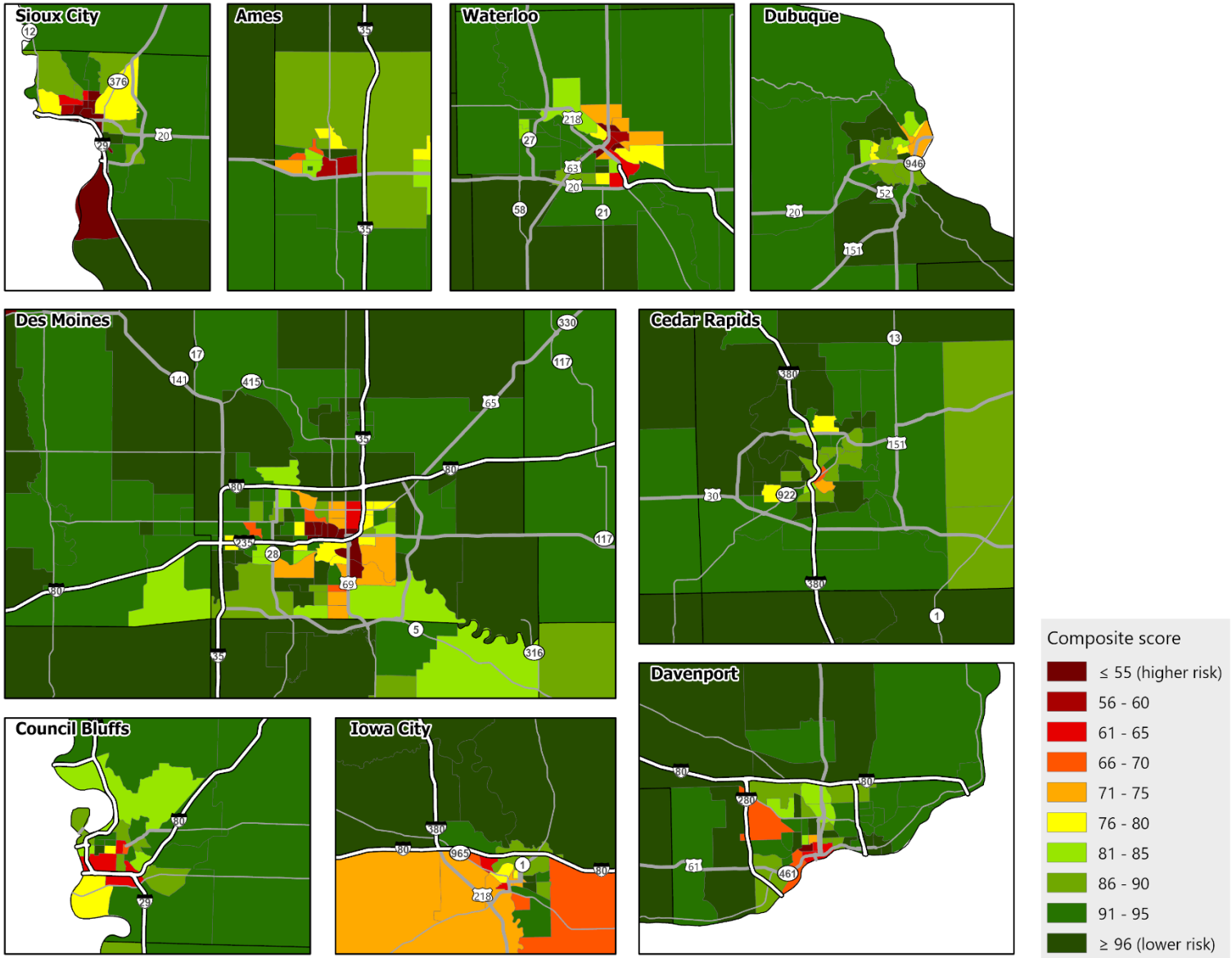
Overall, tracts ranking higher (lower scores) through this analysis tended to occur in the downtowns of large urban areas as well as around some small to medium sized communities around the state. Higher scores tended be associated with suburban and rural areas surrounding larger metros. The analysis helps identify locations where there is a greater risk of accessibility/mobility issues and where strategies related to multimodal transportation options and enhanced public outreach may be most beneficial. Figures 4.6 and 4.7 show the results of the accessibility/mobility analysis. The overall distribution of tract-level composite ratings ranged from 32-100, with an average score of 85.3. The Appendix includes additional information on the methodology and individual maps for each of the attributes in the analysis.

Figure 4.6: Accessibility/mobility analysis composite scores – statewide view



Source: Iowa DOT

Figure 4.7: Accessibility/mobility analysis composite scores – urban insets



Source: Iowa DOT

Motor Vehicle Division Services

To the average Iowan, one of the most visible parts of the Iowa DOT is the Motor Vehicle Division (MVD). MVD plays many roles in providing opportunities to businesses and individuals to have access to transportation. MVD ensures that individuals have proper licenses to safely drive and that vehicles meet safety standards and are legally titled and registered. The division provides services to businesses to ensure safe and efficient freight movements. MVD is focused on providing quality customer service and maintaining accessibility to individuals and businesses.

Driver and Identification Services
Driving lawfully requires a driver's license. MVD is responsible for reviewing and approving the state's driver education curriculum, including behind-the-wheel instruction to ensure new drivers have the skills and knowledge necessary to operate safely. This curriculum needs to be kept up to date to incorporate technology changes in vehicles and new trends in roadway design. MVD is creating a stakeholder group to advance the driver education curriculum to ensure the best preparation for new Iowa drivers. MVD and certain County Treasurers license drivers following the completion of both written and behind-the-wheel tests.

MVD takes special care to ensure that commercial drivers are properly trained, tested and licensed with credentials that will be recognized across the country as goods flow to, from, and through Iowa.

MVD also ensures that all Iowa driver license and identification products meet federal legal identity needs. Iowa complies with federal REAL ID requirements and MVD is working to ensure that Iowans can have a REAL ID-compliant driver license or identification card that will allow individuals access to federal facilities and commercial air travel once the program takes full effect in 2023.

Vehicle Registration and Titling
MVD oversees the issuance of titles, registrations, and license plates by County Treasurers to more than 4.5 million personal and commercial vehicles. This is important to ensure safety as vehicles must meet federal standards and the title and registration process also informs customers of possible damage or mileage-based issues for vehicles. Proper titling and registration protects ownership status on vehicles, and MVD's dealer licensing program helps protect consumer rights.

The division supports efficient truck freight movements by coordinating Iowa's participation in international registration and fuel tax agreements. MVD issues permits to appropriately oversize/overweight loads that are necessary to handle special bulk commodities, large pieces of equipment, and components of key construction projects, including wind turbine blades.

Motor Carrier Support
MVD helps motor carriers keep freight moving in Iowa by ensuring that truck freight movements in Iowa remain compliant with state and federal law, and that oversize/overweight loads are completed safely by properly routing trucks to minimize adverse impacts to the transportation infrastructure. MVD coordinates Iowa's participation in the International Registration Plan, the International Fuel Tax Agreement and the Unified Carrier Registration. These programs ensure that trucks moving to, from, and through Iowa are properly registered and that fuel taxes and registration fees are proportionally distributed among all member jurisdictions which contributes to ensuring a safe and efficient highway infrastructure across the United States and Canada. MVD issues special permits to oversize or overweight loads that are necessary to safety route large non-divisible pieces of equipment and components of key construction projects, including wind turbine blades and certain special bulk commodities through Iowa. This permitting process ensures that the loads can be moved

safely and that critical infrastructure – especially bridges – is protected and does not experience abnormal degradation. MVD actively works to educate and support motor carrier partners and will be initiating a new program in 2022 to hold periodic in-person meetings with carriers to review the application process and address broad motor carrier issues.

Revenue Collection

MVD collects millions of dollars annually to support the Road Use Tax Fund from titles, vehicle registrations, fuel taxes, electric vehicle registrations, driver license fees, and special license plates. The MVD Accounting section balances, clears, and audits all financial transactions handled by MVD and County Treasurers.

Accessibility

MVD serves persons with disabilities by distributing parking placards and helps non-drivers navigate in society with legal identification cards. The division also issues titles for vehicles owned by government agencies, including for public transit and shared-ride taxi services.

MVD has also expanded its role in helping individuals access the transportation system through the Get There Your Way program, created to improve personal mobility and access to information regarding an individual's options for transportation, whether it be through driving themselves, using public transit, or relying on other services available to them. The MVD has also increased its outreach efforts to ensure its services are accessible to all groups in Iowa's communities. A specific example is the recent addition of an Iowa DOT employee at the Mitchellville Correctional Center and the Newton Correctional Release Center to assist offenders with their transportation options prior to their reintroduction to society. The MVD also has mobility "kits" available to bring licensing services to where people are, whether it be at special events or unplanned circumstances such as a natural disaster.

As technology evolves, the MVD is moving more of its services to easily accessible online options when possible, such as online commercial and noncommercial driver's license renewal. The MVD is also working to roll out mobile ID, which will provide individuals with the option of having an updated driver's license on their smartphone. From an operations perspective, the MVD continually works to improve communication with customers. This includes the recent creation of an Advance Customer Experience (ACE) team consisting of various subject matter experts. The ACE team's function is to take the more complex, difficult cases from frontline teams so that the flow of customer questions and needs can be met more expeditiously. This helps improve answers and responses to customers seeking information about their individual transportation needs.

These examples are just a few of the many ways that the MVD is involved in helping individuals and motor carriers access the system. Continued advancement of these initiatives will be critical to continue to improve the accessibility of transportation in Iowa.

Civil Rights

Equity and accessibility are goals of the transportation planning process that are merited whether they are required or not. However, there are many civil rights-related laws and executive orders (EOs) that the Iowa DOT works to ensure are incorporated into the transportation planning process and its day-to-day operations to safeguard that individuals are not discriminated against. While only a few of these regulations will be discussed in this plan, the department's Civil Rights Bureau works to ensure all civil rights and non-discrimination laws are incorporated into the department's work. To this end, the Iowa DOT assures that no person shall on the grounds of race, color, national origin, sex, age, and disability be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any Iowa DOT service, program, or activity regardless of whether those programs and activities are Federally funded or not.

Title VI and Limited English Proficiency (LEP)

Title VI of the Civil Rights Act of 1964 and its implementing regulations provide that no person shall be subjected to discrimination on the basis of race, color, or national origin under any program or activity that receives Federal financial assistance. The Iowa DOT has a Title VI Plan and Title VI Program and works to ensure its protections are fully implemented in department activities. LEP is a closely related topic. In 2000, EO 13166 was signed, entitled Improving Access to Services for Persons with Limited English Proficiency. It prohibits recipients of Federal financial assistance from discriminating based on national origin by failing to provide meaningful access to services to individuals who are LEP. This protection requires that LEP persons be provided an equal opportunity to benefit from or have access to services that are normally provided in English. The Iowa DOT has an LEP Plan that examines its services and the population it serves, identifies needs related to LEP individuals, and provides examples of providing meaningful access. An example of a commonly used technique is translating public meeting notices into other languages when there is a sizeable portion of the project area that speaks that language.

Environmental Justice

An overlapping but distinct topic from Title VI is environmental justice (EJ). EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, was signed into law in 1994 and requires that "each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States." The Federal Highway Administration (FHWA) defines EJ as "identifying and addressing disproportionately high and adverse effects of the agency's programs, policies, and activities on minority populations and low-income populations to achieve an equitable distribution of benefits and burdens."

EJ is the term used to describe the uneven environmental and social hardships that disadvantaged groups bear. EJ is a broad and multifaceted social welfare issue. Within the realm of transportation, consideration of EJ is important given that impacts of transportation can be both beneficial (e.g., improved access and mobility) and burdensome (e.g., increased noise and congestion). Because of the diverse and potentially uneven transportation impacts, it is important that EJ be considered throughout the transportation planning process, including short- and long-range planning and public participation outreach efforts. Specifically, by identifying the transportation patterns of underserved groups and involving them in the public participation process, the needs of these groups can be determined and assessed to guide transportation investment and ensure impacts are distributed as equitably as possible.

Americans with Disabilities Act (ADA) of 1990

Another issue closely tied to EJ under the umbrella of civil rights is compliance with the ADA. Title II of this legislation emphasizes the accessibility of infrastructure within the public right-of-way. Title II also requires the Iowa DOT to develop a transition plan to bring facilities into compliance with the ADA. As a result, a transition plan was developed identifying specific steps the Iowa DOT will take to achieve ADA compliance. These steps are:

1. Identify physical obstacles limiting the accessibility of programs or activities to individuals with disabilities.
2. Describe in detail the methods that will be used to make facilities accessible.
3. Develop a schedule for achieving compliance.
4. Identify the Iowa DOT's ADA coordinator who will be responsible for ADA compliance.
5. Develop a grievance procedure to review complaints.
6. Initiate public involvement and provide community awareness.

To ensure ongoing compliance with ADA requirements, the Iowa DOT will perform periodic reviews of the transition plan and update it as necessary. Implementing the transition plan has involved evaluating and planning for numerous infrastructure assets, including:

- Iowa DOT buildings.
- Public transit facilities (bus stops and shelters) in the state right-of-way.
- Bicycle facilities within the state right-of-way.
- Pedestrian facilities, including curb ramps and traffic signal call buttons, within the state right of way in municipalities with less than 5,000 people. (Those over 5,000 should have their own transition plans.)

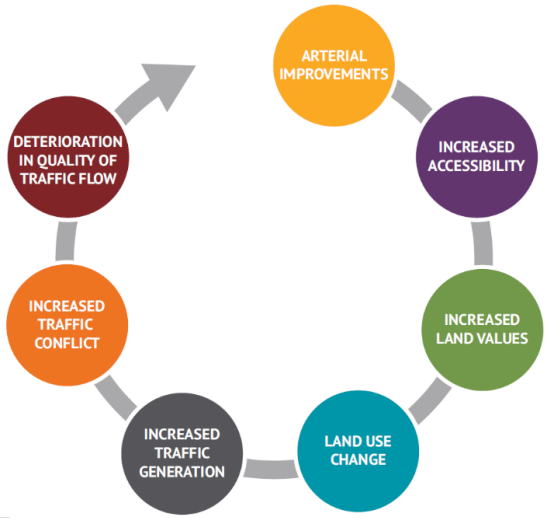
Land Use, Livability, and Quality of Life

Federal surface transportation reauthorization bills have continued to emphasize the need to consider land use and quality of life as one of the ten transportation planning factors. In land use planning, areas are often classified to accommodate a variety of uses, such as residential, commercial, industrial, agricultural, and others. Coordinating land use and transportation planning is essential in creating more sustainable, vibrant, and well-connected communities. Several recent planning initiatives such as new urbanism, smart growth, complete streets, and transit-oriented development are only achievable when cooperation between the transportation and land use sectors takes place. In addition to creating healthier, safer, and more efficient communities, sensible land use decisions are essential to Iowa's economy, where urban expansion can lead to the loss of valuable farmland.

The linkage between transportation and land use is also demonstrated through access management, which is the management of vehicular access points to adjacent land parcels. Managing access points increases safety and efficiency for travelers. Common access management techniques include providing larger spaces between driveways and side streets; increasing the distance between access points and traffic signals; safe turning lanes; median treatments; and right-of-way management.

While policies, principles, and strategies for integrating transportation and land use can be established on the state level, the most visible coordination takes place on the local level. Figure 4.8 illustrates the cyclical nature between land use and transportation, and shows the need to be continuously mindful of present and future land use needs when making transportation investment decisions. Transportation improvements can themselves induce additional travel by increasing accessibility and mobility. This can apply not only to roadways, but other modes as well.

Figure 4.8: Transportation and land use cycle



Source: FHWA

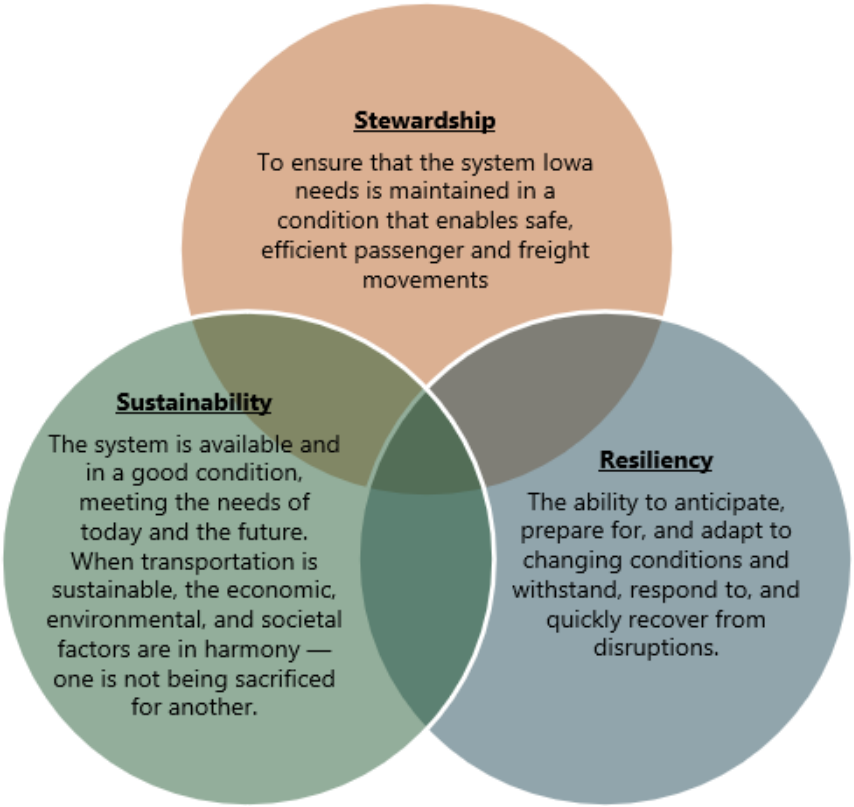
In the transportation planning process, livability is an important consideration in maintaining a community's quality of life. A livable community has a well-connected transportation network with many transportation choices and better facilities, which in turn provides access to quality jobs, housing, schools, and other amenities. Transportation enhances quality of life both by providing these vital connections and options, and also by being an attraction in and of itself, such as a highly developed trail system. These types of features can be key for businesses looking to recruit and retain workers.

Enhancing livability in Iowa through transportation can be achieved by investing in multiple transportation modes, maintaining roadway infrastructure, expanding bicycle and pedestrian facilities, utilizing new technologies, and coordinating new investments with surrounding communities. As Iowa's population grows, it is important to strengthen communities through valuing and supporting the existing transportation network.

Resiliency and Sustainability

Iowa's extensive transportation system empowers the movement of people and goods throughout the state to reach diverse destinations. This network provides a reliable backbone to the state's economy and serves as a crossroads for economic productivity for the nation. However, this system, like all systems, is vulnerable to disruptions in the form of natural and human-induced events. While resiliency and sustainability activities have been occurring for some time, the focus on them and enhancement of them has increased significantly in recent years. Resiliency and sustainability are building blocks of stewardship. The Iowa DOT has the responsibility not only to meet the expectations of the public to ensure that the system is available and in good condition, but that it will continue to be so in the future, despite pressures from fiscal constraints and increasing natural disasters. Incorporating resiliency and sustainability principles into the decision-making process and project development will further support the Iowa DOT's commitment to stewardship of Iowa's transportation system. Iowa DOT's definitions of these three elements are shown in Figure 4.9.

Figure 4.9: Stewardship, resiliency, and sustainability



Source: Iowa DOT

Over the last couple of decades, Iowa has been increasingly impacted by natural disasters, including historic flooding, snowstorms, tornados, and derechos. This trend is likely to increase as climate data shows strong trends towards increasing temperatures, precipitation, stream flows and flooding. Additionally, awareness of human-induced disruptions has amplified as vigilance for potential terrorism and cyberattacks has increased. Examples of potential disruptions to Iowa's transportation system include the following.

- Human-induced hazards
  - Averse actor physical threat
  - Congestion
  - Crashes
  - Cyberattack
  - Asset failure
- Natural, environmental, and extreme weather events
  - Flooding
  - Erosion
  - High wind
  - Increased precipitation (e.g., rain, snow, ice)
  - Landslide/rockfalls
  - Tornados and derechos
  - Snow/blizzard

While trying to prepare for or mitigate potential disruptions, it is important to recognize that transportation programs and projects serve several different and sometimes competing objectives. With constrained budgets and conflicting priorities, it can oftentimes be difficult to justify making decisions in the short-term, even if they make sense in the long-term. Sustainability is a concept that allows decisionmakers to make balanced decisions while considering the economic, social, and environmental effects of the agency's actions.

Air Quality and Climate Change

Air quality and climate change are two issues closely tied to the subjects of resiliency and sustainability. The Iowa DOT has been monitoring a number of recent air quality developments, particularly those related to the National Ambient Air Quality Standards (NAAQS) for particulate matter and ozone. The NAAQS for particulate matter were last adjusted in 2012, and the NAAQS for ozone was most recently lowered in 2015. The Environmental Protection Agency anticipates issuing a new rulemaking on the particulate matter NAAQS in 2022-2023. Iowa continues to remain in attainment for both criteria air pollutants; a nonattainment status would result in additional transportation planning and programming requirements for the state.

As Iowa prepares for the possibility of increasing air quality regulation, the state is also preparing for the effects of a changing climate. These impacts, particularly extreme weather events, would not only affect the state in areas such as agriculture and public health, but could also result in serious implications for Iowa's transportation infrastructure. According to Climate Change Impacts on Iowa, a 2010 report by the Iowa Climate Change Impacts Committee, the 2008 flooding in Iowa accounted for $660 million in infrastructure losses. Damage from the 2019 floods topped $1 billion. Climate changes Iowa is already experiencing include increased precipitation, higher temperatures, agricultural challenges, habitat changes, and public health effects.

Iowa's changing climate and air quality levels have the potential to affect the state's current transportation infrastructure and future project decisions greatly, and it is vital these issues are considered during the planning process.

Current Efforts

Several resiliency and sustainability efforts have been undertaken or are underway. Following the 2019 floods that had severe impacts along the Missouri River and Mississippi River, a flood resiliency analysis was conducted to screen the Primary Highway System to identify locations vulnerable to a 100-year flood event. The analysis also focused on robustness and redundancy elements of the system; the results of this analysis are included the highway analysis section of Chapter 5. Other resiliency efforts have included coordination of Emergency Relief (ER) program items related to the 2019 floods, including completion of detailed damage inspection reports, and defining betterment design standards and guidance for embankment protections, which can help stabilize slopes.

Sustainability efforts have included the long-running Iowa Living Roadway Trust Fund, which was established in 1990 and has provided millions in funding for research and demonstration projects, vegetation inventories, education and training programs, gateway landscaping, snow and erosion control, roadside enhancement, and more. Also, the concept of integrated roadside vegetation management has a long history in Iowa; it integrates the use of native and other select types of vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadsides. This helps reduce mowing and use of herbicides. Another sustainability effort included a pilot study of six bridges to develop a methodology to evaluate their vulnerability to climate change and extreme weather; the lessons learned can then be applied to future bridge designs.

Working Groups

The Iowa DOT has established working groups for both resiliency and sustainability. Both groups have begun meeting regularly, established charters, and are beginning work that will help more fully integrate these themes into Iowa DOT's work.

Resiliency Working Group

The resiliency working group provides guidance, support, and coordination of resiliency efforts within the Iowa DOT. This includes proactive efforts to increase the system resiliency and response efforts to restore the operation of the system after a disruption. The group plans to accomplish this through synthesizing existing efforts, developing standard operating procedures, and strategically planning for future events. The mission of the resiliency working group is to properly prepare for and reduce the impact of future disruptions to Iowa's transportation system.

Underway and planned activities include:

- Research best practices relating to incorporating resiliency into the project development process.
- Develop standard operating procedures relating to incorporating resiliency into Iowa's project development process.
- Establish an internal workflow for applying to FHWA's ER Program and for implementing betterments.
- Identify past projects within Iowa that demonstrate resilient practices in planning or engineering.
- Adopt a statewide network screening to identify areas of greatest vulnerability to disruptions.
- Identify and maintain a listing of engineering countermeasures that increase the resiliency and reduces the vulnerability of the transportation system.
- Develop engineering design standards for select countermeasures.
- Incorporate resiliency into the planning process.

Sustainability Working Group

The sustainability working group aims to provide agency-wide guidance in developing and implementing sustainable practices through the creation of focus areas and agency wide goals. The committee will serve as the sustainability governance body within the department and act as a resource for new sustainability programs. This ongoing support will help ensure that the Iowa DOT considers or adopts new sustainability practices as appropriate. The group will accomplish this through the creation of focus areas with metrics that can be utilized to gauge the department's performance, research of potential opportunities to reduce the department's environmental impact or carbon footprint, and the unification of the Iowa DOT behind these initiatives. Sustainability can be implemented across many facets of the department, including facilities, fleet, roadside management, construction, operations, resiliency, purchasing, indirect infrastructure, planning, workforce, and agencywide areas.

Underway and planned activities include:

- Develop a sustainability strategy, including mission, vision, and key principles.
- Conduct a sustainability assessment.
- Create a structured communication plan for sustainability.
- Document a workflow for sustainability within the agency.
- Develop a Sustainability Plan for the agency.
- Create an initial work plan and recommendations to implement the Sustainability Plan.
- Participate in research projects to improve sustainable transportation infrastructure in Iowa.

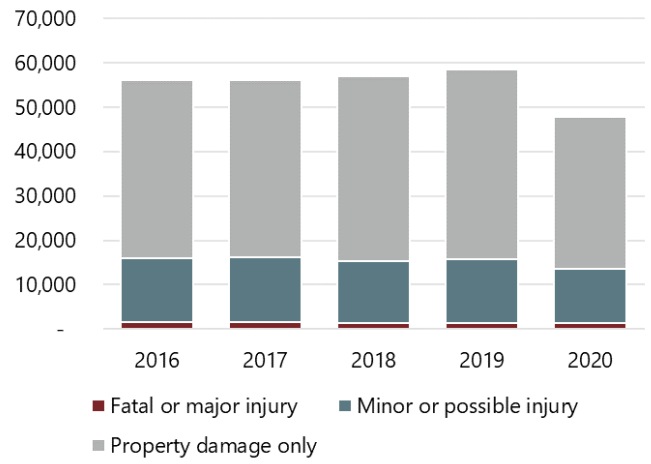
Safety

Safety is at the heart of the Iowa DOT and the SLRTP. The department emphasizes safety in all efforts, including enforcement, education, engineering, and emergency response. Safety is most often thought of in terms of the highway mode, but each modal area is an important part of an interrelated transportation system. The overriding goal for all aspects of transportation safety is to reduce fatalities and injuries, thereby reducing personal and economic losses experienced by families, employers, and communities, and improving Iowa's quality of life. Educating users, designing safer facilities, and joining with partners in collaborative efforts can achieve this.

Safety Trends

Figure 4.10 shows total crashes by severity between 2016 and 2020. There were over 275,000 crashes including 1,725 fatalities on Iowa roadways. The year 2016 was an outlier for fatalities with 402 fatalities; there have been an average of 331 per year since. While total crashes dropped by about 10,000 from 2019 to 2020, likely due to the COVID-19 pandemic and decreases in travel, the total number of serious (fatal or major injury) crashes only decreased by 2%. The longer-term trend of fatalities in the state has been decreasing, but is still far above zero, which is the only truly acceptable number.

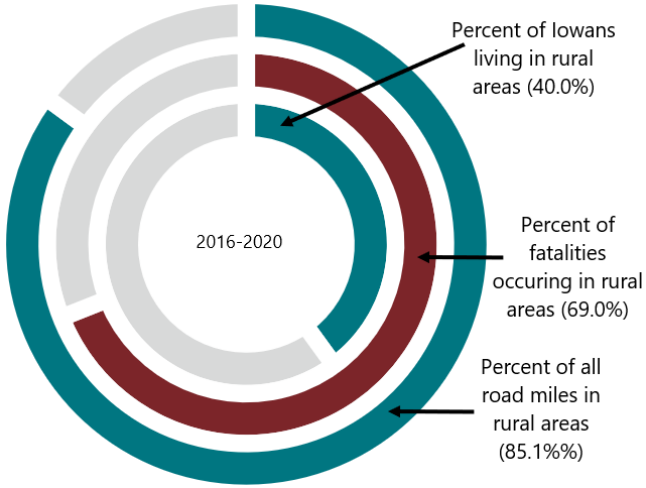
Figure 4.10: Total crashes by severity, 2016-2020



Source Iowa DOT

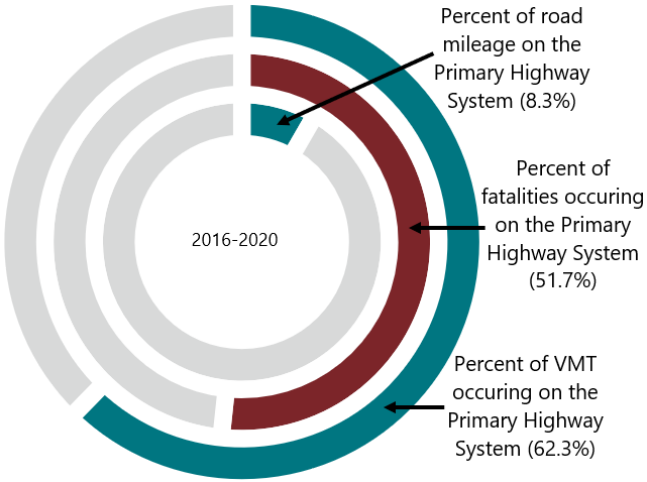
Although the rural population continues to decline in Iowa, roadway fatalities in rural areas continue to represent a higher number of Iowa's fatalities as compared to urban areas, as shown in Figure 4.11. Part of the reason for this is that the majority of Iowa's vast roadway system is in rural areas. Overall, 69% of Iowa fatalities occurred in rural areas during this period. Fatalities are also over-represented on the Primary Highway System relative to its mileage, but not when compared to the amount of vehicle miles traveled (VMT) on the system, as shown in Figure 4.12. In other words, roughly half of fatalities occurred on the Primary Highway System, while it accounts for only 8.3% of the state's road mileage, but 62.3% of the state's VMT.

Figure 4.11: Crash fatalities and rural areas, 2016-2020



Source: Iowa DOT

Figure 4.12: Crash fatalities and the Primary Highway System, 2016-2020



Source: Iowa DOT

Safety Planning Efforts

Strategic Highway Safety Plan

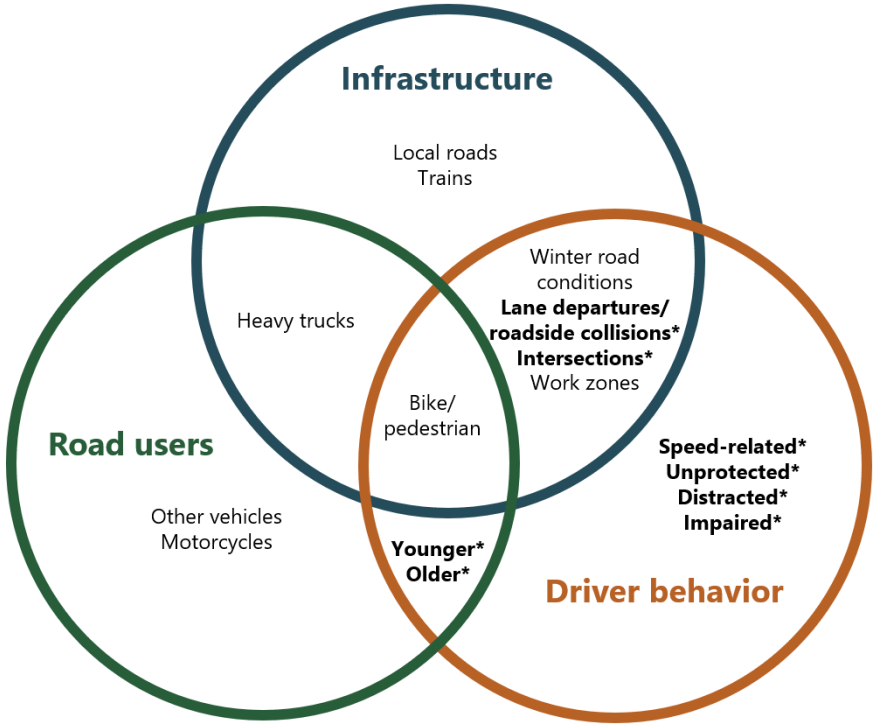
Surface transportation reauthorization bills have continually reinforced the importance of safety. An important federal program is the Highway Safety Improvement Program (HSIP), which includes a requirement for states to develop a Strategic Highway Safety Plan (SHSP). According to the U.S. Department of Transportation, an SHSP is a "statewide coordinated safety plan that provides a comprehensive framework for reducing fatalities and serious injuries on all public roads." The purpose of the SHSP is to identify effective safety strategies to address areas of greatest need to make roadways safer.

The 2019-2023 SHSP is the fourth such planning effort in Iowa since it became a requirement. Iowa's SHSP was developed in consultation with the SHSP Implementation Team, which is composed of individuals representing the E's of safety – education, emergency medical services, enforcement, and engineering. These representatives supported a multidisciplinary approach and provided updates on programs, policies, and educational campaigns for their respective organizations, as well as data on the latest research for their areas of expertise.

An important SHSP component is the evaluation of safety emphasis areas, which involves identifying and attributing crashes to one or more designated emphasis areas to prioritize and develop strategies for the areas that have the greatest opportunities for reducing fatal and serious injury crashes. For this SHSP, the prioritization of Iowa's 18 safety emphasis areas was supported by an analysis of crash data and an extensive statewide input process involving Iowa's traffic safety stakeholders. The result of these efforts was the determination of eight of the areas as priority safety emphasis areas. The Implementation Team identified strategies that provide the greatest opportunity to reduce fatalities and serious injuries for each of the eight areas.

To facilitate the prioritization process, the Implementation Team decided to group the safety emphasis areas into three broad categories: infrastructure, road users, and driver behavior. Figure 4.13 demonstrates the relationships between these categories and the safety emphasis areas analyzed in this plan. This illustration also reveals how strategies related to each of these safety emphasis areas might also have an impact on secondary areas as well.

Figure 4.13: Safety emphasis areas



Note: the eight priority safety emphasis areas are bold and marked with an asterisk.

Source: Iowa DOT

Local and District Road Safety Plans

Another planning effort occurred to take proactive steps for addressing crashes on rural roadways. Using Minnesota's local road safety plans (LRSP) as a model, the Iowa DOT began developing county specific LRSPs in 2015. The LRSPs analyze the types of crashes occurring on the road system and use a risk-based assessment to identify proactive improvements to mitigate crashes. The result of an LRSP is a prioritized list of safety projects for the county that proactively address the safety performance of roadways. The Iowa DOT then developed a District Road Safety Plan (DRSP) for each of its six districts. The DRSPs identified systemic safety improvements along the primary highway network based on a segment and intersection risk factor analysis. The DRSPs included a prioritized list of safety improvement projects for each District, and many of these projects have been implemented.

Modal Safety

Transportation safety is most often thought of in terms of the highway mode and crashes, yet it is an important component of each mode of transportation. The following provides a brief overview of safety considerations for other modes.

Aviation Safety

System planning and aviation programs strive to maintain infrastructure and services promoting safety in Iowa's aviation transportation system. Services specific to safety include a statewide network of aviation weather systems, a runway marking program, and windsocks for airports. While the Federal Aviation Administration certifies pilots, commercial airports, and aircraft, Iowa assumes responsibility for certifying that public-use airports meet minimum safety standards. The state also sponsors education safety programs geared toward pilots, aircraft mechanics, airport operators, and aerial applicators.

Aviation safety measures such as accident rates or statistics are challenging to report for multiple reasons. Many of the aircraft that fly over the state and may have an emergency or incident are not based in Iowa. Also, an aircraft incident in Iowa does not necessarily reflect any infrastructure or service issues with airports in the state.

Bicycle and Pedestrian Safety

Bicycle and pedestrian facilities interplay with highway and local street systems and include both shared and separated facilities. Iowa has incorporated many safety strategies and programs to protect those using bicycle and pedestrian facilities. These strategies and programs include the distribution of Transportation Alternatives Program (TAP) funding across metropolitan planning organizations (MPOs) and regional planning affiliations (RPAs), where it is primarily used for bicycle/pedestrian projects; federal and state recreational trails programs; the Complete Streets Policy and design guidance; safety compliance; AASHTO design guidelines; facility compliance; optimization of signal design; and support for bicycle helmet use.

Bicyclists, pedestrians, and individuals using personal conveyances or mobility assistive devices are vulnerable road users. When pedestrians and bicyclists are involved in a crash, they are often more vulnerable because of the effects of speed and lack of physical protection. From 2012-2020, about 6.5% of Iowa's crash fatalities and major injuries each year were non-motorized users. While there is some year-to-year variation, the overall trend has been relatively flat. Bicyclists and pedestrians were included as a safety emphasis area in the 2019-2023 SHSP, and additional planning work has been done since then including the development of the Statewide Bicycle and Pedestrian Systemic Safety Analysis in 2020. This work is the basis of the bicycle/pedestrian analysis discussed in the highway needs and risks section of Chapter 5.

Public transit safety

Safety is integrated throughout public transit, including planning, design, operations, maintenance, employee training, technology development, and implementation of the Federal Transit Administration's drug and alcohol testing programs. Intelligent technology systems, such as in-vehicle cameras and radio communications, are incorporated when possible to enhance safety. A notable planning requirement that became effective in 2020 is the development of Public Transportation Agency Safety Plans for agencies that receive urbanized area formula funds. In Iowa, that translates to the 12 agencies that are located in urban areas of 50,000 or more. The plans include the agency's safety management systems, including the agency's safety management policy and processes for safety risk management, safety assurance, and safety promotion; an employee reporting program; and performance targets..

Rail safety

Iowa's rail system includes both commercial freight and passenger rail. Due to the large number of rail and highway intersections, rail crossing safety is critical. Several rail crossing safety programs are administered by the Iowa DOT, including the federal-aid Highway-Railroad Crossing Safety Program, the Grade Crossing Surface Repair Program, and Iowa's Highway Railroad Grade Crossing Safety Program. Safety programs support projects such as grade separations, track maintenance, and signal upgrades. The Iowa DOT also cooperates with implementation of the National Rail Safety Action Plan and supports Operation Lifesaver, which is a nonprofit education and awareness program dedicated to ending highway-rail collisions.

Over the last ten years, there were 378 crashes between highway and railroad traffic and 331 train derailments, with a relatively consistent number occurring each year. A total of 85 injuries and 98 fatalities resulted from those crashes and derailments, both with inconsistent trends by year.

Security

Security is an important consideration in the transportation planning process, and received heightened attention following the terrorist attacks of September 11, 2001. Security should not be thought of only in terms of criminal or terrorist attacks, but also for the same vulnerabilities that resiliency efforts are often focused on – natural and manmade incidents, such as floods, tornadoes, and hazardous materials spills. In Iowa, recent flooding, derecho, and winter weather events have dramatically affected both rural and urban transportation systems, requiring adjustments to response policies and procedures. All modes of transportation are vulnerable to disruption due to natural or manmade incidents. The Iowa DOT partners with agencies at all levels of government to implement security and emergency management initiatives.

The Traffic Operations Bureau is responsible for overseeing the Iowa DOT's security and emergency response efforts. Many of the bureau's core functions relate to managing and operating the system and are a key part of these efforts. This includes several intelligent transportation system (ITS) components. Iowa has a 511 traveler information system in operation, which has important applications for both emergency operations and homeland security concerns. The 511 system is a nationwide program that is administered and funded at the state level and provides callers, website visitors, and app users with free access to real-time, route-specific travel conditions, weather conditions, incidents, congestion, and construction information. Live feeds from the Iowa DOT's network of traffic cameras are available to the public. Dynamic message signs are also part of roadway safety and security ITS applications. The Iowa DOT has placed large electronic signs on Interstates and primary highways for congestion mitigation, traffic management, and emergency diversion efforts. This system is operated remotely from the Iowa DOT.

The Iowa DOT partners and coordinates security-response efforts with a variety of entities, including local agencies such as county sheriff and city police departments, which provide critical local enforcement services. Private companies such as rail lines, trucking companies, emergency medical services, and towing firms also play a critical role in transportation security. This is especially true where the Iowa DOT has little jurisdictional authority. Other important partners include local urban and rural planning agencies, the Governor's Traffic Safety Bureau, and the Iowa Department of Homeland Security.

While security of the transportation system is essential at all times to keep people and the economy moving, during emergencies, the transportation network is critical for agencies to be able to respond. When there is a significant incident, disruption, or disaster, transportation is required for emergency responders, equipment, and supplies to travel to affected locations to provide support. The public may need to travel to obtain care or supplies, or to evacuate from an affected area. The highway network is typically the backbone of any emergency response, but other modes may be critical as well, such as moving supplies by air or coordinating with public transit agencies to evacuate vulnerable individuals.

The Iowa DOT's Emergency Management (EM) Service Layer Plan, completed in 2019, provides an overview of emergency management activities and the linkages to other traffic operations activities. Another plan, the Traffic Incident Management Service Layer Plan, addresses management of day-to-day incidents on the transportation system, but the EM Service Layer Plan outlines Iowa DOT's role in large scale emergencies. This includes those that happen commonly, such as winter storms and flooding, as well as other less common but potential events, such as nuclear power plant emergencies, cyber security attacks, and others. The EM Service Layer Plan includes objectives that reflect guidance from the National Incident Management System (NIMS), the National Response Framework (NRF), and other resources. These

objectives are focused on minimizing impacts, enhancing safety, improving coordination, reducing risk, and enhancing overall response efforts.

EM at the state level is organized by Emergency Support Functions (ESFs), following the NRF. There are 15 defined ESFs, including transportation, which aid in federal and other agency coordination. When warranted, such as during the severe 2019 flooding in western Iowa, the State Emergency Operations Center (EOC) will be activated and ESFs applicable to the emergency event will report to the EOC to assist with coordination of information and resources to support incident command. Outside of situations like this, there is much ongoing work including planning and training, special event coordination, after action reviews, and EM exercises.

Security in general and emergency management in particular will continue to be a key consideration in the Iowa DOT's efforts. A proactive approach and coordination with many public and private partners will continue to be keys to success.

Technology

Technology is rapidly changing in the field of transportation. These changes will affect more than just mode choice and auto ownership; the impacts will likely affect how we utilize increasing amounts of data and how the future economy will function. Although experts disagree with how quickly some innovations will be adopted, it is clear technology will continually be integrated into the transportation system and there is paradigm-shifting potential for the way people travel. Despite quickly changing technology, concerns and barriers still exist related to the cost, safety, security, privacy, and regulation of these new technologies. As the ways people travel and goods are transported continue to change, the Iowa DOT will continue to adapt to help ensure Iowa has a safe and reliable transportation system.

Transportation Options

As discussed in Chapter 3, many recent developments in technology are already influencing how people travel. Transportation network companies, such as Uber, Lyft, and others, connect passengers with drivers who provide the transportation in their own vehicles, typically through a website or mobile app. Some public transit services are working with these companies to help riders make the first-mile/last-mile connections to transit routes. Shared transportation services are emerging that enable travelers to utilize vehicles they do not own on a limited, on-demand basis, typically by paying online or at a kiosk. Bike-sharing programs exist in some Iowa communities, and car-sharing programs are becoming more common nationwide. Transportation subscription services are also emerging, which enable consumers to pay a fee allowing them access to multiple modes of transportation. While many of these types of services are primarily applicable in urban areas, they are beginning to change the way people choose to travel, and may have significant effects on future planning across modes.

E-commerce

E-commerce is growing significantly and impacting market trends and freight movement, with even more rapid growth experienced over the last two years resulting from the COVID-19 pandemic. According to the U.S. Department of Commerce, e-commerce has grown from less than one percent of total retail in 2000 to close to 14 percent in 2021. This trend is projected to continue in years to come.

This new model of buying and selling has changed the way retailers and consumers interact with each other as purchasing goods online typically means bypassing traditional brick-and-mortar stores and traveling directly from a warehouse or distribution center to consumers' homes, or vice versa when product returns are necessary. Some of this shift represents the last mile trip for consumer goods now being made by a delivery truck rather than store-to-home trips by consumers.

Online sales of most products, from clothing to perishable items like groceries, are experiencing growth. This means an increased emphasis on the reliability and timeliness of truck transportation, changing truck delivery patterns, an increase in shorter trips, and a greater strain on local infrastructure. Other related impacts include an increased demand for air cargo and efficient terminals and changing land use and development patterns such as locating inventory and distribution closer to population centers.

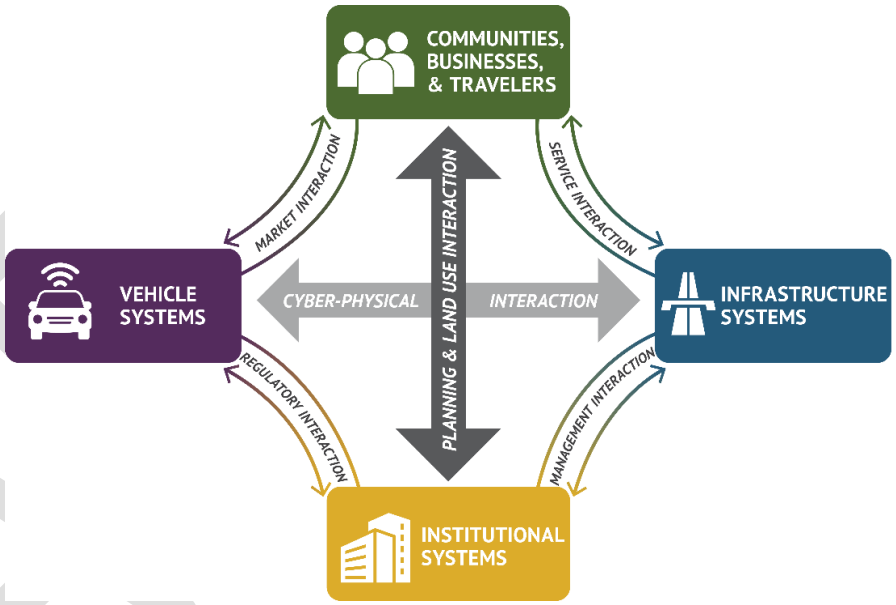
Cooperative Automated Transportation (CAT)

The American Association of State Highway and Transportation Officials (AASHTO) defines Cooperative Automated Transportation (CAT) as: "All modes of transportation working together to improve safety, mobility, equity, and operations efficiency through interdependent vehicle and systems automation and information exchange." CAT systems encompass a broad spectrum of vehicles and devices to support all modes of travel, infrastructure (physical and digital), parties, and regulations, all of which are ever changing. While the industry is rapidly evolving, these technologies stand to have profound impacts on the built and social environments.

As highlighted in Figure 4.14, it is important to realize there is more to roadway automation than enhancements to the vehicle itself. Other systems need to be enabled or upgraded/retrofitted to support one another and the use of these public transportation system by communities, businesses, and travelers. These system interactions will be critical to ensure successful deployment and the safe integration of connected and automated vehicles and infrastructure.

FHWA notes that automated transportation on public roadways is anticipated to occur within specific use cases. These may include freight and package delivery (long haul freight, local freight delivery, and personal delivery devices (PDDs)); transit (automated fixed route, on-demand, or microtransit service, including low-speed shuttles); individual transit and commuting with automated vehicles; and agency operations (e.g., automated street sweepers).

Figure 4.14: Components of cooperative automated transportation



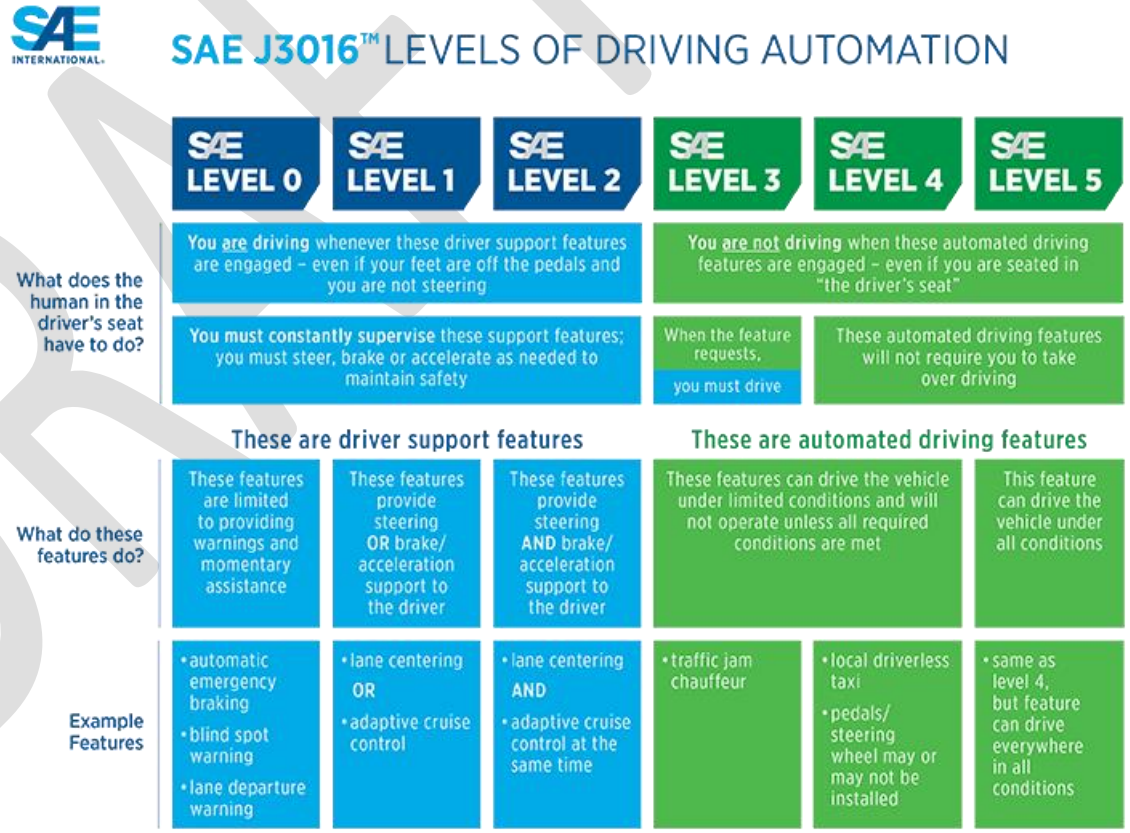
Source: FHWA

These types of use cases will likely be the way initial CAT deployments occur in Iowa and supporting them will be important as Iowa's CAT environment evolves. The impacts of these automation use cases and potential operational needs will vary for the Iowa DOT, local partners, and transportation users across the various roadway system levels. For example, most communities will not be directly impacted by long haul freight automation because this use case will emphasize movements on full access-controlled facilities like the Interstate highway system. Conversely, personal vehicle, robo-taxi, or small automated PDDs are anticipated to have varying impacts on how communities plan, address traffic considerations, and invest in infrastructure, as well as impacts to vulnerable road users, such as pedestrians and bicyclists. The Iowa legislature has begun addressing issues that will help some of these uses, such as removing a specific following distance (which clears the way for truck platooning), passing an ADS framework that makes it possible for driverless capable vehicles to operate in Iowa and provides the Iowa DOT with broad rulemaking authority, and passing legislation related to the operations of personal delivery devices.

Levels of Automation

The Society of Automotive Engineers (SAE) developed a taxonomy of vehicle automation systems, illustrated in Figure 4.15. The taxonomy shows six levels, ranging from no automation at Level 0 to full automation at Level 5, which can be used to understand the spectrum of possibilities when discussing CAT. Broadly, SAE levels 1 and 2 are vehicle safety features known as advanced driver assistance systems (ADAS), many of which are available in vehicles now, while SAE levels 3 to 5 are known as automated driving systems (ADS).

Figure 4.15: Levels of driving automation



Source: Society of Automotive Engineers International

There are many different ADAS features that are available in vehicles today. These advanced vehicle systems vary across vehicles and in terms of how they operate. Broadly speaking, these technologies aim to monitor and warn the driver, or take a more active role by intervening to avoid a collision or provide controlled assistance to the driver. However, it is critically important that drivers understand that ADAS still require the driver of the vehicle to be present, alert, and maintain primary control. Continuous public education, particularly regarding ADAS features currently available in vehicles and what they can and cannot do, is critical. Notable ADAS features include:

- **Collison warning systems**: Blind spot warning; forward collision warning; lane departure warning
- **Collision intervention**: Automatic emergency braking; blind spot intervention; pedestrian automatic emergency braking
- **Driving control assistance**: Adaptive cruise control; lane centering and lane keeping assistance

Given the current availability of ADAS and the potential development of ADS, the Iowa DOT views planning for CAT as a two-pronged approach. This involves supporting the drivers and ADAS of today while also supporting the ADS of tomorrow. When possible and prudent, investments that support both should be pursued.

Anticipated Deployment Timelines

While some companies are beginning to identify deployment of their automated transportation technology solutions in the next three to five years, such as automated truck freight operations on access controlled Interstate facilities from on-ramp to off-ramp, specific timelines for increased market adoption and penetration are not well known. There are a variety of reasons for this, including that the business case for automation is continually developing, it is complex, innovation is continually evolving technology, and there is a patchwork of state policy and legislation with limited federal or national standards, policy, and legislation.

The next decade is anticipated to focus on widespread adoption of ADAS for both commercial and passenger motor vehicles. More advanced ADS deployment timelines are anticipated to vary by the technology use case. Nationally there are deployments and testing areas occurring for a variety of automated transportation use cases.

According to the Iowa DOT CAT Service Layer Plan, the trends, activities, and challenges related to CAT point to the following three parallel transitions that are likely to occur over the coming decades.

1. A progressive increase in the level of automation and connectivity in privately-owned vehicles – the rate of which is difficult to estimate.
2. Increased use of fully autonomous (i.e., no on-board driver controls) shared vehicles for transit, shuttles, rideshare, mobility-on-demand, and commercial vehicles.
3. Increasing enactment of legislation, policies, and regulations by federal, state, and local governments to ensure safe and equitable operations and foster better understanding by all stakeholders.

Within the past several years, a planning study was completed for the rural portions of I-80 across Iowa and included a report on automated transportation. A range of scenarios for CAT adoption rates were studied, which varied significantly from relatively slow and conservative growth to a rapid increase of automated vehicles in the fleet. Given the quickly changing nature of these evolving technologies, there is a great deal of uncertainty regarding the specific timing and composition of the future of CAT and ADS, with recent predictions trending towards more conservative deployment timelines.

Planning for CAT

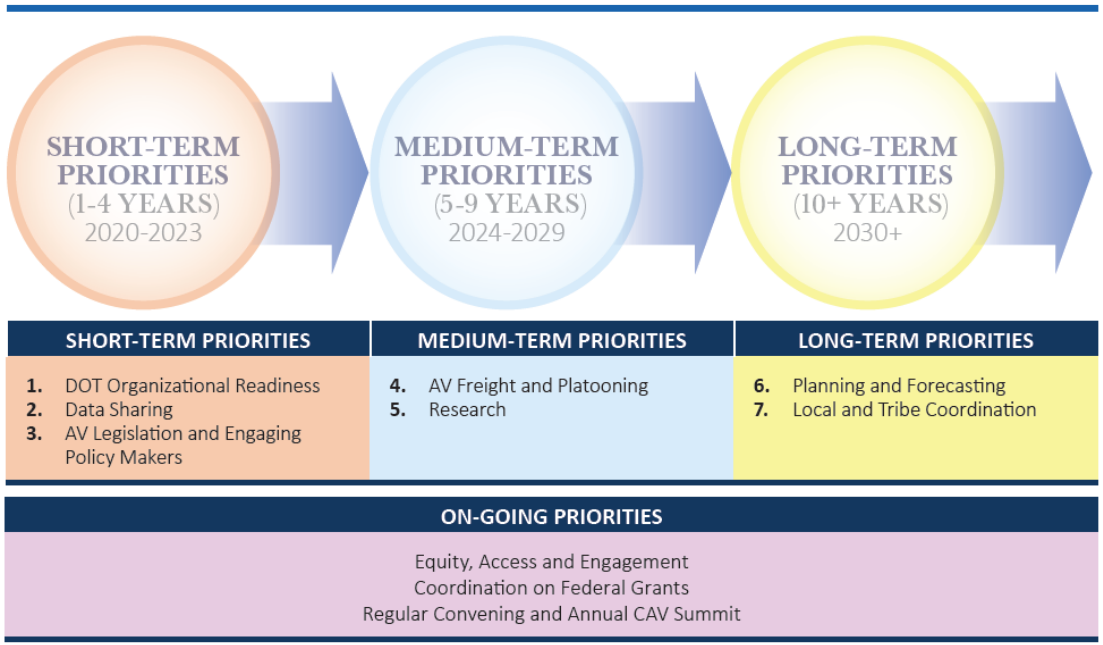
In recent years there has been a significant increase of planning for CAT across government levels. As technology continues to evolve, and in support of other related needs and strategies of the plan, it is important that Iowa DOT coordinates and align with neighboring states and national partners to ensure technology deployment is approached in a coordinated manner.

Nationally, AASHTO released its ten connected and automated vehicle (CAV) policy principles in 2021 to outline its position on policy in this arena, and the Iowa DOT supports integrating these principles into the planning process.

- A National strategy and vision are needed.
- Safety is paramount.
- Support sustainability.
- The future is connected and automated.
- Promote innovative Federal infrastructure investment.
- Advance equity, access, and quality of life.
- Preserve traditional State and Federal roles.
- Uniform national policy is essential to avoid a patchwork approach.
- Strong Federal leadership is crucial to foster industry collaboration and community engagement.
- Promote data sharing that preserves data privacy and security.

At a regional level, the Mid America Association of State Transportation Officials (MAASTO), which includes Iowa, has developed a 2030 CAV Regional Strategy outlining short-, medium-, and long-term priorities, shown in Figure 4.16. Iowa DOT is involved as a lead state on several strategies related to these initiatives.

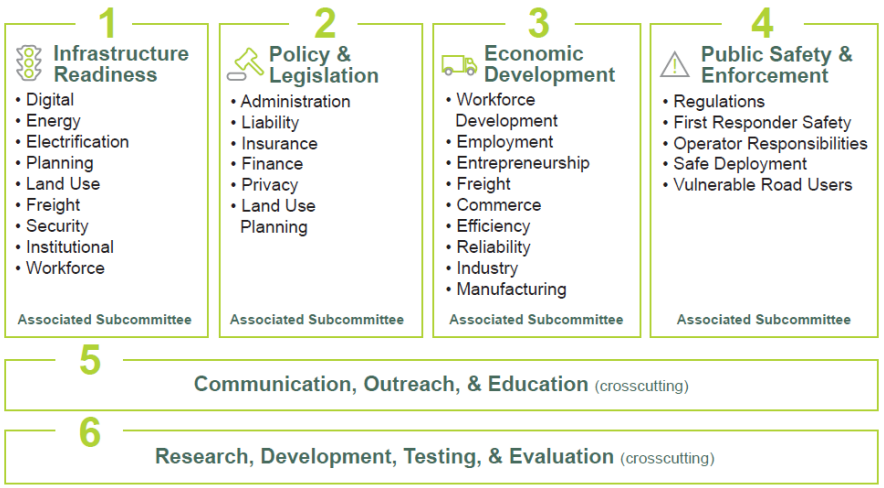
Figure 4.16: MAASTO CAV 10-year strategy



Source: MAASTO CAV Regional Strategy

At the state level, the Iowa Advisory Council on Automated Transportation (ATC) has been established to increase roadway safety, personal mobility, and freight movement within the state of Iowa by advancing highly automated vehicle technologies. Membership includes agencies from local, state, and federal levels, university research partners, and other stakeholders. The ATC provides guidance, recommendations, and strategic oversight of automated transportation activities in the state. The ATC includes several subcommittees to help guide activities for its strategic objective areas, as shown in Figure 4.17.

Figure 4.17: Iowa Advisory Council on Automated Transportation (ATC) strategic objective areas



Source: Iowa ATC

The ATC dedicated a meeting in 2021 to discussing considerations, impacts, and actions the Iowa DOT should be focusing on related to CAT. Some key takeaways included the following.

- There are short-term challenges with the misuse and misunderstanding of the current technology in vehicles; public education will be key.
- Physical, digital, communications, and cyber-security readiness is important for CAT.
- There will be challenges with operating in Iowa's varied weather and rural roadway environments.
- There remains uncertainty over how and by who the needed infrastructure improvements will be paid for, as well as liability concerns.
- It is important to collaborate across jurisdictions for a seamless experience for the public.
- It is necessary to increase the workforce size and skills related to automated vehicles.
- Environmental justice and accessibility are key considerations as CAT is developed and deployed.

Iowa DOT has also developed a CAT Service Layer Plan as part of its overall transportation systems management and operations (TSMO) planning process. This document, released in 2019, describes challenges and opportunities, existing services and conditions, future direction, gaps and actions to bridge them, performance metrics, and estimated costs. The plan includes the following CAT objectives.

- Manage the Iowa digital CAT infrastructure in order to increase Iowa's AV readiness.
- Ease the entry and ongoing operations of connected and automated vehicles in Iowa through appropriate physical infrastructure additions.
- Identify and define the business processes needed to allow and support CAT within Iowa.
- Secure Iowa travelers, transportation providers, residents, and physical and digital infrastructure against intentional or unintentional threats.

As technology progresses and regional plans and national guidance continue to be developed, it is important that Iowa aligns with these efforts and determines how to incorporate these initiatives into modal and system plans and project development processes. An example of this is addressing the impacts of automation on vulnerable road users and incorporating this into the Strategic Highway Safety Plan.

Opportunities, Risks, and Planning Issues

The rise of CAT holds much potential for improving the transportation system, such as reduced crashes and increased mobility and accessibility. Efficiency of operation coupled with clean energy technology could have substantial benefits to the environment. CAT could have significant effects for commercial industries, as it should help reduce costs and increase reliability and efficiency. In addition, full automation would potentially help provide a solution to the increasing truck driver shortage in the country. But, as noted in the American Planning Association's (APA) report Planning for Autonomous Mobility, the rise of automated transportation may create new problems. These include the need for more drop-off zones, vehicle storage and/or circulation issues when vehicles are not in use, expensive new infrastructure to maintain, and perhaps even the rise of sprawl due to reduced costs of travel and vehicle ownership. Sound planning will be important to ensure that benefits are supported and potential risks are mitigated.

One of the biggest attractions of CAT is the potential to eliminate driver error. This would have substantial improvements to transportation safety, as the vast majority of crashes are at least partially caused by driver error. Another significant opportunity and risk related to CAT is equity. While CAT holds much potential to assist those facing transportation challenges, if equity, accessibility, and inclusive design are not part of the conversation early on, CAT also carries the risk of exacerbating mobility challenges that some individuals face in accessing equitable transportation options. This will be particularly problematic if CAT develops in ways that are exclusive to those with more financial resources or those without disabilities.

As the CAT Service Layer Plan notes, a wide variety of Iowa DOT services are expected to be impacted by CAT, particularly as ADAS and eventually ADS become more common. These include:

- Driver education and training services
- Vehicle registration and licensing
- Roadway and supporting infrastructure design
- Transportation operations
- Information sharing with Iowa residents and travelers

In addition to potential service changes, the CAT Service Layer Plan also notes potential system modifications that may be needed to accommodate CAT, including the following examples.

- Full-depth shoulders to allow for a future CAT-designated lane when reconstructing roadways.
- Strengthening pavement design to accommodate high volumes of vehicles traveling along a more precise wheel path.
- Supporting connected infrastructure networks by installing continuous fiber, wireless communications, and/or power along corridors.
- Adding cameras, sensors, and other roadside equipment for vehicle-to-infrastructure communication.
- Placing Global Positioning Systems (GPS) reference markers along the Interstate medians for AV positioning during unstable satellite connectivity. This could be LIDAR in combination with known points to obtain position information.
- Installing roadside objects (technology based or non-technology based) to support navigation and guidance (e.g. signs that are readable by both AVs and humans).
- Establishing new standards for lane striping frequency, composition, or width.
- Providing pull-out areas for CAVs.

Besides impacts to Iowa DOT services and the transportation system, examples of other impacts of increasing CAT could include changes in patterns of vehicle ownership, the amount of funding generated through traditional transportation revenue mechanisms, the amount of parking needed by cities and individual households, the distance people live from work, and many others. Traffic forecasting methods will need to be adapted based on CAT being part of the freight and passenger vehicle fleets. The potential impacts of technology and changing travel patterns can lead to some types of projects being considered higher risk, in the sense that they may become less necessary or need to be re-evaluated. Examples of these types of projects include the following.

- Purchasing right of way
- Highway capacity expansion
- Roadside infrastructure (e.g., dynamic message signs, overhead sign trusses)

Technology changes may have significant implications at not only the planning level, but at the project development level. Major projects can take many years to design and build, and the changing nature of transportation may require adaptation and scope refinement not just before, but also during the project development process. It will be important to find the right balance of project elements based on known current needs and benefits and uncertain future needs and benefits. The emerging technologies rightsizing policy statement discussed in Chapter 5 is meant to help the Iowa DOT navigate this issue.

Travel and Tourism

Enhancing travel and tourism was recently added as a federal transportation planning factor. The transportation system has an important role in facilitating travel and tourism. While technology has greatly augmented navigation in recent years, the Iowa DOT still produces critical aids to help individuals plan their trips and find their way. These include items such as the state transportation map and the state bicycle map, as well as resources like Iowa 511, which provides current information on many issues such as road incidents or closures, traffic congestion, and winter driving conditions. Also, having consistent and clear roadway signage is essential to help motorists navigate safely.

The transportation system can also be a tourism feature in and of itself. Many parts of Iowa have well-developed land and water trail systems, which can attract visitors to the state and also act as quality of life amenities to help recruit and retain new residents and employees. Other modes of transportation have special tourism connections as well, such as scenic railroad trips, historic transit trolleys, and river cruises on the Mississippi River. Two transportation system elements that relate strongly to travel and tourism are rest areas and byways.

Rest Areas

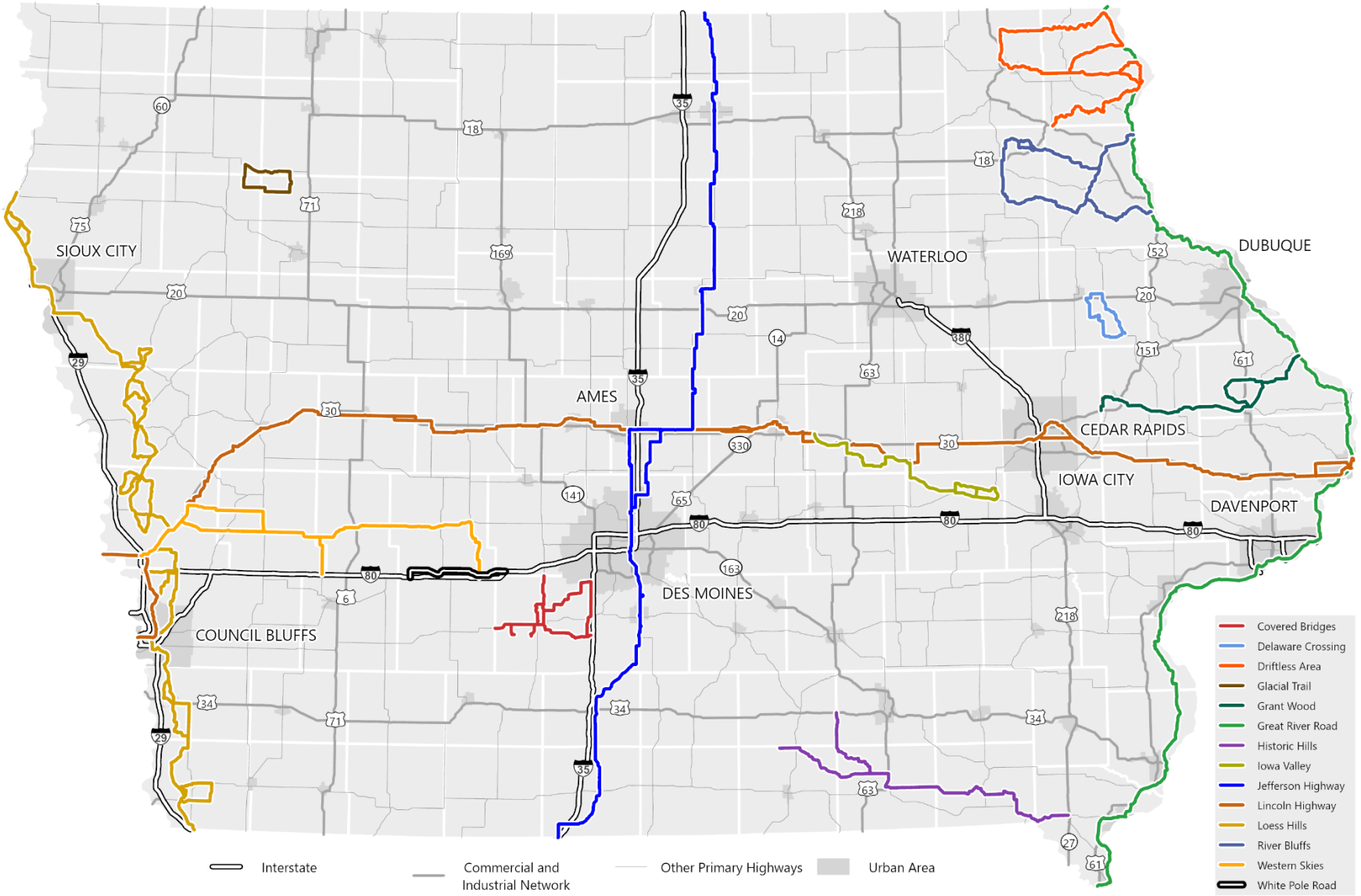
Rest area facilities owned and operated by the Iowa DOT along Interstates in Iowa play an important role in the transportation system. Travelers and freight haulers value the convenient parking and facilities they provide. Many of Iowa's rest areas have been upgraded to include expanded facilities and grounds with unique interpretive themes. In 2020, a study was finalized to develop a management plan for Iowa's 38 full-service and 16 parking-only rest areas. The outcome was a plan that involves managing the rest area system by upgrading buildings and expanding truck parking at some facilities, while closing other lesser used and smaller facilities as they age.

A truck parking study also showed that commercial truck drivers reported a significant need for additional freight truck parking throughout the Interstate system. A project developed to help this issue is the Truck Parking Information Management System (TPIMS), an 8-state effort that provides drivers, fleet managers, and owner-operators with up-to-the-minute parking availability along major freight corridors, including Iowa's Interstates. Continued implementation of TPIMS will help with the truck parking issue, along with expanding truck parking at existing facilities where feasible, and exploring partnerships with other public and private entities.

Iowa Byways

Iowa has two national scenic byways and 12 state byways, shown on Figure 4.18. These routes offer a variety of scenic, cultural, and historical features. The Iowa DOT helps ensure routes are signed and administers the byways program, which accepts nominations for new byways or changing existing byways every four years. This program was established to identify, protect, and enhance roadways in Iowa which exemplify the state's scenic and historic resources. This effort is carried out through volunteer work and cooperation between interested citizens, organizations, local governments, and the Iowa DOT. Once the Iowa DOT designates a route as a state byway on the basis of scenic and historic qualities, applicants are then responsible for funding tourism and promotional plans. Byways also have corridor management plans to provide guidance to help preserve, enhance, and promote the byways. Federal grant opportunities may be available in the future for scenic byways for certain infrastructure projects.

Figure 4.18: Iowa's byways



Source: Iowa DOT

Transportation Systems Management and Operations

Traffic on Iowa's roadways has grown steadily over time, which has also increased the potential for crashes and congestion. Optimizing performance of the system is critical to keep traffic flowing in a safe and efficient manner. This is embodied in the strategic approach of transportation systems management and operations (TSMO). The aim of TSMO is to proactively manage the performance of the state's transportation system, particularly by managing or mitigating congestion and incidents. This includes current Iowa DOT strategies such as monitoring the system through traffic cameras and speed sensors, quickly deploying response resources to incidents, and providing traveler information through platforms like Iowa 511. TSMO also includes efforts to prepare for and adapt to changing technology, such as automated vehicles and proactively enabling "smart" highway corridors with data and communications capacity.

Mobility challenges occur on Iowa's roadways every day. Recurring congestion, due to issues like poor signal timing or bottlenecks, accounts for a portion of this issue. However, in Iowa, most congestion is of a non-recurring type, such as bad weather, traffic incidents, and work zones, which account for close to three quarters of Iowa's highway delay. Some of these issues can be planned for, such as work zones; others, like traffic incidents, can arise without warning, making monitoring the system and preparedness to respond critical.

Non-recurring congestion can happen anywhere in the state at any time, and the impact of congestion goes well beyond a traffic event. In calendar year 2020, there were an average of approximately 2,740 traffic incidents on state roadways per month. For crashes, there was an average crash clearance time of 75 minutes, while lane blocking incidents involving a tractor trailer had an average clearance time of over 2 hours. These durations are concerning, because each minute a lane is blocked can lead to 4 to 5 minutes of delay, and for each minute that a primary incident continues, the likelihood of a secondary crash increases by 2.8 percent. The U.S. DOT estimates that secondary crashes represent more than 20 percent of all crashes and are often more deadly than the primary incident. Fewer incidents and quicker clearance of incidents help to reduce congestion, allowing the transportation system to operate more safely and efficiently.

TSMO is about much more than responding to incidents. Cost-effective TSMO strategies are used to improve service by "taking back" the transportation system capacity lost to congestion without necessarily adding lanes. TSMO can involve technological solutions, innovative design, management of peak-hour demand, and usage of other modes besides driving. TSMO is important because it deals directly with the root causes of congestion, offers the potential to improve safety and efficiency, and can help to maximize existing infrastructure capacity through cost-effective strategies. This helps lead to a more sustainable transportation system than by adding new capacity. In addition to incorporating specific TSMO strategies into project development, key TSMO-related activities include:

- Management of the day-to-day traffic operations on the highway system through the 24-hour statewide Traffic Management Center (TMC).
- Management of the emergency transportation operations (ETO) response efforts on behalf of the Iowa DOT.
- Management and maintenance of the 511 Travel Information System.
- Deployment and maintenance of Intelligent Transportation Systems (ITS) on the highway system.
- Development and maintenance of a coordinated, comprehensive statewide traffic incident management (TIM) response plan.
- Traffic critical projects planning and deployment.

- Traffic incident and emergency management, including federal Emergency Relief program, statewide/regional TIM planning, state and local agency coordination, emergency management, and major incident after-action reviews.

TSMO Planning

There has been a significant increase in TSMO planning efforts at the Iowa DOT over the past decade. While TSMO activities were occurring prior to 2013, that year saw the initial Iowa DOT TSMO assessment conducted. In 2016, Iowa DOT's first TSMO Plan was created, with a focus on traffic congestion and other related roadway issues such as incidents, safety, and efficiency. The plan was comprised of a Strategic Plan and Program Plan, both completed in 2016, and a series of Service Level Plans to be developed over the following years. Completed Service Level Plans include:

- Traffic incident management
- Emergency management
- ITS and communication
- Cooperative automated transportation
- Traveler information
- Work zone management
- Traffic management center

Many projects and activities from the Program Plan were also completed or are underway, and Iowa DOT's organizational structure relative to TSMO has continued to grow and evolve. A statewide TIM committee and the TSMO steering committee help promote TSMO in Iowa. They also helped guide an update to the TSMO Plan in 2021, which continues to address congestion and safety and includes a set of TSMO program projects, services, and activities to help advance TSMO in Iowa. The TSMO Plan Update, to be finalized in 2022, builds on existing activities and recognizes the evolution of Iowa's transportation system. The original Plan was entirely internally focused. The TSMO Plan update includes several recommendations based on outreach to Iowa's nine metropolitan areas.

The purpose of Iowa DOT's TSMO Plan is to improve the performance of Iowa's transportation system. TSMO uses and improves upon infrastructure, processes, technology, and other components of the system that Iowa already has, and takes a proactive role in system management. A number of TSMO projects, services, and actions are identified in the plan for the following categories.

- **Collaboration**: The effectiveness of TSMO activities depends on the ability of divisions, bureaus, districts, partner agencies, and other stakeholders to work together. Taking advantage of opportunities to build internal and external relationships will help with communication and overcoming challenges in the future.
- **Culture**: Represents the values and beliefs that lead to certain decisions being made. Through a business case or outreach opportunities, TSMO messaging can be communicated to others inside and outside of the agency to gain support.
- **Systems and technology**: Appropriate planning, construction, operations, and maintenance of systems and technology ensures operational needs of an agency are met. By developing standard protocols and an iterative data management process, transportation solutions can be effective in enhancing mobility.
- **Performance measurement**: Used to evaluate the effectiveness of mobility strategies and whether additional changes need to be made to achieve mobility goals. Performance measures are essential for making the business case for TSMO to decisionmakers and the public, and for gauging program success. Furthermore, monitoring performance measures regularly allows the program to be constantly improved and advances institutional continuous improvement.

- **Business processes**: Includes all the planning, budgeting, procurement, and process development required for TSMO programs. To be implemented, TSMO activities and initiatives must be supported financially and institutionally. Protocols and procedures are necessary for TSMO to become ingrained in agency culture.
- **Organization and staffing**: Technically qualified staff and an organizational structure that unites TSMO activities into an integrated project delivery approach are key to supporting effective TSMO solutions. Through training, identifying TSMO responsibilities, and building relationships across teams, TSMO functions can be ingrained in an agency's day-to-day work efforts.

Integrated Corridor Management (ICM)

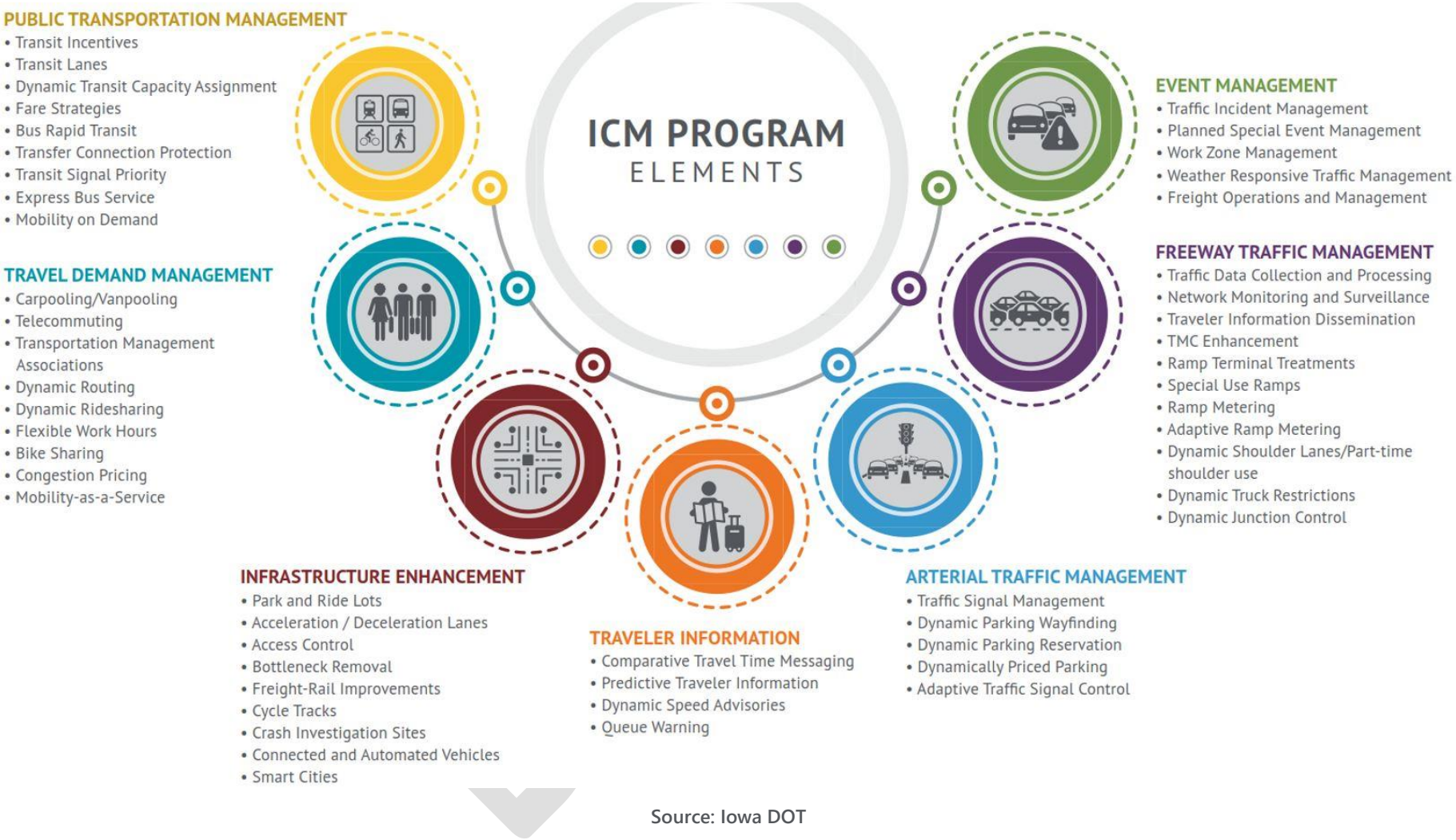
A specific type of operations-focused concept that is now being used in Iowa is integrated corridor management (ICM). This provides a framework for coordination among multiple jurisdictions, stakeholders, and modes of transportation in an area to ensure holistic solutions to transportation issues are being evaluated and implemented. ICM strategies that promote integration among freeways, arterials, and transit systems can help balance traffic flow and improve performance of the entire corridor. The benefits of ICM can include:

- Fewer traffic incidents
- Reduced amount of time an incident has the potential to impact traffic, in turn increasing safety and mobility
- More predictable travel times
- The ability to more quickly make incident information available on traveler information sources
- Increased or more complete information about other routes or travel options if an incident or traffic congestion does occur
- Increased use of other routes or travel options to meet the demand of traffic
- Reduced vehicle emissions and fuel consumption resulting from congestion

An ICM project has been underway for the Des Moines metropolitan area since 2018, with the aim of cost-effectively and proactively managing traffic in the area, which is expected to grow substantially in the coming decades. The project has involved consideration of a host of strategies, shown on Figure 4.19.

Strategies that have been studied in more detail for potential near-term implementation include median barrier gates, queue spillback mitigation, signal optimization, and ramp naming conventions. Many of these have involved partnering with local jurisdictions and stakeholders to ensure successful projects. Several advanced freeway management strategies are also being considered for future implementation, including dynamic shoulder use, dynamic speed advisories, lane use control, and ramp metering. These types of strategies help improve roadway capacity, safety, and reliability through real-time traffic detection and control. To be successful, they will require significant coordination between the Iowa DOT, local jurisdictions, and stakeholders. These strategies would be new to both the Iowa DOT and the Des Moines area, and will require not just infrastructure, but changes in how the infrastructure is monitored and managed as well as significant public education efforts.

Figure 4.19: ICM program elements



Source: Iowa DOT