IOWA DOT
GETTING YOU THERE

2019-2028 TRANSPORTATION ASSET MANAGEMENT PLAN

September, 2019

IOWA DOT

CONTENTS

1. INTRODUCTION

Transportation asset management is a strategic approach to managing transportation infrastructure. It embodies a philosophy that is comprehensive, proactive, and long term. 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.

Background

Iowa Department of Transportation (DOT) is implementing Transportation Asset Management (TAM) across its business practices and processes. Previously, Iowa DOT had used a combination of preventive maintenance and worst-first approaches to manage its bridges and roads. 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.

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. Over the past decade, transportation agencies throughout the United States have found that this balanced approach extends the useful lives of their 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.

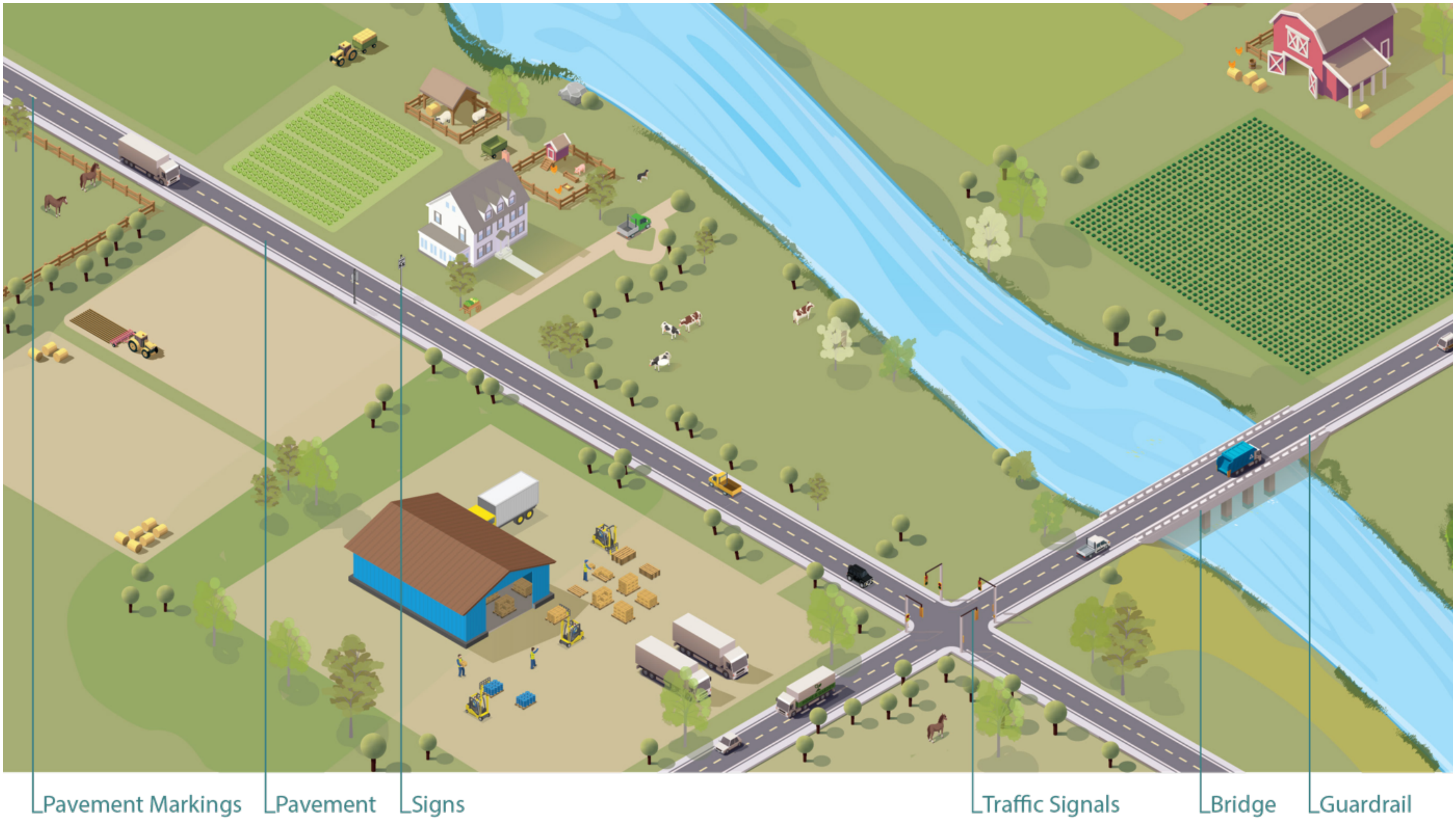
What the Plan Includes

In July 2012, the U.S. Congress passed a transportation bill referred to as Moving Ahead for Progress in the 21st Century (MAP-21). This legislation requires every state DOT to develop a risk-based transportation asset management plan (TAMP) to improve and preserve the condition of assets on the National Highway System (NHS), with the plan containing the following elements at a minimum:

- Summary listing of the bridge and pavement assets on the NHS in each State, including a description of the condition of those assets.
- Asset management objectives and measures
- Performance gap identification
- Life cycle cost and risk management analysis
- Financial plan
- Investment strategies.

The NHS is a federal designation for a system of roadways which includes the Interstate Highway System and other roads important to the nation's economy, strategic defense and overall mobility. Figure 1-1 shows typical highway assets in Iowa. While the TAMP focuses on bridges and pavements, the transportation network includes a variety of other assets. Iowa DOT works to maintain all of these assets in order to keep travelers safe, promote mobility, and make progress towards state and national transportation goals.

Figure 1-1. Typical Highway Assets



This document, Iowa DOT's TAMP, meets federal requirements. It describes how Iowa DOT manages its bridges and pavements throughout their lives and provides a framework that will guide funding decisions across Iowa DOT districts, divisions, bureaus, and offices. In addition to meeting the requirements of MAP-21, Iowa DOT's TAMP meets the following objectives:

- Defines clear links among agency goals, objectives, and decisions
- Defines the relationship between proposed funding levels and expected results
- Develops a long-term outlook for asset performance
- Documents how decisions are supported by sound information
- Develops a feedback loop from observed performance to subsequent planning and programming decisions
- Improves accountability for decision making
- Unifies existing data, business practices, and divisions to achieve Iowa DOT's asset management goals

TAM Goals and Guiding Principles

This TAMP supports Iowa DOT's goals and objectives and supports progress towards national goals established in MAP-21. Consistent with best practices nationally, Iowa DOT's asset management goals are to:

- Build, preserve, operate, maintain, upgrade, and expand the transportation system more cost-effectively throughout its whole life.
- Improve performance of the transportation system.
- Deliver to Iowa DOT's customers the best value for every dollar spent
- Enhance Iowa DOT's credibility and accountability in its stewardship of transportation assets

Iowa DOT is implementing and practicing TAM according to a set of guiding principles. These principles are aligned with Iowa DOT's goals and shape the TAMP development process. Iowa DOT's guiding principles for transportation asset management are the following:

- Asset management is policy driven. Funding decisions reflect Iowa DOT's vision for how the transportation system should look in the future.
- Asset management is performance based. Iowa DOT understands the condition of its assets, defines performance targets, and makes decisions that support these targets.
- Asset management involves making trade-offs. Iowa DOT has options for how to allocate transportation funding. It evaluates these options and makes informed decisions regarding the best path forward.
- Asset management relies on quality information. Iowa DOT uses data and analytical tools to support its decisions.
- Asset management requires transparency and accountability. Iowa DOT documents how funding decisions are made. It monitors performance, tracks progress towards performance targets, and reports on results.

Local Coordination

Iowa DOT recognizes that most people using the highway system are more concerned with their trip than with who manages each road section. The DOT works with local agencies in Iowa to coordinate asset management efforts to help everyone get the most value from public roads. Although the primary focus of this document relates to the management of Iowa's primary road network managed by Iowa DOT, there are places where the plan also references the condition of local National Highway System (NHS) assets, and how Iowa DOT works with local governments in Iowa to coordinate management of the system. Such references are intended to be responsive to federal requirements related to the content of this plan, in particular with respect to the NHS. Iowa DOT does not direct local agency investment decisions, and the inclusion of information concerning these assets should not be considered to substitute for local agency decision-making processes.

Federal regulations require the State, metropolitan planning organizations (MPOs), and providers of public transportation to establish agreements related to performance management elements, including the target setting and reporting process and the collection of data for the State asset management plan for the NHS. Iowa DOT has established agreements between the State and MPOs in each MPO's annual unified planning work program (UPWP), and with transit providers through their annual consolidated funding applications. The agreements provide for coordination with MPOs during the Iowa DOT's target-setting process, and for MPOs to coordinate with the Iowa DOT during their target setting processes. The agreements also provide for the Iowa DOT to take the lead in providing performance-related data, and focus on sharing existing data rather than creating new data collection responsibilities. Further coordination between these agencies occurs in the development of the state's group Transit Asset Management Plan for small urban and rural providers, and its associated annual target-setting process.

Related Planning Documents

Iowa DOT's 2017 statewide transportation plan, called Iowa in Motion 2045, established a vision for Iowa DOT: "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 an environmentally conscious manner." The plan focuses on four investment areas, with a heavy emphasis on stewardship:

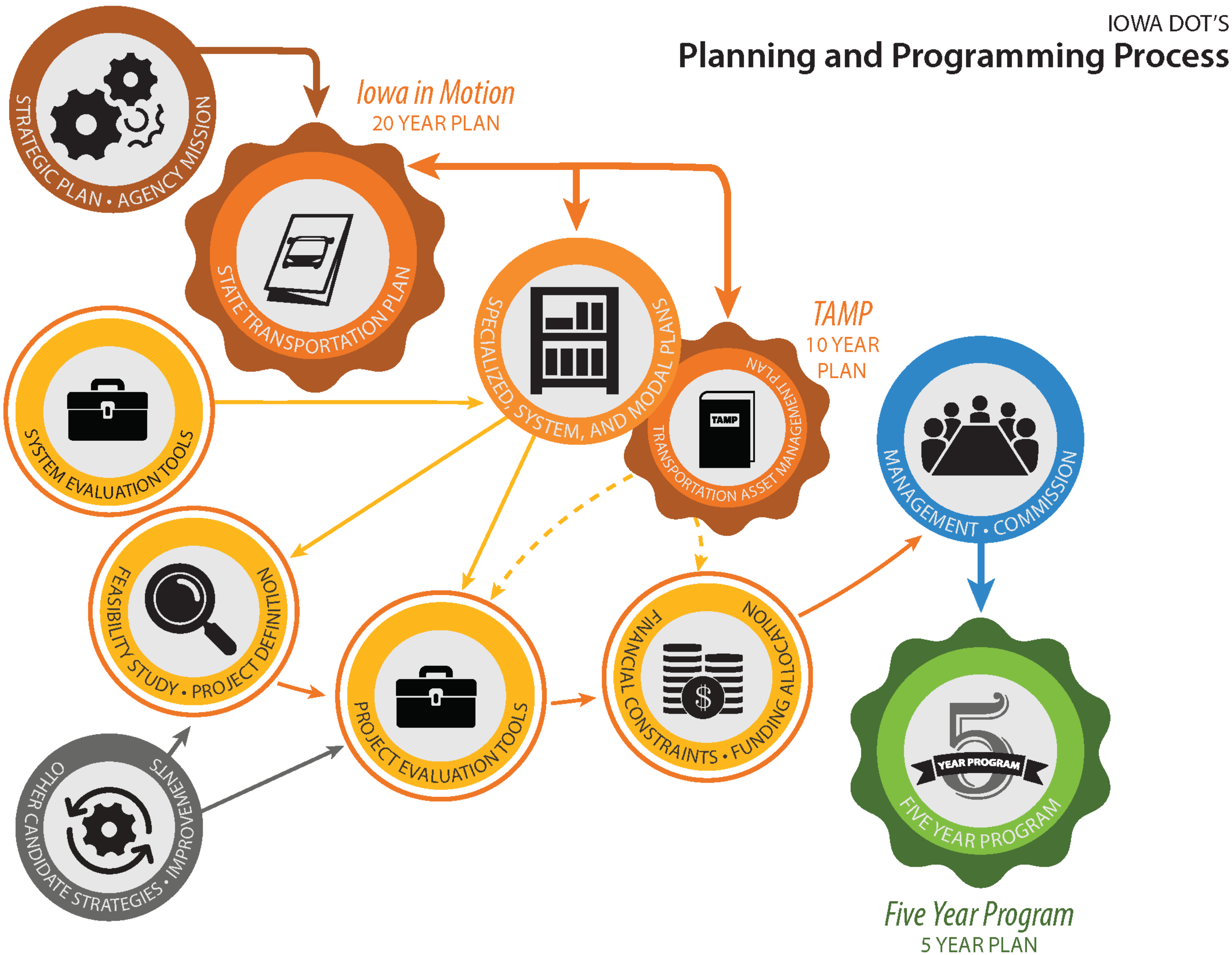
- **Stewardship** through maintaining a state of good repair
- **Modification** through rightsizing the system
- **Optimization** through improving operational efficiency and resiliency
- **Transformation** through increasing mobility and travel choices

This TAMP describes how Iowa DOT manages the existing highway system. Preserving and improving this system is critical for achieving the system vision. The TAMP also connects Iowa in Motion and system/modal plans to Iowa DOT's Five-Year Transportation Improvement Program (Five-Year Program). Iowa in Motion defines a vision for the transportation system over the next 20 years, while the Five-Year Program 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 Iowa Transportation Commission, a seven-member, governor-appointed body, is responsible for ultimately approving the statewide transportation plan and Five-Year Program. Iowa DOT must implement asset management in alignment with the guiding principles in this chapter and through a funding program approved by the Commission.

Figure 1-2 shows the relationships between Iowa DOT's various planning documents and processes.

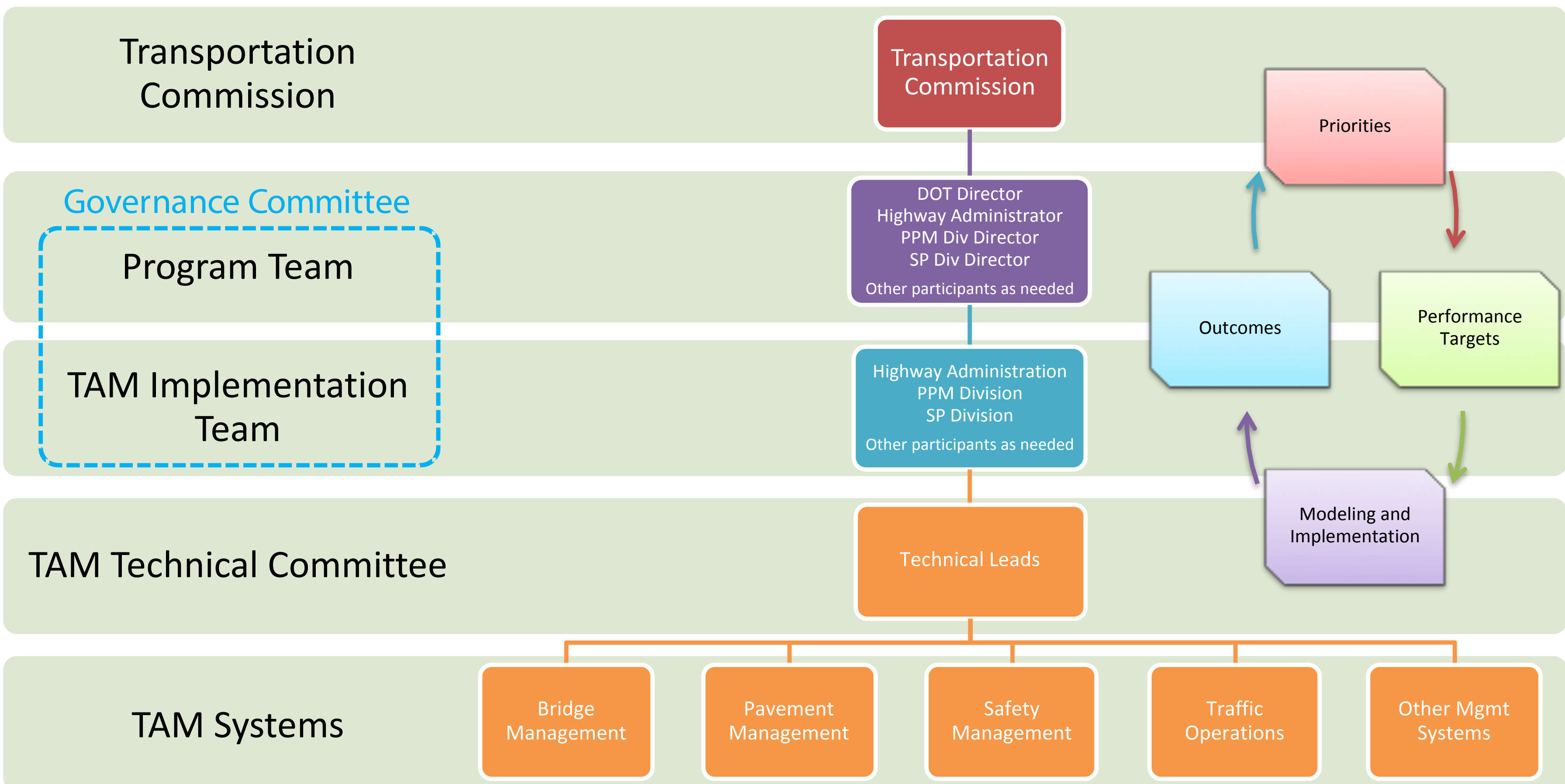
Figure 1-2. Planning and Programming Documents and Processes



Agency Structure Related to TAM

The development of Iowa's first TAMP, completed in November of 2016, was led by a TAMP steering committee. The current TAM governance structure was developed based on the recommendation of the first TAMP and a subsequent gap analysis process. Iowa DOT's TAM governance structure is depicted in Figure 1-3.

Figure 1-3. TAM Governance Structure



The Governance Committee's role is to design a process and governance structure that will do the following:

- 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 Governance Committee is composed of staff involved with developing and delivering the highway program. The members are listed in Table 1-1.

Table 1-1. TAM Governance Committee

Role	Name	Organizational Unit
Program Team	**Mark Lowe**	Department of Transportation
	Stuart Anderson	Planning, Programming & Modal Division
	Mitch Dillavou	Highway Administrator
	John Selmer	Strategic Performance Division
TAM Implementation Team	**Matt Haubrich**	Organizational Improvement
	Peggi Knight	Research & Analytics Bureau
	Deanna Maifield	Project Management Bureau
	Donna Matulac	Traffic Operations Bureau
	Tammy Nicholson	Location and Environment Bureau
	Garrett Pedersen	Systems Planning Bureau
	Charlie Purcell	Project Delivery Division
	Jon Ranney	District 2
	Don Tebben	Program Management Bureau

TAMP Organization

The TAMP is organized as follows:

1. **Introduction.** This chapter gives an introduction of TAM, an overview of Iowa's asset management goals, and describes how the document is organized.
2. **Asset Inventory and Condition.** This chapter presents the inventory and current condition of both National Highway System (NHS) and state pavements and bridges in Iowa, categorized by system and owner. This chapter also defines Iowa's performance measures.
3. **Life Cycle Planning.** This chapter describes Iowa DOT's strategies for managing pavement and bridges over their life cycle to minimize agency and user costs.
4. **Performance Assessment.** This chapter details a set of scenarios predicting future conditions of Iowa's pavements and bridges over a ten-year period, detailing the gap between current and predicted conditions and Iowa DOT's desired state of good repair. This chapter also includes Iowa's targets for asset condition.
5. **Risk Management.** This chapter discusses risks to Iowa's pavement and bridges that could impact the achievement of TAM goals and objectives. It presents a mitigation strategy for addressing Iowa's highest priority risks.
6. **Financial Plan and Investment Strategies.** This chapter weighs detailed projected future revenues and expenditures for asset management-related uses. It also describes Iowa's investment strategies for best achieving its goals and objectives given available resources.
7. **Process Improvements.** This chapter includes a set of planned future asset management-related improvements.

This TAMP focuses on pavements and bridges on the NHS, which includes the Interstate system that is required by federal rules. Locally-owned NHS pavements and bridges are included in the TAMP. It also includes all state-owned pavement and bridge assets to help Iowa DOT improve asset management results.

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.

2. ASSET INVENTORY AND CONDITION

Asset inventory and condition data are the foundation for managing transportation assets. Inventory and condition data are valuable for communicating the extent of Iowa's assets and the current state of those assets. These data are also the building blocks for other asset management processes. Accurate inventory and condition data are needed for supporting asset management processes such as life cycle planning, projecting funding needs, developing projects, and monitoring asset performance.

Introduction

This chapter presents summary information on asset inventory, outlines how Iowa DOT assesses asset condition, and describes the current condition of Iowa's bridges and pavements. Assets in this chapter, and throughout the TAMP, are broken out to show both the state-owned system and the NHS. The NHS includes both state-owned and locally-owned assets.

Federal Requirements

A state's TAMP must contain a description of asset inventory and condition of NHS bridges and pavements. In reporting conditions for pavements and bridges on the NHS, the TAMP must include the federally-defined performance measures detailed in 23 CFR Part 490. These requirements describe measures of good, fair and poor condition for pavements and bridges calculated using data reported to the FHWA. States are also required to obtain necessary data from other NHS owners in a collaborative and coordinated effort.

System Summary

Iowa's transportation system includes many physical assets; the most important in terms of cost and extent are bridges and pavement. Bridges and pavement in this TAMP are classified in the following systems:

- NHS: a system of roadways that the federal government has designated essential for national connectivity. The NHS includes all Interstates. The NHS in Iowa is shown in Figure 2-1.
- Iowa Primary Highway System: the network of state highways maintained by Iowa DOT, which includes both NHS and Non-NHS routes. The Primary Highway System is shown in Figure 2-2.

Iowa's pavement and bridge assets are also classified by ownership:

- Iowa DOT owns and maintains Interstate, Non-Interstate NHS, and Non-NHS assets. Collectively, the assets owned by Iowa DOT make up the Primary Highway System.
- Local entities own and operate portions of the Non-Interstate NHS, as well as large extents of county and local roadways.

Figure 2-1. NHS in Iowa

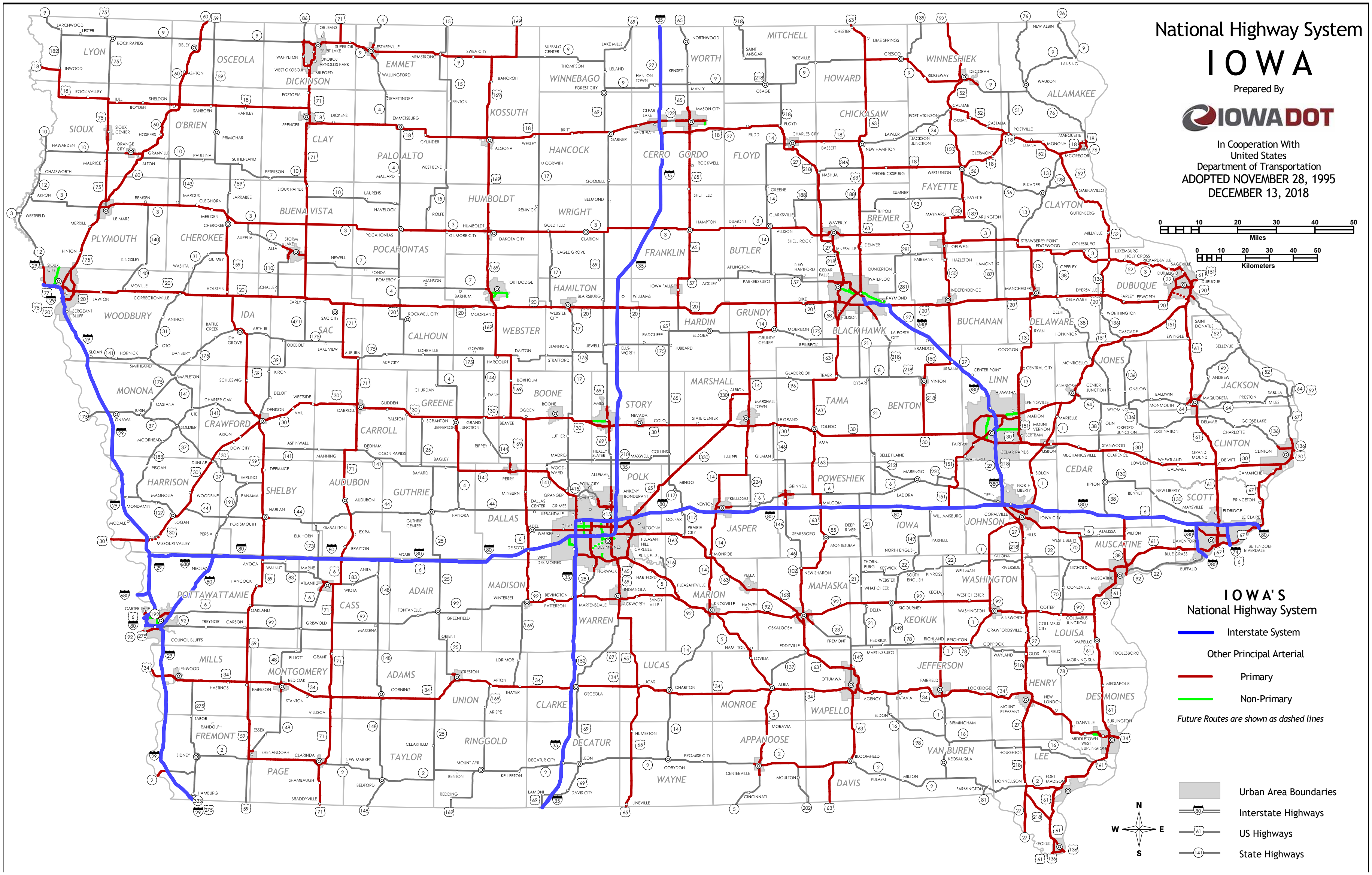
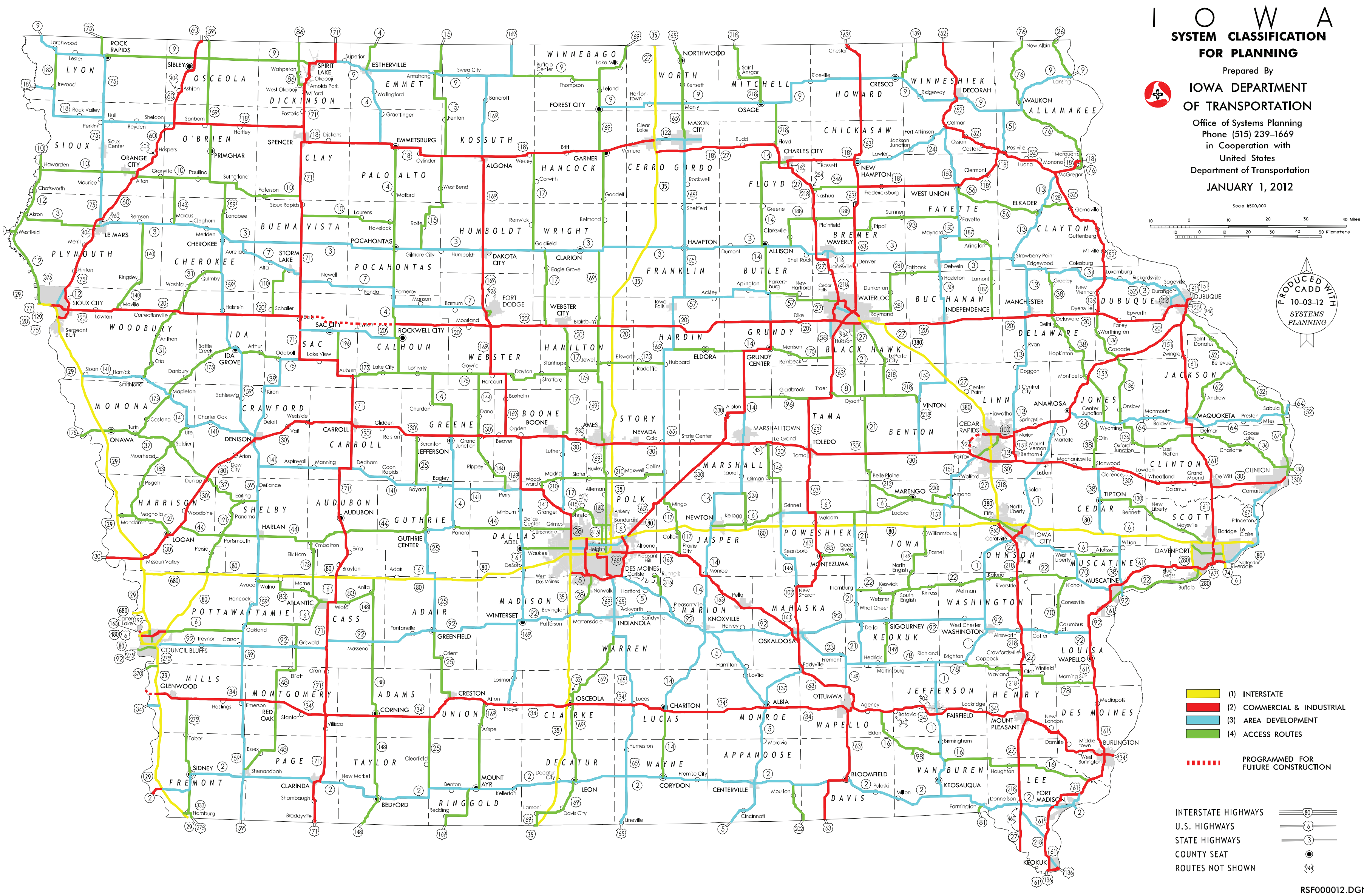


Figure 2-2. Primary Highway System Map



Note: an up-to-date interactive map of Iowa Highway Networks is available at https://iowadot.maps.arcgis.com/home/index.html.

This plan presents bridges and pavements on the NHS and on the state-maintained system. For depicting NHS conditions, this TAMP uses definitions of good, fair, and poor condition developed by the FHWA and required for use in the TAMP. Iowa DOT also tracks state performance measures on the Primary Highway System for bridges and pavement.

This TAMP uses bridge data reported by Iowa DOT to the National Bridge Inventory (NBI) and NHS pavement data reported by Iowa DOT to the Highway Performance Management System (HPMS) for the NHS inventory and condition values.

As detailed later in the document, Iowa DOT works with other agencies in Iowa to manage the transportation network. A small portion of the NHS in Iowa is locally owned or maintained. Other NHS owners in Iowa are listed in Table 2-1.

Bridge

A bridge is a structure built to span barriers to the roadway. Bridges help transportation networks cross over waterways, terrain obstacles, and other roads or rail guideway. The FHWA defines a bridge as a structure having an opening measured along the center of the roadway of more than 20 feet, which includes some culverts. Bridges play a critical role in a transportation system, enabling travel where it would be otherwise impossible. Bridges must be preserved and maintained to keep transportation user costs low and to guarantee the safe, efficient movement of people and freight.

Bridge Performance Measures

Federal

FHWA has developed condition ratings to describe the overall condition of bridges and culverts nationally. Ratings of good, fair, and poor are used as classifications for bridge condition. A bridge in good condition has no condition problems and no maintenance needs in

Table 2-1. Local NHS Asset Inventory

Planning Agency	Local Agency	Bridge Deck Area (sq ft)	Pavement Lane Miles
INRCOG	Black Hawk County		0.54
RPA 16	Des Moines County		0.99
CMPO	Linn County	16,100.3	8.14
AAMPO	Story County		0.57
RPA 5	Webster County		1.90
AAMPO	City of Ames	14,059.5	15.66
BSRC	City of Bettendorf		0.58
RPA 8	City of Camanche		0.45
INRCOG	City of Cedar Falls		10.25
CMPO	City of Cedar Rapids	93,514.1	62.82
DMAMPO	City of Clive	9,496.6	4.86
MAPA	City of Council Bluffs	318,124.0	31.53
BSRC	City of Davenport	2,986.2	3.32
DMAMPO	City of Des Moines	287,510.5	74.24
DMATS	City of Dubuque	20,842.5	6.82
INRCOG	City of Elk Run Heights		5.70
INRCOG	City of Evansdale	12,682.2	3.81
RPA 5	City of Fort Dodge	4,441.1	25.26
MPOJC	City of Iowa City	16,937.8	
RPA 7	City of Janesville		0.08
CMPO	City of Marion	18,726.3	16.69
RPA 2	City of Mason City		1.99
RPA 1	City of McGregor		0.40
RPA 10	City of Mount Vernon		0.04
DMAMPO	City of Pleasant Hill	6,461.9	1.27
INRCOG	City of Raymond	1,701.7	2.30

Table 2-1. Local NHS Asset Inventory

Planning Agency	Local Agency	Bridge Deck Area (sq ft)	Pavement Lane Miles
SIMPCO	City of Sioux City	34,183.6	20.82
DMAMPO	City of Urbandale	8,025.8	29.56
INRCOG	City of Waterloo	54,312.6	35.56
RPA 16	City of West Burlington		5.45
DMAMPO	City of West Des Moines	7,305.1	33.76
Total		**927,411.8**	**405.34**

the near future. A bridge with a poor condition rating is not unsafe, but should be considered for repair, replacement, restriction posting, weight limits, or monitoring on a more frequent basis.

FHWA requires that states use the following measures in their TAMPs to describe condition, set targets, and analyze performance gaps of NHS bridges.

- Percentage of NHS bridges classified in good condition (weighted by deck area)
- Percentage of NHS bridges classified in poor condition (weighted by deck area)

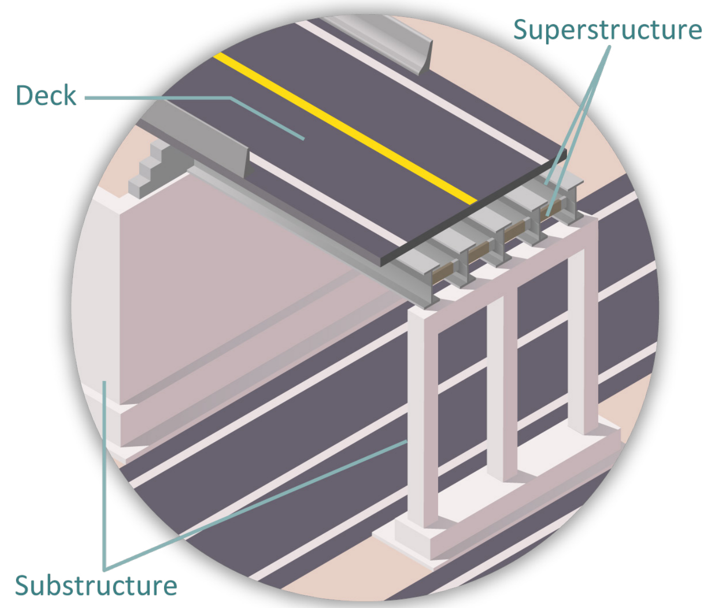
Note that if a bridge is not in good or poor condition, it is deemed to be in fair condition.

Iowa DOT inspects its bridges using practices consistent with the National Bridge Inspection Standards (NBIS) for federal bridge inspections. Most bridges must be inspected on a 24 month cycle at a minimum. More frequent inspections are required when a bridge meets specific criteria established by the State.

FHWA allows a state to establish criteria to extend the inspection frequency for a given bridge to a maximum of 48 months. Iowa has FHWA-approved criteria to extend the frequency to 48 months on some bridges. This data has been maintained for almost 40 years and is used to calculate federal and state performance measures.

Inspectors record overall ratings for a bridge's deck, superstructure and substructure on a scale from 0 (failed) to 9 (excellent). Bridge component condition ratings are used to classify the bridge as being in good, fair or poor condition. A graphical depiction of the three bridge components is shown in Figure 2-3. The lowest of the three ratings for deck, superstructure and substructure (or a culvert rating for a culvert) determines the overall rating of the bridge. If this value is 7 or greater, the bridge is classified as being in good condition. If it is 5 or 6, the bridge is classified as being in fair condition, and if it is 4 or less, the bridge is classified as being in poor condition.

Figure 2-3. Bridge Components



State

In addition to the federal performance measures, Iowa DOT developed and uses a Bridge Condition Index (BCI) to aid in the prioritization of state-maintained bridge projects for replacement and maintenance. The BCI is based on data collected as part of the National Bridge Inventory (NBI) inspections. The index combines a bridge's condition, its ability to provide adequate service, and how essential it is for the traveling public into a single index.

The BCI is reported on a 100-point scale, with 100 representing the best condition possible on the index. A bridge rated 50 or higher is considered to be in a state of good repair.

The BCI reflects the overall condition of the bridge, considering; structural condition, load carrying capacity, horizontal and vertical clearances, width, traffic levels, type of roadway it serves, and the length of out-of-distance travel if the bridge were closed.

Bridge Inventory and Conditions

Iowa has 24,087 bridges and Iowa DOT is responsible for maintaining 4,159 of these bridges, including bridges on the National Highway System (NHS) and state highways. Local governments throughout the state maintain the remaining bridges. Some bridges owned by local governments are on the NHS system and these assets are included in the TAMP. A summary of Iowa's bridges is presented in Table 2-2. Bridge condition is represented in terms of FHWA's performance measure. State-owned bridges are also measured using BCI.

Bridge Condition History

Iowa DOT's bridges are in relatively good condition overall, and recent trends show that overall conditions are relatively stable. Although the number of poor bridges has been going down over the past decade, the number of poor bridges is expected to begin to grow again due to funding limitations to address bridges in fair condition. In addition, many structures are coming to the end of their designed service life. This means that they will need major rehabilitation or even replacement at some point in the near to mid-term future.

Table 2-2. Bridge Inventory and Condition

Owner	System	Count	Deck Area (ft^2)	Good	Fair	Poor	BCI < 50
Iowa DOT	NHS	2,561	33,350,027	48.9%	49.1%	2.1%	106
	Non-NHS	1,598	12,087,103	51.7%	47.0%	1.3%	54
	Total	**4,159**	**45,437,130**	**49.6%**	**48.5%**	**1.8%**	**160**
Other	NHS	41	927,412	47.8%	40.6%	11.6%	
	Total	**41**	**927,412**	**47.8%**	**40.6%**	**11.6%**	
All	NHS	2,602	34,277,439	48.9%	48.8%	2.3%	
	Total	**4,200**	**46,364,542**	**49.6%**	**48.4%**	**2.0%**	

Note: there are more than 19,000 locally owned bridges in Iowa that are not on the NHS. Those assets are not included in the TAMP.

Figure 2-4. Primary Highway System Bridge Condition History

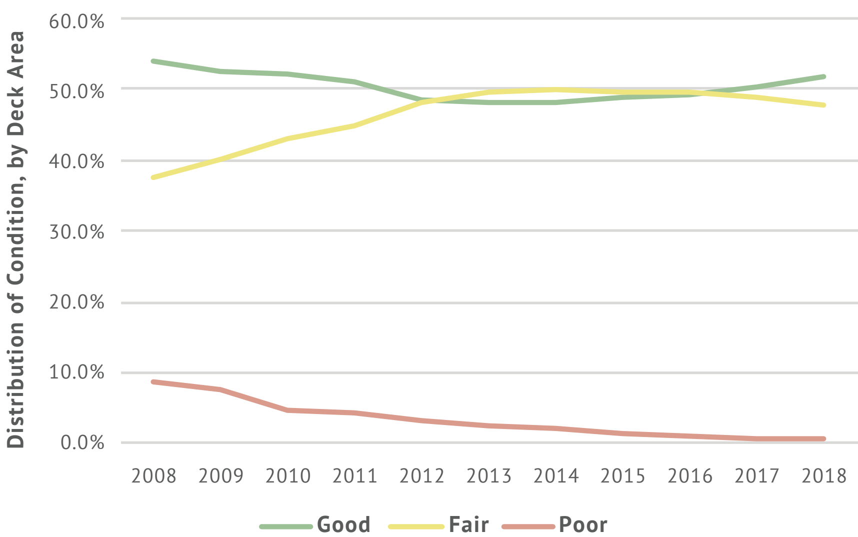


Figure 2-5. Primary Highway System Bridge Age

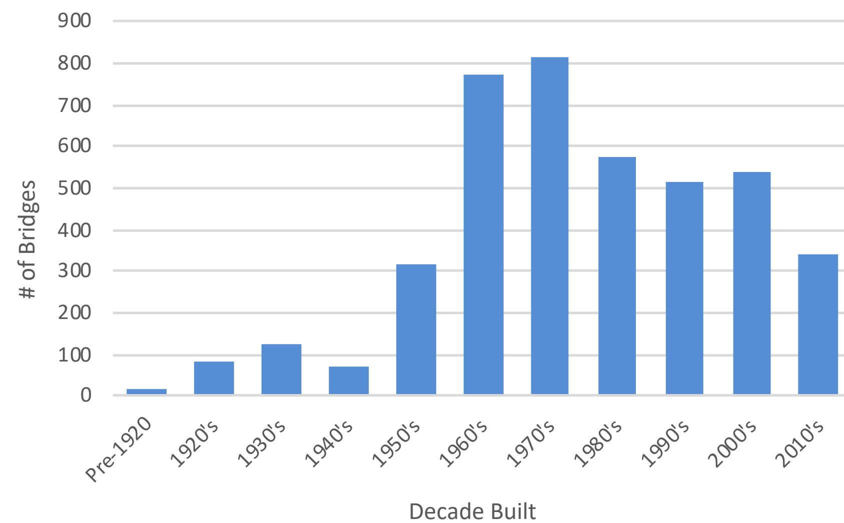


Figure 2-4 show the historical percentage of good, fair, and poor bridges of the primary highway system, as defined by the FHWA bridge measure. Trends show that conditions have been fairly stable, although they do fluctuate from year to year. The percentage of deck area in poor condition has decreased and the percentage of deck area in fair condition has increased.

Bridge Age

The average age of Iowa DOT's bridges is 38 years. About 25 percent of the bridges are over 50 years old, and the average age of bridge structures is going up. In 10 years, almost half of the bridges on the state highway system will be over 50 years old. In comparison, a typical bridge lasts about 60 years. Figure 2-5 is a graph of the age distribution of the bridges on the primary highway system.

Pavement

Pavement is the layered structure that forms the road. Pavements are designed to support anticipated traffic loads and provide a safe and relatively smooth driving surface. Maintaining pavements in good condition lengthens their life, enhances safety, helps reduce road users' operating costs, and reduces vehicle emissions. On the other hand, rough roads cause more wear and tear on vehicles, increasing user costs. Iowa DOT's pavements represent a mixture of asphalt pavement, concrete pavement, and composite (asphalt over concrete). Just over half of the network is composite pavement.

A typical pavement structure is shown in Figure 2-6, and a typical concrete pavement structure is shown in Figure 2-7.

Figure 2-6. Pavement Structure

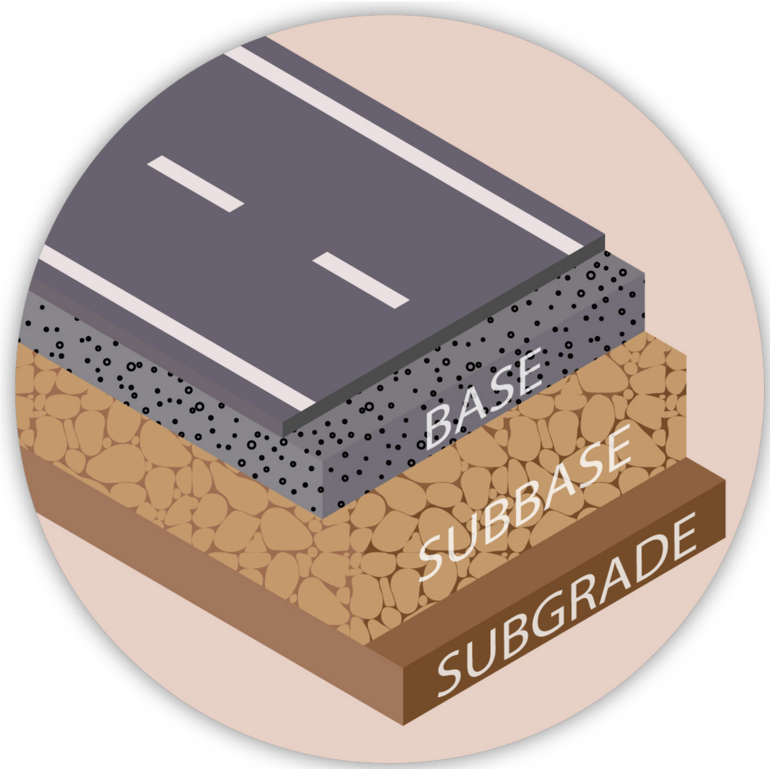
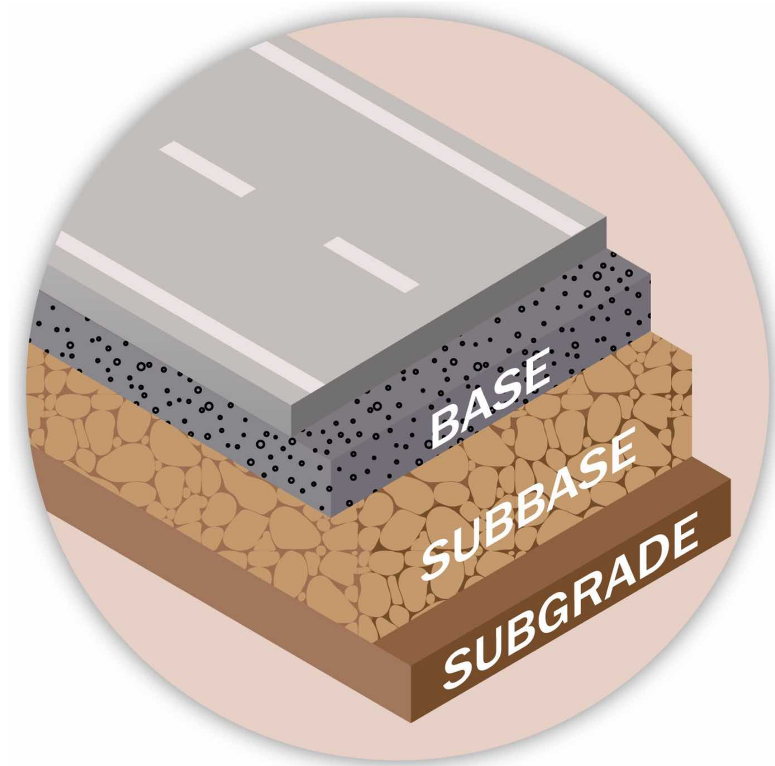


Figure 2-7. Concrete Pavement Structure



Pavement Performance Measures

Federal

FHWA has established four performance measures for NHS pavement conditions:

- Percentage of pavements on the Interstate System in Good condition
- Percentage of pavements on the Interstate System in Poor condition
- Percentage of pavements on the NHS (excluding the Interstate System) in Good condition
- Percentage of pavements on the NHS (excluding the Interstate System) in Poor condition

Each of the performance measures are calculated based on data reported to the HPMS. The following metrics are used to calculate the pavement condition performance measures:

- **Pavement roughness** is an indicator of discomfort experienced by road users traveling over the pavement and is measured using the International Roughness Index (IRI).
- **Rutting** is quantified for asphalt pavement by measuring the depth of ruts along the wheel path. Rutting is commonly caused by a combination of high traffic volume and heavy vehicles.
- **Cracking** is measured in terms of the percentage of cracked pavement surface. Cracks can be caused or accelerated by excessive

loading, poor drainage, frost heaves or temperature changes, and construction flaws.

- **Faulting** is quantified only for concrete pavements. Faulting occurs when adjacent pavement slabs are misaligned. It can be caused by slab settlement, curling, and warping.

A graphical depiction of the four pavement condition metrics is shown in Figure 2-8.

For each of the above metrics, FHWA has established thresholds for good, fair and poor condition. Conditions are assessed using these threshold criteria for each 1/10-mile long pavement section. An individual section is rated as being in good condition, if all of the metrics are rated as good, and poor when two or more are rated as poor. All other combinations are rated as fair. The lane miles in good, fair and poor condition are tabulated for all sections to determine the overall percentage of pavements in good, fair and poor condition. These thresholds are summarized in Table 2-3.

Figure 2-8. Pavement Condition Metrics

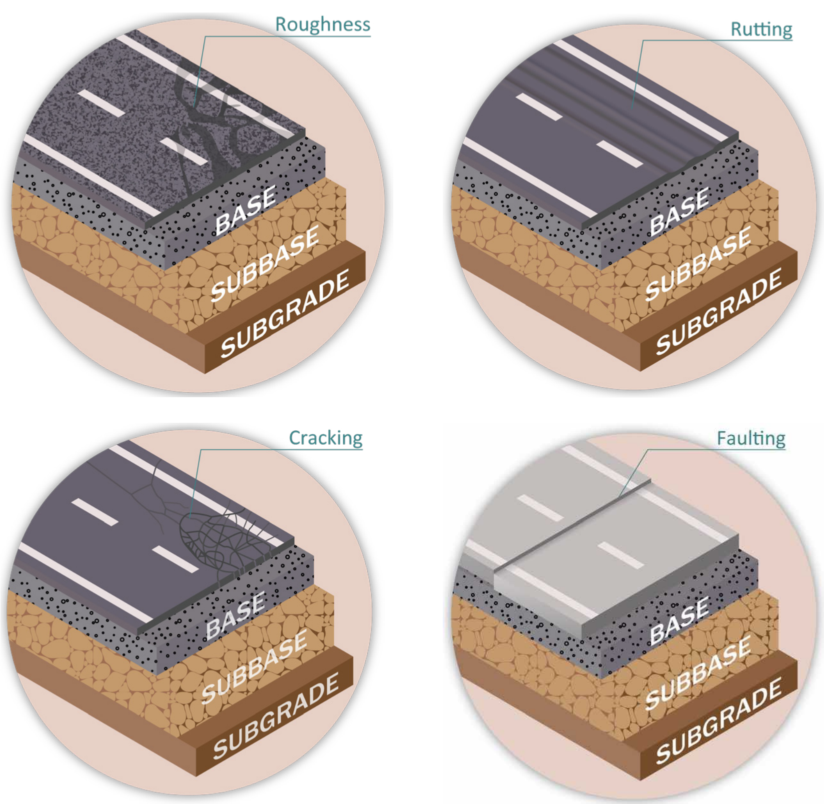


Table 2-3. FHWA Pavement Metric Condition Thresholds

Metric	Good	Fair	Poor
IRI (inches/mile)	<95	95-170	>170
Rutting (inches)	<0.20	0.20-0.40	>0.40
Cracking (%)			
- Asphalt	<5	5-20	>20
- Jointed Concrete	<5	5-15	>15
- Continuously Reinforced Concrete	<5	5-10	>10
Faulting (inches)	<0.10	0.10-0.15	>0.15

State

Iowa DOT reports pavement condition using a Pavement Condition Index (PCI). PCI is a metric developed by Iowa DOT that accounts for a pavement's ride quality and the amount of cracking, faulting, and rutting on it. Iowa DOT uses PCI thresholds for good, fair, and poor that differ by roadway type, as shown in Table 2-4.

Iowa DOT uses the good, fair, and poor categories to track and communicate the overall condition of its pavements. It uses the more detailed, underlying condition data when evaluating and prioritizing specific pavement projects.

Table 2-4. PCI Thresholds

Category	Interstate	Non-Interstate NHS	Non-NHS
Good	**76-100**	71-100	71-100
Fair	**51-75**	46-70	41-70
Poor	**0-50**	0-45	0-40

Pavement Inventory and Conditions

Iowa's pavements include the NHS (which is broken into Interstate and non-Interstate systems), non-NHS state highways, county roads, and city streets. Overall, Iowa's roadway system includes over 240,000 lane miles of roadway. Iowa DOT is responsible for 23,625 of these lane miles. The Iowa DOT-owned highways are known as the primary highway system. The primary highway pavement inventory is expected to grow strategically over the next decade as targeted corridors may be expanded to improve mobility and address existing and projected capacity concerns.

Pavement inventory and conditions in Iowa are summarized in Table 2-5. Pavement condition is represented in terms of FHWA's performance measure. State-owned assets are also measured using PCI.

Note that Iowa does not currently track conditions on non-Interstate NHS by asset owner. Total non-Interstate NHS conditions are tracked and reported below.

Table 2-5. Pavement Inventory and Conditions

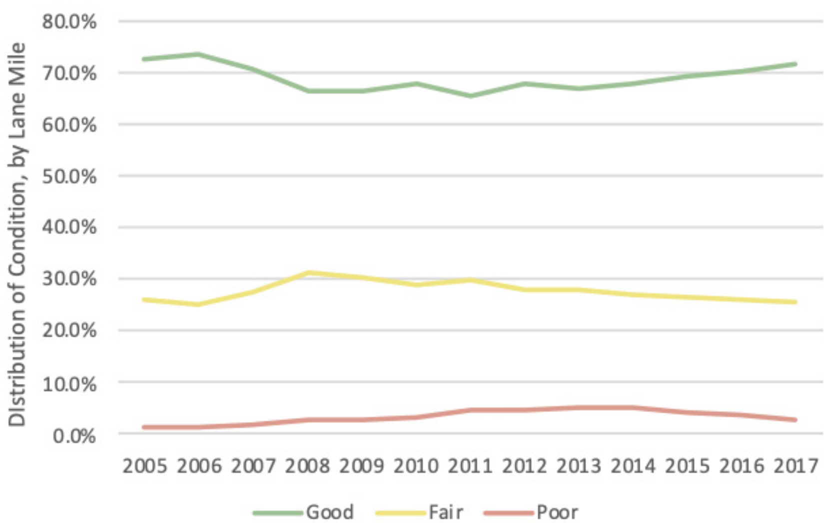
Owner	System	Lane Miles	Good	Fair	Poor	Average PCI
Iowa DOT	Interstate	3,436	57.8%	41.7%	0.5%	83
	Non-Interstate NHS	12,964	37.5%	58.8%	3.7%	72
	Non-NHS	7,225				69
	Total	**23,625**				**72**
Other	NHS	405				
	Total	**405**				
All	Interstate	3,436	57.8%	41.7%	0.5%	83
	Non-Interstate NHS	13,369	37.5%	58.8%	3.7%	
	Non-NHS	7,225				69
	Total	**24,030**				

Note: there are more than 200,000 lane miles of pavement in Iowa that are not owned by Iowa DOT and are not on the NHS. Those assets are not included in the TAMP.

Pavement Condition History

Figure 2-9 shows the distribution of Good, Fair, and Poor non-Interstate primary highway system pavements based on the Iowa DOT PCI over the past decade. Conditions on the network have fluctuated from year to year, but have remained relatively stable overall.

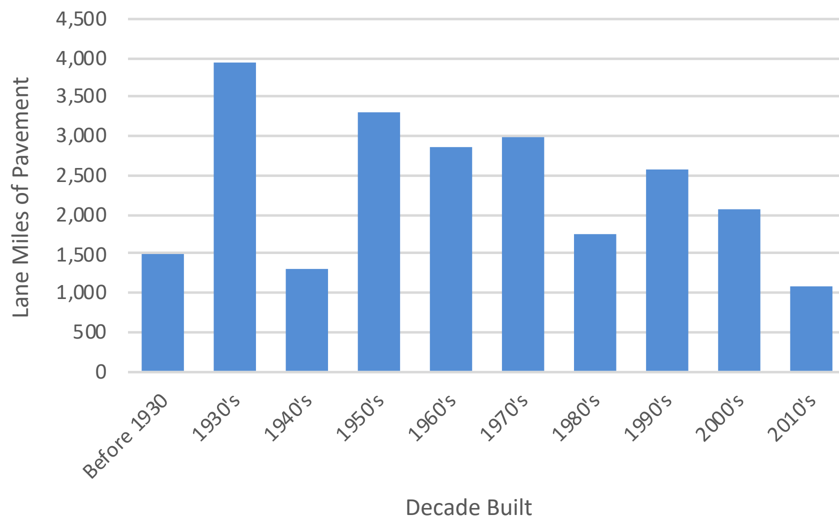
Figure 2-9. Non-Interstate Primary Highway System Pavement Condition History



Pavement Age

The primary highway pavement system is aging. Over half of the primary pavements are more than 55 years old, substantially exceeding their design service life. Nearly a third of the pavements are over 80 years old. In addition, thousands of miles of the primary system have had significant rehabilitation to keep them in serviceable condition. Figure 2-10 is a graph of the age distribution of the pavement on the primary highway system.

Figure 2-10. Primary Highway System Pavement Age



3. LIFE CYCLE PLANNING

Asset management is a series of processes intended to achieve and maintain a state of good repair over the life cycle of an asset. One key process is life cycle planning (LCP), 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 bridge and pavement management systems, Iowa DOT can estimate the cost of managing its bridges and pavements and determine the optimal mix of treatments to perform to achieve condition goals at low cost.

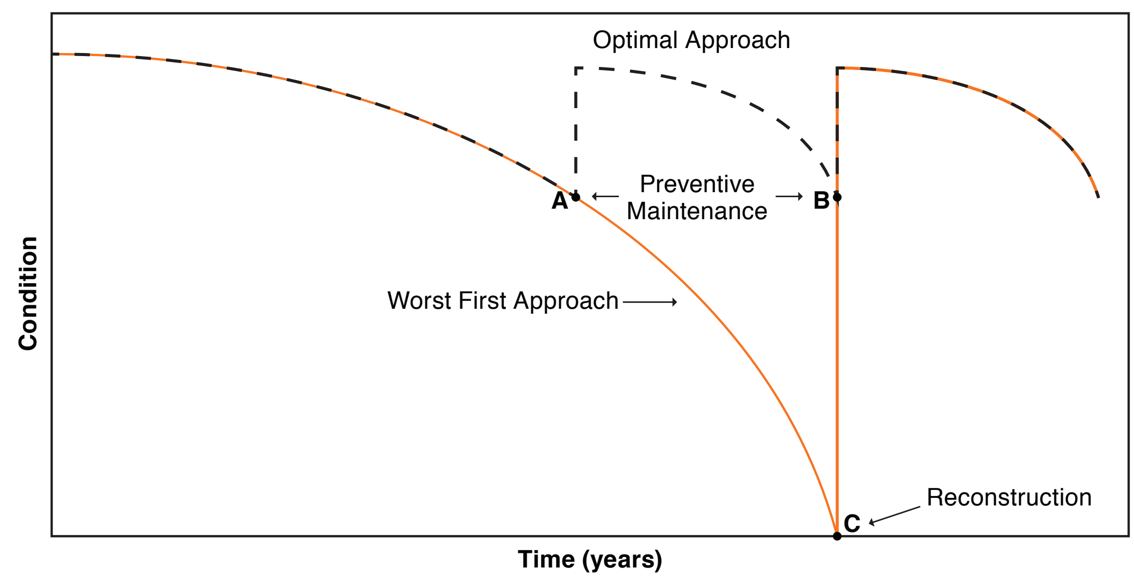
Introduction

This chapter presents Iowa DOT's LCP approach for bridges and pavement. LCP is defined in 23 CFR 515.5 as "a process to estimate the cost of managing an asset class, or asset sub-group, over its whole life with consideration for minimizing cost while preserving or improving condition."

Life cycle costs are the costs of managing an asset from inception through disposal. Many agencies, including Iowa DOT, have historically used a "worst-first" approach to bridge and pavement management. This approach focuses on replacing the poorest bridges and pavements first. A more cost-effective approach considers treatments that slow down deterioration and prolong asset life. This strategy is typically less expensive than letting an asset deteriorate to the point of needing replacement.

Figure 3-1 illustrates the two approaches. The solid line represents an asset that is built and deteriorates to point B before any work is performed. Once work is performed, the condition improves to point C. The dashed line shows work being done at point A. The asset's condition improves and then eventually deteriorates to point C. The cost of

Figure 3-1. LCP Approach vs Worst-First Approach



performing work at point A can be significantly lower than waiting until point B.

Generally, an effective life cycle plan emphasizes performing timely maintenance activities to keep an asset in good condition while avoiding, where possible, assets deteriorating to poor condition. Once an asset deteriorates to poor condition, treatment options are more expensive. The benefit of such a strategy is that it has the potential to reduce long-term costs to both the transportation agency and road users. Treating assets long before they reach a poor condition shortens the impact to the motoring public, yields a higher level of pavement or bridge condition over time, and improves the image of the state. LCP also provides the information needed to determine how best to prioritize asset investments when funding levels are insufficient to meet all the transportation system's needs.

Federal Requirements

FHWA requires that State DOTs establish a process for conducting LCP at the network level for NHS pavements and bridges. The following elements must be included in an LCP process:

- Identification of deterioration models
- Potential work types, including treatment options and unit costs
- A strategy for minimizing life cycle costs and achieving performance targets
- Asset performance targets

In addition, LCP should include future changes in traffic demand and information on current and future environmental conditions, including extreme weather events, climate change and seismic activity.

Bridge

Data Collection

Bridge inventory and condition data is collected every 24 months or 48 months, if criteria for the 48 month frequency is approved by FHWA, through inspections performed in accordance with FHWA's National Bridge Inventory (NBI) inspection standards. Each inspection is documented in the Structure Inventory and Inspection Management System (SIIMS) database. The documentation for an inspection includes photos, sketches, inspector's notes, condition ratings for specific elements, NBI data, and recommendations for maintenance. The inspection documents are reviewed by the Quality Control (QC) Team in the Bridges and Structures Bureau.

Along with the required NBI data, additional information is collected to enhance and support bridge management. Many individual bridge items and their corresponding conditions and configurations are documented during the biennial inspections. These elements include the National Bridge Elements (NBE), Bridge Management Elements (BME), and Agency Developed Elements (ADE). Iowa DOT also collects additional data items during every inspection.

NHS bridges, including Local NHS bridges, make up the bridge asset class. For bridges, the asset sub-groups include mostly concrete bridges and steel bridges, along with other types.

A culvert is considered to be an NBI bridge if the culvert is greater than 20 feet in length along the roadway. The bridge asset subgroup of culverts is excluded from LCP because no material adverse effect on the development of sound investment strategies will occur by eliminating these assets. This lack of impact is due to the extremely long life along with the long-term stability of these assets. Maintenance considerations only begin to occur around 75 years of service.

The SIIMS database is used by all bridge owners in Iowa. The NBE and NBI data collected in this system are imported into the AASHTOWare Bridge Management System (BrM).

Treatments

Bridges are designed to last over 50 years, and to withstand a variety of different distresses over their life. However, the individual components of a bridge deteriorate at different rates over time, and require treatment – in some cases multiple times over the life of the bridge – to maintain a bridge in good overall condition.

Routine maintenance is required on a bridge to replace bridge joints. If joints are allowed to fail, then water and road salts may seep into the bridge deck, superstructure and substructure, shortening the life of these components.

A bridge deck is exposed to truck traffic, road salt, and other distresses. Bridge decks typically last 15 to 25 years before they must be rehabilitated through placement of a new deck overlay, and they are often patched multiple times over their life. If a deck is not rehabilitated in a timely fashion, then the only feasible treatment may be to replace the deck or the entire bridge.

Treatments performed on a bridge's superstructure and substructure vary depending on the bridge's materials. Steel bridges require periodic repainting to avoid corrosion. Weathering steel does not require paint but should be washed on a regular basis. Concrete girders and other structural members may require periodic patching. The beam ends near joints are the structural members most prone to deterioration, and these may require periodic repair.

As a bridge ages the maintenance and rehabilitation costs incurred in keeping the bridge in service tend to increase. At some point it becomes more cost effective to replace a bridge than to continue to rehabilitate it. Also, it is generally more cost effective to replace smaller structures such as culverts, rather than to rehabilitate these.

Table 3-1. Bridge Treatments and Unit Costs

Work Type	Treatment Family	Project Treatment	Typical Unit Cost
Preservation	Paint steel	Routine painting of steel girders	$10/sq. ft.
Preservation	Wash weathering steel	Wash weathering steel girders on a regular basis	$4,000/ bridge
Maintenance	Strip seal joint repair	Replace glands	$100/ft.
Maintenance	Expansion joint replacement	Install new expansion joints	$2,000/ft.
Rehabilitation	Deck overlay	Dense concrete overlay	$50/sq. ft.
Rehabilitation	Deck overlay	Epoxy Polymer overlay	$30/sq. ft.
Preservation	Epoxy injection	Inject epoxy into delaminated areas under deck overlays.	$12/sq. ft.
Maintenance	Deck patching	Repair delaminated and spalled areas of a deck	$100/sq. ft.
Maintenance	Prestressed girder repair	Repair girder ends under joints	$1,500/ beam end
Rehabilitation	Deck replacement	Replace bridge deck	$75/sq. ft.
Reconstruction	Bridge replacement	Replace bridge	$325/sq. ft. of existing bridge deck area
Reconstruction	Culvert replacement	Replace culvert	$650/CY/ft.
Construction	New bridge	New bridge	$118/sq. ft.
Construction	New culvert	New culvert	$650/CY/ft.

Where there are functional issues with a bridge, such as limitations in the bridge's clearances, load carrying capacity, or traffic capacity, replacement is often the most cost-effective alternative.

Iowa DOT's typical bridge treatments and costs are listed in Table 3-1. These treatments and costs are entered into the NBI Optimizer described in the next section, and used to generate recommendations for treatments.

Modeling Approach

Iowa DOT models deterioration and projects future conditions using a tool called NBI Optimizer, developed by IDS Consulting. The NBI Optimizer predicts future conditions of each bridge in the network, simulates the application of bridge treatments, and prioritizes treatments subject to a budget constraint.

Performing an analysis in the NBI Optimizer requires data on existing conditions, a set of feasible treatments, business rules concerning what treatments are feasible under what conditions, and models for predicting deterioration.

Most of the treatments listed in Table 3-1 are included in the system. For each of these the system further specifies for which types of bridges the treatment may be performed, under what circumstances the treatment is feasible, and the impact of the treatment. The treatment assumptions and other details of the system are provided in the configuration of the NBI Optimizer is detailed in the 2014 report "Risk-Based Prioritization and Multi-Objective Optimization for Long-Term Network-Level Preservation Planning of Bridges in Iowa" prepared by IDS Consulting for Iowa DOT.

The NBI Optimizer uses historic NBI data to create multivariate inductive deterioration models for approximately 3,200 bridge structures (culverts and border bridges excluded) on the state highway system. The deterioration models incorporate consideration of a range of variables, such as age, traffic volume, design load, and deck type. The tool includes separate deterioration models for deck, superstructure and substructure ratings for 13 different groups of Iowa DOT bridges. Each deterioration model predicts condition ratings as a function of age.

Note that certain bridges are excluded from the NBI Optimizer analysis and their needs are handled outside the system. These are complex structures that are not easily modeled, including selected "big bridges" with unique design characteristics. There are 34 such "big bridges", 18 of which are on the NHS. For each of these bridges, Iowa DOT establishes specific maintenance and preservation activities. These bridges include the large border bridges, which are managed through coordination with the neighboring state. Five-year project needs are evaluated annually with each border state. If one of these bridges is nearing replacement, the planning effort will begin 10 years before the replacement is needed. Further, culverts are handled separately outside of the NBI Optimizer.

Strategy

Developing the lifecycle strategy for a bridge network involves determining what work should be performed on a given bridge, and how to prioritize the work between bridges given a constrained budget. The prioritization approach must consider both lifecycle cost considerations, and the criticality of addressing a bridge's needs.

For instance, a deck overlay may have high priority given that an overlay, if performed in time, can reduce the lifecycle cost of maintaining the bridge. However, rehabilitating or replacing a bridge in poor condition may merit high priority, as well, if the bridge is at risk of closure in the event needed work is deferred.

The NBI Optimizer applies the treatments and business rules described previously to determine what work is recommended for a given bridge. To prioritize work between bridges the system calculates a measure called Risk Index (RI). This index is the product of two separate values: a condition index and a risk factor. In the system bridges are prioritized for treatment based on the change in RI resulting from the work recommended for the bridge.

When performing an analysis in the system the user specifies an overall budget, as well as budgets by treatment type. The user also specifies whether the objective of the analysis is to minimize risk or maximize condition. The system then simulates bridge conditions and selects treatments for each bridge to maximize the objective function subject to the budget constraints.

During the configuration of the NBI Optimizer, Iowa DOT implemented a risk-based prioritization scheme based on the existing Iowa DOT Priority Ranking method, as well as a comprehensive database of preservation methods commonly used by Iowa DOT. The preservation methods database included the range of work types, formulae for calculating costs and benefits, and a set of applicable constraints for each preservation method based on Iowa DOT policies and work practices.

During the initial configuration of the NBI Optimizer, Iowa DOT evaluated a range of different scenarios for different groups of bridges and different budgets. For each scenario Iowa DOT staff evaluated what treatments were recommended, the overall performance yielded in terms of condition and risk. Based on this initial analysis documented in the 2014 report, Iowa DOT finalized the treatments and business rules in the system, as well as the percentage of the total budget that can be used for each type of treatment. This effort yielded an initial, optimized, risk-based 20-year preservation plan for the state-owned bridge inventory. The plan reflected Iowa DOT's life cycle strategy for its bridges considering lifecycle cost consideration, the agency's desired state of good repair, and available resources.

For subsequent analyses, including the analyses performed to develop this TAMP, Iowa DOT has performed additional analyses in the NBI Optimizer using the lifecycle strategies established through the initial configuration of the system. While it is possible to define different sets of treatments and/or treatment constraints for different scenarios, in practice Iowa DOT uses the same basic lifecycle strategy for each investment scenario tested. The scenarios thus vary based on overall budget, but not other parameters. By comparing scenario outcomes, bridge managers can evaluate the impacts of a given scenario on bridge condition and the level of risk, and use this information to help make the case for needed investments.

Implementing LCP Strategy

Iowa DOT's Bridge Maintenance and Inspection Unit recommends bridge maintenance activities based on the results of the bridge inspections described previously. This information is then forwarded to a bridge engineer, who is responsible for making rehabilitation and reconstruction recommendations and developing cost estimates.

The Bridges and Structures Bureau (BSB) compiles the rehabilitation and reconstruction recommendations and prioritizes them based on their urgency. Urgency is evaluated on a scale of one to four, where one means "implement a project as soon as practical," and four means "hold as a future candidate for the Five-Year Program."

Each year, BSB discusses the priorities with each District. At this annual meeting, BSB reviews all newly recommended projects from the past year to determine if they should be candidates for the Five-Year Program. If more than one work type is proposed for a given structure, each recommendation is given an importance rating of high, medium, or low.

After meetings with Districts, BSB reviews all priority one candidates to determine if the current Five-Year Program needs to be adjusted to accommodate them earlier in the program. BSB also determines which projects can be developed for construction in the final year of the upcoming Five-Year Program.

If costs of priority one candidates exceed available budgets, BSB prioritizes them using a process that considers bridge condition index (BCI), project cost, development time, and public needs. If all priority one candidates are programmed, priority two and three candidates are then considered. This process continues until funding is exhausted.

The process described above focuses on the condition of Iowa's bridges. In addition, Iowa DOT replaces a few bridges each year to accommodate capacity needs, and major urban interstate reconstruction projects often include replacing bridges that might not have been candidates otherwise.

Based on the results of the NBI Optimizer analysis and process outlined above, Iowa DOT typically allocates 70 to 74 percent of bridge funding for replacements, 9 to 23 percent for rehabilitation, and 7 to 17 percent for maintenance.

Pavement

Data Collection

Pavement condition data is collected on the Interstate System each year. The rest of the non-Interstate NHS and primary highway network has data collection on a biennial cycle with data on about half of the system being collected each year. Inspection vehicles equipped with sensors collect data on pavement smoothness and pavement surface defects. These defects include items like cracking, faulting, rutting, spalling, and patching.

In addition, Iowa DOT periodically conducts the following more detailed condition assessments:

- Assessment of structural capacity using a falling weight deflectometer: 5-year cycle and upon request
- Assessment of pavement subsurface using ground-penetrating radar: 5-year cycle and upon request
- Assessment of pavement friction: 5-year cycle

The collected data is reviewed according to Iowa DOT's Pavement Condition Management Data Quality Plan to ensure both data quality and completeness. After this review, the data is included in the pavement management information system (PMIS), which is the database for pavement data. Past years of pavement data are also saved in PMIS so pavement conditions can be tracked over time. Additional data about the history of the pavement and traffic are also stored in the system. The pavement history includes the construction date, pavement thickness, pavement width, and quality of aggregate used in the pavement. The data is assigned to individual pavement management sections that are referenced by mile posts and can be located by a linear referencing system. This allows the data to be used by geographic information systems (GIS). This methodology provides for the best available data to be used in the LCP analysis.

Interstates, Non-Interstate NHS, Non-NHS pavements, and Local NHS pavements compose the pavement asset classes. With respect to asset subgroups, the pavement management system (PMS) performs analyses for the pavement types of Asphalt, Composite, and Jointed Concrete; however, the federal performance reporting requirements combines the pavement subgroups of Asphalt and Composite pavements. Iowa DOT uses the dTIMS software for the pavement management analysis.

No pavement asset subgroup is excluded from LCP.

Treatments

Pavements deteriorate under loading from traffic, especially heavy trucks, and due to exposure to routine weather (freeze-thaw), or extreme events such as flooding, unusual heat waves, or harsh winters. Pavements are all designed to withstand their expected conditions, but the actual conditions vary by location. There can also be some variation in the materials and techniques used in construction. These variations mean not all pavements display the same types of distresses as they age. Common distresses include rutting, raveling, joint faulting, joint deterioration, cracking, and rough ride. Depending on the age of the pavement and the types of distresses that can be seen or measured, different treatments may be effective or ineffective in extending the life of the pavement.

Consistent with the principles of asset management, a wide range of work types are used to maintain pavements. These work types differ based on the pavement condition. Generally, this work is divided into five categories: construction, reconstruction, rehabilitation, preservation, and maintenance.

Construction involves building a new roadway section or a significant reconfiguration of an existing roadway. Construction projects are identified in long range planning documents, the Five-Year Program and the Statewide Transportation Improvement Program (STIP). These projects involve issues that extend beyond the pavement condition. These larger issues include items such as safety, capacity, freight, operations, economic, and other considerations. Since these projects involve many different configurations and environments, there is not a standard per-mile cost for construction. Each project will have an individual scoping and planning document prepared by the Department to determine its economic cost and benefits.

Treatments for the other work types are indicated in Table 3-2. The table does not cover all possible treatments for each work type, but it does cover those most commonly used and their approximate cost per lane mile. The treatment family is a grouping used in the pavement management software that helps identify the work type. The project treatment(s) are the alternatives that may be selected from a treatment family. The typical costs reflect the average project costs for each lane mile of the treatment. Actual costs of an individual project will differ from those shown in the table, but these costs are considered typical and used in the benefit–cost analysis of the pavement management software.

Table 3-2. Pavement Treatments and Costs

Work Type	Treatment Family	Project Treatment	Typical Cost/ Lane Mile
Construction	Construction	New HMA or PCC Pavement	Project Specific
Reconstruction	Reconstruction	New HMA or PCC Pavement	$875,000 Interstate $700,000 Non-Interstate
Rehabilitation	Major Structural Rehabilitation (More than 4.5 inches of structure needed)	Crack and Seat with HMA Overlay, HMA Overlay or PCC Overlay	$500,000 Interstate $425,000 Non-Interstate
Rehabilitation	Minor Structural Rehabilitation (3.0 to 4.5 inches of structure needed)	HMA Overlay or PCC Overlay	$380,000 Interstate $280,000 Non-Interstate
Rehabilitation	Functional Rehabilitation (Less than 3.0 inches of structure needed)	HMA Overlay	$350,000 Interstate $220,000 Non-Interstate
Rehabilitation	Cold in Place Recycling	Cold-In-Place Recycling	$250,000
Preservation	Diamond Grinding I & II	Diamond Grinding I & II	$50,000 Diamond Grinding I & 2 Interstate $25,000 Diamond Grinding I Non-Interstate $50,000 Diamond Grinding II Non-Interstate
Preservation	Thin Surface Treatments	Thin Lift HMA, Microsurfacing and Chip Seal	$30,000
Maintenance	Maintenance	Patching, Crack Filling and Sealing, Slurry Leveling and Joint Repair	Variable – Based on project quantity and density

Modeling Approach

Pavement management is a process that utilizes data about the current condition of pavements, estimated benefits from pavement treatments, computer modeling to forecast future pavement conditions, and budget constraints to assist in determining how to best manage pavement assets over time. Pavement management is using data to assist in determining the right treatment at the right time on the right pavement so that the most value is received from the funds invested in the road network.

Iowa DOT uses the dTIMS PMS to help manage state owned highways. The goal of the PMS is to assist in developing pavement selections and treatments based on data that will allow the Iowa DOT to manage pavements over their whole life.

Performing an analysis in the PMS requires data on existing conditions, a set of feasible treatments, business rules concerning what treatments are feasible under what conditions, and models for predicting deterioration.

In dTIMS, treatments and supporting business rules are specified through decision trees. Example decision trees for thin surface treatments and functional rehabilitation are shown in Figures 3-2 and 3-3.

Every year, Iowa DOT pavement engineers use algorithms to develop deterioration models for each pavement section based on the condition data from that section. These performance models predict the anticipated future condition of each pavement section if no work is performed. The pavement management system uses these deterioration models to forecast future conditions of each section and select appropriate treatments for the current and future years of an analysis scenario (typically 10 years). Figure 3-4 is an example deterioration curve from PMS where a diamond grind treatment is applied in year 2019 to an existing PCC pavement.

Figure 3-2. Thin surface treatment decision tree from PMS.

Cost	$30,000 / lane mile
IRI	If IRI > 80, 78% improvement, otherwise unchanged
Friction	50
Rutting	If rutting > 0.25, 50% improvement, otherwise unchanged
Fault Average	
Crack Ratio	Reset to zero
Structural Cracking	Reset to zero
Structure Need	
Joint Spalling	
Pavement Type	
Age	Reset Thin surface pavwement age, Structural Cracking, Crack Ratio, and Friction to zero

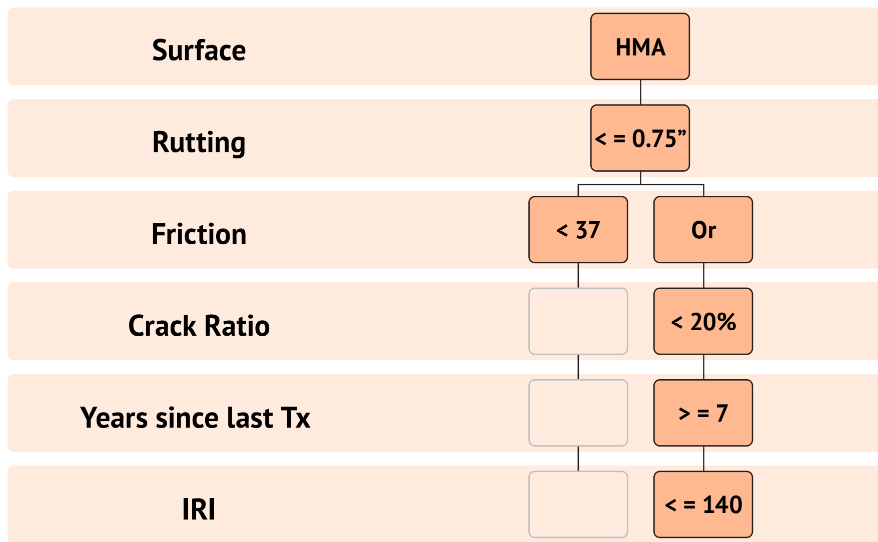


Figure 3-3. Functional rehabilitation decision tree from PMS.

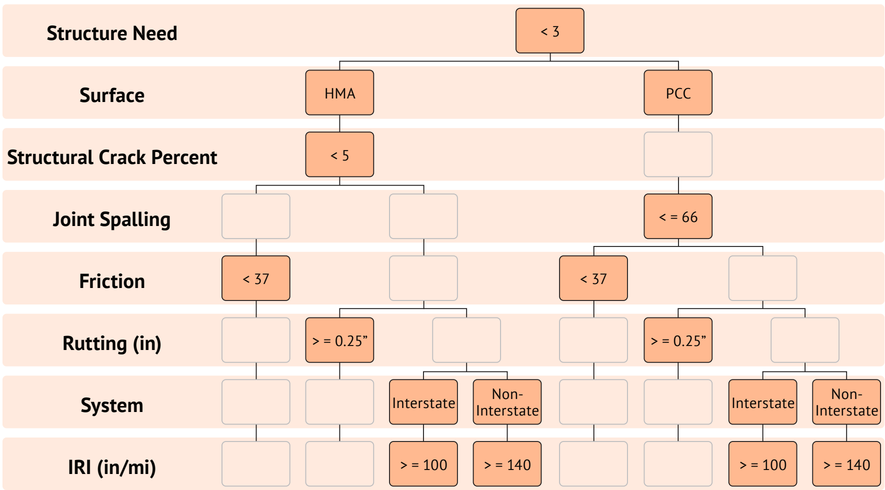


Figure 3-4. Example PMS deterioration curve for a PCC pavement with diamond grinding in 2019.

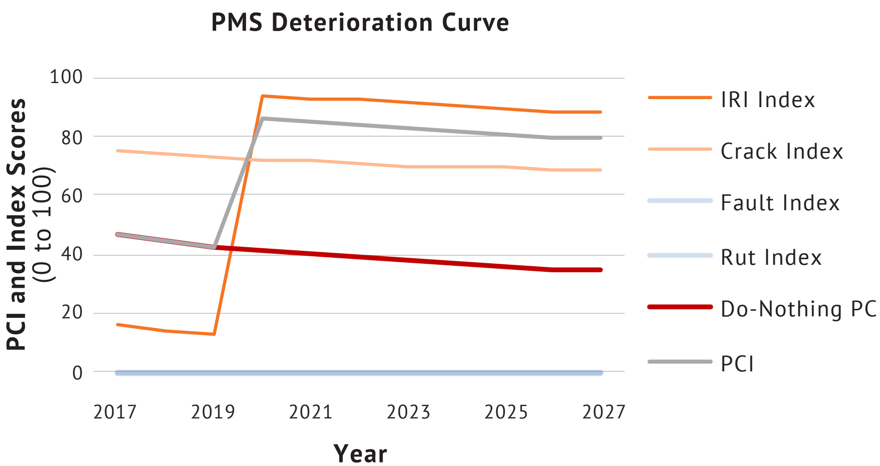
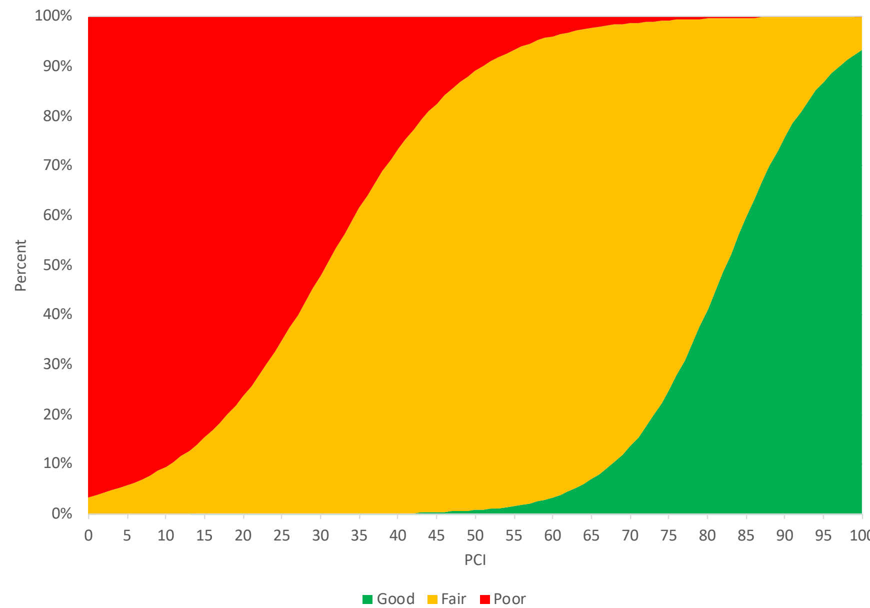


Figure 3-5. Prediction of Good/Fair/Poor Condition Based on PCI



Note that dTIMS predicts PCI and other pavement distresses for each pavement management section. The system is not configured to predict the FHWA good/fair/poor measure as this is aggregated by 1/10 mile section rather than by pavement management section. To establish the relationship between PCI calculated by management section and good/fair/poor condition calculated each 1/10 mile, Iowa DOT performed a statistical analysis between these measures using existing data, and then fit smoothed curves for using in mapping PCI to good/fair/poor condition. The resulting curves were applied to the predicted PCI values generated by dTIMS for each pavement management section to obtained predicted good/fair/poor conditions. Figure 3-5 shows the best-fit curves used for this analysis.

Figure 3-6. Historical and Projected Traffic Volumes

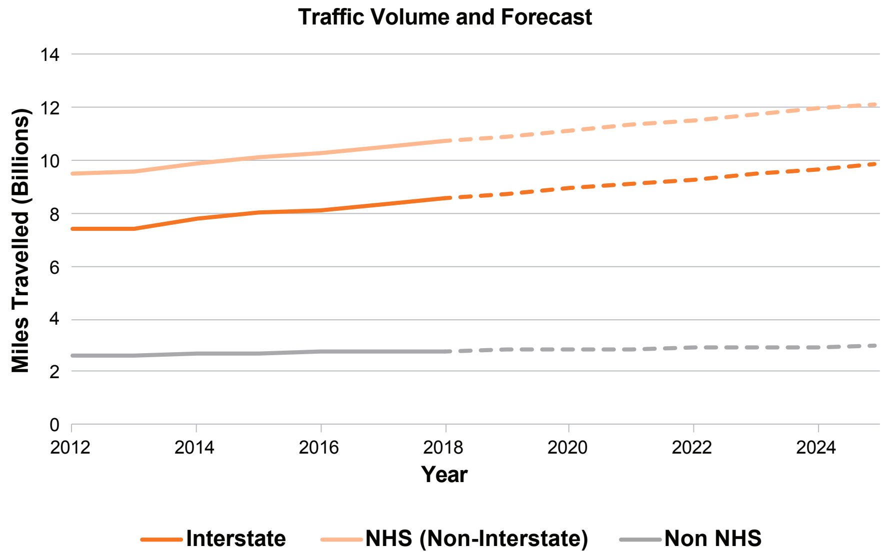
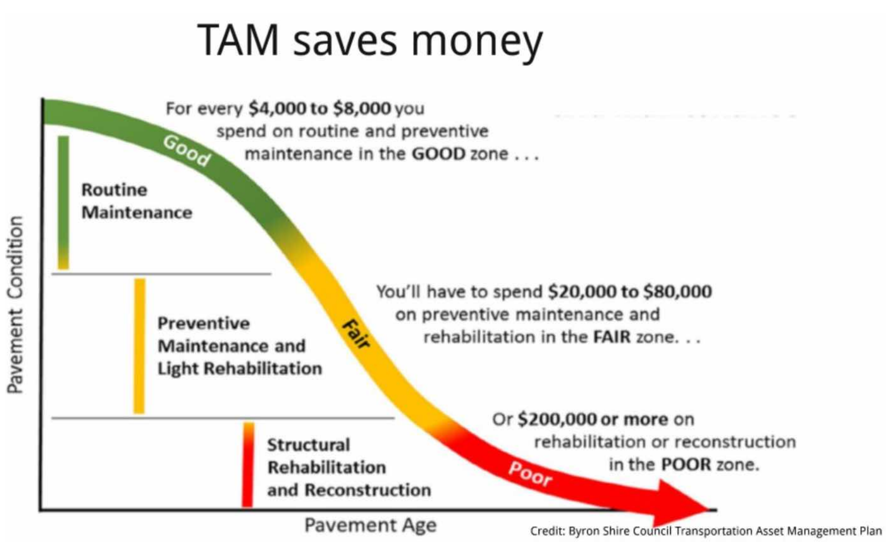


Figure 3-7. Pavement deterioration, treatment, and cost curve.



An important consideration in the asset management planning process is the amount of traffic that Iowa's roadways serve. Figure 3-6 shows actual traffic volumes in Iowa from 2012 through 2015, and projected volumes from 2016 through 2025. The impact of traffic is incorporated in the deterioration models described above.

Truck traffic, in particular, is hard on pavements. Iowa DOT projects a 66 percent growth in truck traffic over the next 20 years. This level of projected traffic growth is an indication of increased economic activity. As traffic volumes increase, the importance of maintaining existing roadways increases. At the same time, wear and tear on roadways increases, and there is more pressure to allocate money to capacity expansion projects. These trends further strengthen the need for Iowa DOT to implement asset management.

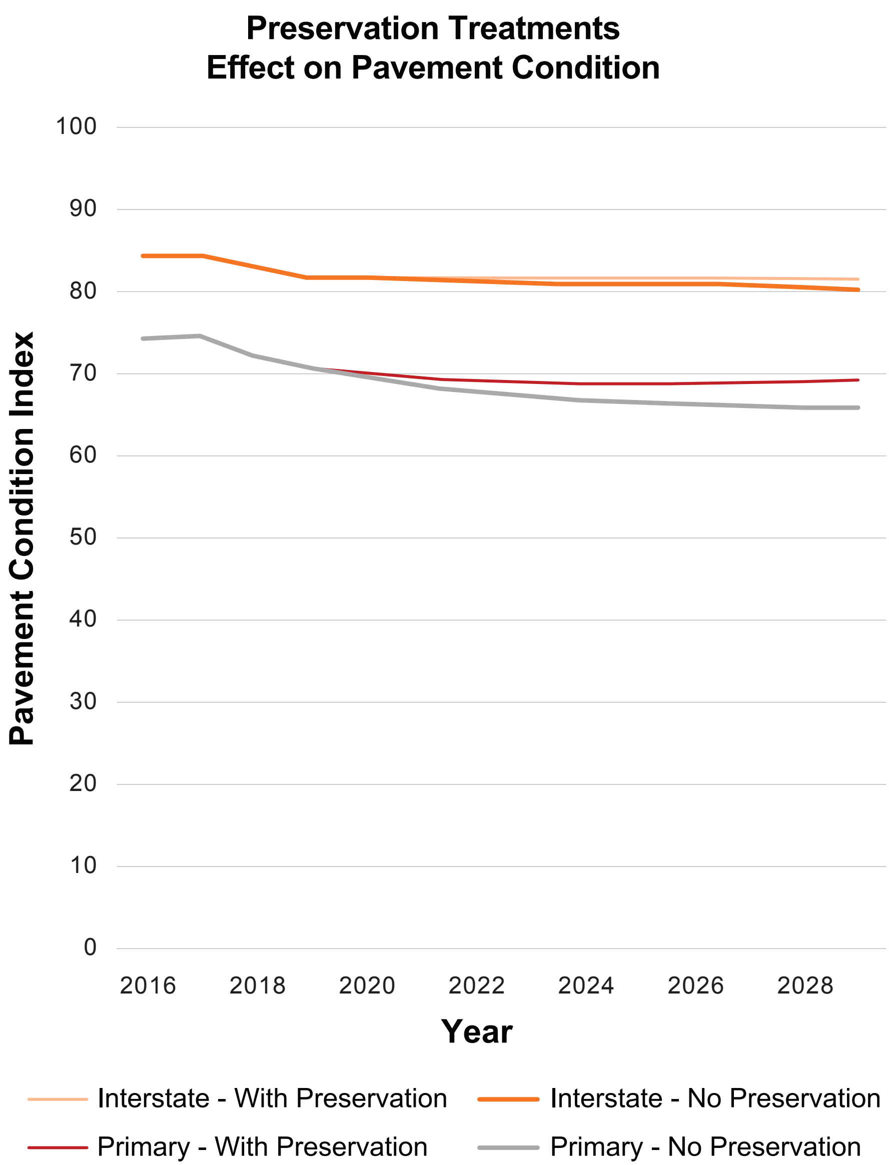
As a mitigation for the increasing truck traffic, Iowa DOT evaluates the structural capacity of all pavements at least every 5 years to determine the need for extra pavement thickness. This evaluation is used as a part of the PMS decision-making process.

Strategy

Good pavement management is all about selecting the right treatment at the right time on the right pavement section. The PMS allows for a systemwide identification of treatment options to help determine the right time for each treatment on each pavement section based on a given funding scenario. In most cases, a treatment is applicable to a given pavement section for multiple years. If the treatment is not applied within that time period, the pavement deteriorates to a point where a more substantial and more expensive treatment is needed. Figure 3-7 shows the value of performing timely maintenance.

In selecting what treatments to perform, the PMS calculates the cost and benefits of applying each feasible treatment to each pavement section for each year of the analysis. Benefit is defined as the improvement in performance (measured by change in PCI

Figure 3-8. Effect of preservation program on pavement condition.



multiplied by lane miles) from applying a treatment over the life of that treatment. The pavement management system identifies the mix of actions that will result in the greatest benefit for the pavement network with the available budget.

In the initial configuration of dTIMS, Iowa DOT configured the system such that, absent a specific funding constraint, the system tends to allocate funding to support the agency's desired lifecycle strategies. That is, the system recommends treatments that yield Iowa DOT's desired level of performance for its pavements at minimal lifecycle costs.

When the system is run, a scenario is defined with a budget specified by year. Separate runs are performed for Interstates and other state-owned roads. For each system, preservation treatments are provided a spending cap to control for factors such as available contractor capacity. No additional constraints are placed on different treatments or systems. For each run, the system recommends work to perform to maximize progress towards achieving the agency's desired state of good repair and targets for condition, subject to the available budget. Note that it is theoretically possible to develop and tests different sets of treatments and decision trees for different scenarios. However, in practice Iowa DOT uses the same basic lifecycle strategy for each investment scenario tested – the scenarios vary based strictly upon available budget. Nonetheless, the specific treatments selected do vary based on the available budget, with greater emphasis on thin overlays and other lower-cost treatments when the budget is tightly constrained. By comparing scenario outcomes, pavement managers can make informed decisions about the long-term costs and benefits of their decisions.

Figure 3-8 shows the results of two analyses run in Iowa DOT's PMS to demonstrate the benefits of prioritizing preservation treatments. For this comparison, the PMS evaluated two scenarios at the same level of annual investment. In the "With Preservation" scenario, the PMS applied the available funding, including $10 million dedicated to preservation treatments. In the "No Preservation" scenario, the system was unable to choose any thin surface treatment or diamond grinding and allowed pavements to deteriorate to the point of needing more costly resurfacing overlays before being selected to receive work. Although neither strategy achieves the agency's pavement objective at the defined budget level, the results show consistently better network pavement conditions using the strategy that include preservation treatments.

Implementing LCP Strategy

Iowa DOT also uses the PMS to inform the process of selecting pavement projects. The recommendations of pavement management software are used by program administrators when developing reconstruction, rehabilitation, and preservation programs. Iowa DOT has separate processes for selecting projects for the interstate routes and the remaining primary routes. Interstate projects are prioritized by the Iowa DOT's central office. This allows all interstate projects to compete against each other for funding, regardless of location. The rest of the primary system is managed collaboratively by the central office and the district offices. Generally, construction and reconstruction projects are identified by districts and prioritized by a team from the central office and districts. Rehabilitation, preservation, and maintenance projects are managed by the district offices. In addition to pavement condition data, the Iowa DOT also uses information on the condition of bridges and other structures, safety, traffic volume, capacity, and economic benefit when making these decisions.

For the Interstate System, PMIS data are part of the annual statewide review where potential pavement replacement and rehabilitation projects are evaluated. Districts also use the PMIS data as a resource in the development of the interstate preservation and maintenance programs.

For non-Interstate routes, the Districts use the pavement management recommendations and data in conjunction with site visits, pavement investigations, and local knowledge about roadways to develop the district pavement rehabilitation, preservation, and maintenance programs. The pavement management recommendations do not provide specific maintenance treatments, but the pavement management system does provide data to the district about the current condition and history that is used to prioritize maintenance treatments. These maintenance treatments address specific events or pavement defects in order to maintain a pavement's condition in order to maintain a functional state of operation.

The rehabilitation and preservation projects developed from these procedures become part of the recommendations given to the Iowa Transportation Commission for funding consideration. If they are approved, they become part of the Five-Year Program; and if they are federally funded, the projects are placed in the STIP. As part of the process, the Iowa Transportation Commission is updated on the current condition and estimated future condition of the Iowa DOT's pavements based on various funding scenarios.

Pavement management systems and the modeling software are an evolving process. The modeling efforts have limitations. There are time lags between data collection, data availability, and the analysis; the models do not perfectly predict future conditions, treatment costs are estimates, treatment selection lengths may not be practical or economical, and local knowledge of pavements is not represented in the model. In addition, Iowa DOT considers other factors such as traffic, system classification and a need for funding flexibility when making project selections. Iowa DOT tries to minimize disruption to the traveling public, and promotes longer-term fixes at the end of treatment windows when they align with desired asset management and operational goals.

The factors listed above demonstrate that engineering judgement is needed when reviewing the pavement management output and developing projects. The Iowa DOT strives to have a practical, low cost approach to pavement management and continues to work to improve its pavement management system with better models and better-aligned project recommendations. As an example of this ongoing change, in 2018 on the non-interstate system, approximately 40 percent of the miles treated with 3R funding had a thin surface treatment rather than a conventional overlay.

4. PERFORMANCE ASSESSMENT

An important aspect of asset management is using data to assist in determining the right treatment at the right time on the right pavement so that the most value is received from the funds invested in the transportation network. Iowa DOT uses data about the current condition of assets, estimated benefits from asset treatments, computer modeling to forecast future asset conditions, and budget constraints to assist in determining how to best manage bridge and pavement assets over time.

Introduction

This chapter presents the results of a set of performance scenarios developed for the 10-year period from 2019 to 2028. These have been developed for bridges and pavements to predict future conditions given potential funding scenarios. These performance scenarios build upon the asset inventory and conditions presented in Chapter 2, the life cycle planning process described in Chapter 3, and assumptions regarding potential future funding described in Chapter 6.

This chapter identifies the 2 and 4-year condition targets for bridge and pavement assets on the NHS, the desired state of good repair (SOGR) for those assets, and includes a gap assessment performed to identify the difference between current and projected asset conditions in achieving the desired state of good repair.

Federal Requirements

Using the measures of condition defined by FHWA, State DOTs must specify their desired SOGR for the 10-year analysis period of the TAMP consistent with state asset management objectives. The desired SOGR must also support progress towards achieving goals. National goal areas include safety, infrastructure condition, congestion reduction, system reliability, freight movement and economic vitality, environmental sustainability, and reduced project delivery delays.

As part of the FHWA rule on performance management, 23 CFR Part 490, states must set two and four-year asset condition performance targets. These targets shall be included in the TAMP but will also be reported separately to FHWA. As part of this performance management rule, states are also required to maintain NHS pavements and bridges to meet federally-established minimum condition levels:

- States must maintain bridges on the NHS (including culverts greater than 20-ft in length) so that the percentage of deck area of bridges classified as structurally deficient (equivalent to poor in FHWA's metric) does not exceed 10 percent of the overall deck area in a state. (If FHWA determines a state DOT to be out of compliance for three consecutive years, the state must set aside and obligate funding for eligible projects on bridges on the NHS.)
- States must ensure that no more than 5 percent of pavement lane miles on the Interstate system are in poor condition. (If FHWA determines a state DOT to be out of

compliance in any given year, the state must obligate funding to the National Highway Performance Program (NHPP) and transfer funds from the Surface Transportation Block Grant Program to the NHPP.)

- Funding penalty reassignments will remain in effect until the state is in compliance.
- The consequence of either of these funding penalty reassignments means that Iowa DOT could lose flexibility in the use of federal funds.

FHWA also requires that states establish a performance gap analysis process for TAMPs. Specific requirements for the process are listed below:

- Establish desired SOGR based on Federal requirements and State goals
- Establish state targets for asset condition
- Determine performance gaps
- Develop strategies to close or address the gaps

As part of the gap analysis, states must compare current asset performance to desired performance levels, but they may also compare desired asset performance to target performance to calculate an expected gap.

Bridge Performance Assessment

Iowa DOT defined a set of four performance scenarios for its analysis of future bridge conditions. For each scenario, the same basic lifecycle strategies are followed to the extent feasible considering available funding. The 100 percent scenario represents the expected level of funding for bridges. As discussed further in Chapter 6, a total of $2.3 billion is anticipated to be invested in bridge assets during the 2019-2028 time period.

Other scenarios were defined for budget levels at 75, 150 and 200 percent of expected stewardship funding. Stewardship funding totals approximately $1.4 billion in the 100 percent scenario. The remaining funding of approximately $0.9 billion (reserved for major structures and new construction) was held constant in all of the scenarios.

Iowa DOT's desired SOGR for bridges is to achieve an average BCI of 78 or greater for the Interstate Highway System and an average BCI of 76 or greater for the Non-Interstate Primary Highway System. The desired SOGR was established in consultation with the Iowa Transportation Commission considering Iowa DOT's goals and the national goals articulated in MAP-21. Ideally, Iowa DOT would like to maintain current bridge conditions, but some degree of deterioration may be expected even in the most optimistic scenario. The desired SOGR reflects the best conditions Iowa DOT can expect to achieve for its bridges, consistent with its goals and objectives for the transportation system, lifecycle strategies, and overall level of funding. The desired SOGR is achieved for the 200 percent funding scenario.

Once the scenarios were defined, Iowa DOT used the NBI Optimizer to predict future bridge conditions considering existing conditions, predicted deterioration, feasible bridge treatments, and the available budget. The modeling approach, treatments, and costs are described in Chapter 3. For each scenario a 10-year performance projection was obtained for three groups of bridges (Interstate, Non-Interstate NHS, and Non-Interstate Primary Highway System).

NHS Performance Scenarios

Performance projections for Interstate bridges are shown in Figure 4-1. Each line in the figure represents average BCI on the system for one investment scenario. The investment scenarios are labeled by their average level of funding, expressed as a percentage of expected funding. As indicated in the figure, the condition of interstate bridges is predicted to be maintained in the 200 percent scenario, and is predicted to decline in all of the other scenarios considered.

Figure 4-1. Interstate Bridge Condition Performance Scenarios

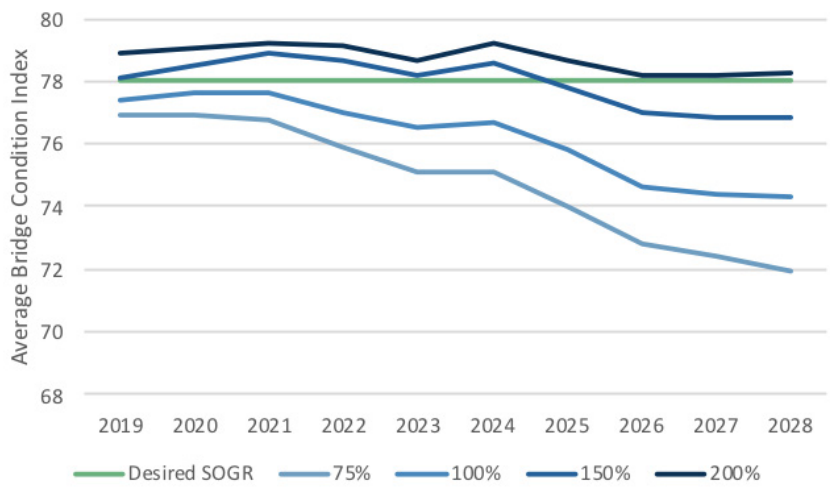
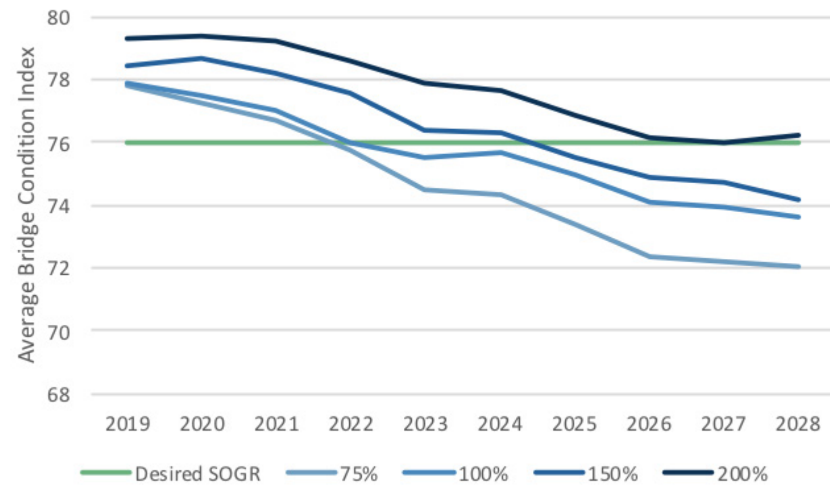


Figure 4-2. Non-Interstate NHS Bridge Condition Performance Scenarios



Performance projections for non-Interstate NHS bridges are shown in Figure 4-2. For these bridges, conditions, measured in BCI, are expected to decline for all of the scenarios considered.

Primary Highway System Scenarios

Performance projections for Non-Interstate Primary Highway System bridges are shown in Figure 4-3. The figure incorporates results for the Non-Interstate NHS bridges illustrated in Figure 4-2, as well as other state-owned non-NHS bridges. As shown in the figure, conditions, measured in BCI, are expected to decline slightly and then remain relatively constant for the 200 percent scenario. Conditions are expected to decline for the other scenarios considered.

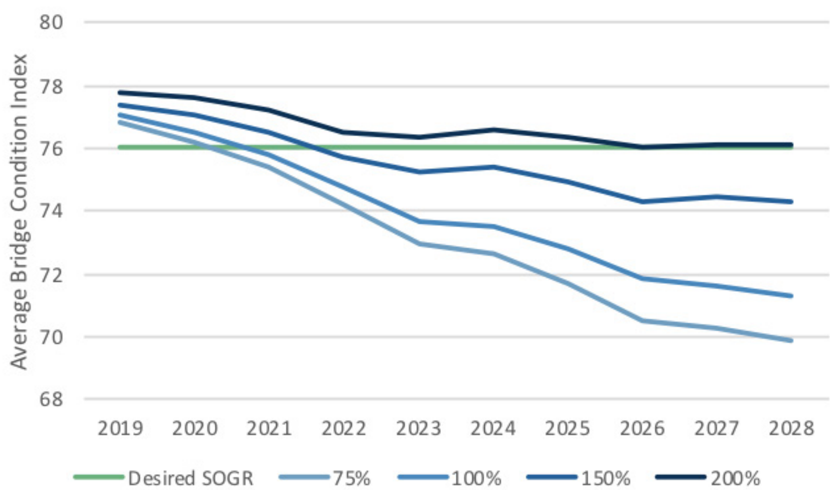
Local Collaboration

Iowa DOT works in partnership with local agencies to promote good bridge management practices for locally-owned bridges, including the locally-owned bridges on the NHS. Iowa DOT provides the Structural Inventory and Inspection Management System (SIIMS) software to local agencies as a tool to help manage local bridges. This software is used to capture the inspection data local agencies are required to provide as part of the annual National Bridge Inventory submittal to FHWA, as well as providing document storage, dash boards, and reports to help local agencies manage their bridges. Iowa DOT also provides other tools and resources to local agencies through support of the Iowa Highway Research Board and Iowa State University's Institute for Transportation Bridge Engineering Center.

Iowa DOT provides manuals and instructional memorandums to assist local agencies in bridge inspection, maintenance, and load rating. These manuals and memorandums provide the necessary information all local agencies need to manage their bridge inventories.

Iowa DOT coordinates with MPOs and local agencies in the establishment of bridge performance targets for the NHS, which includes bridges that are owned by local jurisdictions.

Figure 4-3. Non-Interstate Primary Highway System Bridge Condition Performance Scenarios



Pavement Performance Assessment

The pavement performance assessment was performed in a similar manner to the bridge performance assessment described previously. Iowa DOT defined a set of four performance scenarios for the analysis. For each scenario, the same basic lifecycle strategies are followed to the extent feasible considering available funding. The 100 percent scenario represents the expected level of funding for pavements. As discussed further in Chapter 6, a total of $4.8 billion is anticipated to be invested in pavement during the 2019-2028 time period.

For the other scenarios, funds for certain types of activities were held constant, while funding varied for other activities. Specifically, funds were held constant totaling $3.0 billion for routine maintenance, major construction and certain rehabilitation investments (e.g. major urban Interstate renewal where pavement rehabilitation is portion of the total investment). The remaining funding totaling $1.8 billion in the 100 percent scenario was allowed to vary, with scenarios representing 75 percent, 175 percent and 200 percent of the expected funding.

The desired SOGR for the Interstate System is an average PCI of 80, and the desired SOGR for the Non-Interstate Primary Highway System is a PCI of 75. The desired SOGR was established in consultation with the Iowa Transportation Commission considering Iowa DOT's goals and the national goals articulated in MAP-21. The desired SOGR reflects the best conditions Iowa DOT can expect to achieve for its pavement, consistent with its goals and objectives for the transportation system, lifecycle strategies, and overall level of funding. The desired SOGR is achieved for the 100% funding scenario for Interstate Highway System and the 200% funding scenario for the Non-Intestate Primary Highway System.

Once the scenarios were defined, Iowa DOT used the dTIMS PMS to predict future pavement conditions considering existing conditions, predicted deterioration, feasible pavement treatments, and the available budget. The modeling approach, treatments, and costs are described in Chapter 3. For each scenario, a 10-year performance projection was obtained for three groups of pavements (Interstate, Non-Interstate NHS, and Non-Interstate Primary Highway System).

NHS Performance Scenarios

Pavement performance projections for the Interstate System are shown in Figure 4-4. Each line in the figure represents average PCI on the system for one investment scenario. The investment scenarios are labeled by their average level of funding, expressed as a percentage of expected funding. As indicated in the figure, the average PCI for interstates will be held constant in the 100 percent scenario. Average PCI is expected to improve to the desired SOGR of 85 for the 200 percent scenario, and to decline slightly for the 75 and 175 percent scenarios.

Performance projections for non-Interstate NHS pavements are shown in Figure 4-5. As indicated in the figure, conditions, measured in PCI, are expected to improve in the 175 and 200 percent scenarios. For the 75 and 100 percent scenarios conditions are predicted to decline slightly and then stabilize (at a PCI of 68 for the 75 percent scenario and 70 for the 100 percent scenario).

Figure 4-4. Interstate Pavement Condition Performance Scenarios

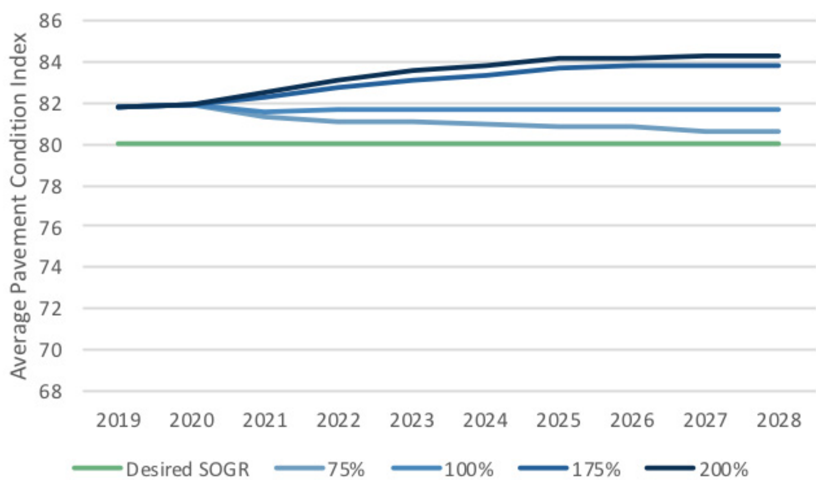


Figure 4-5. Non-Interstate NHS Pavement Condition Performance Scenarios

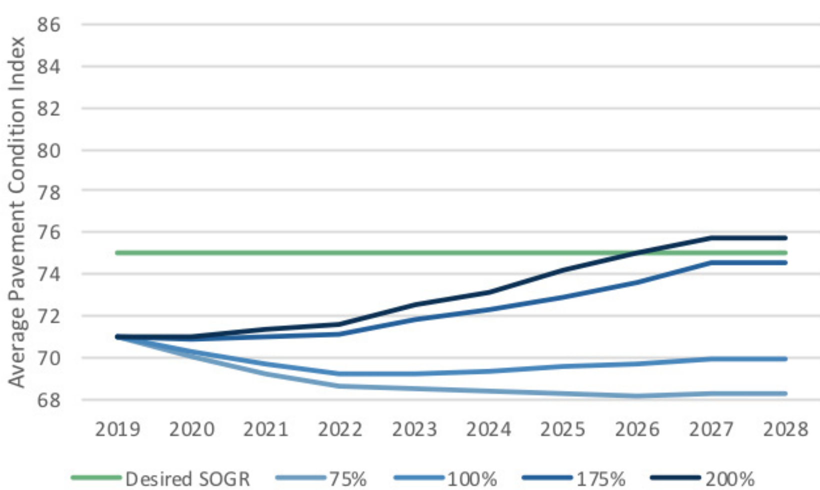
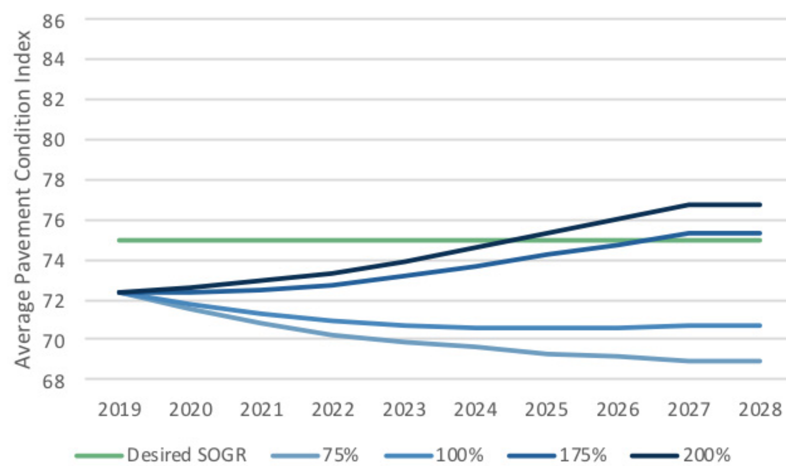


Figure 4-6. Primary Highway System Pavement Condition Performance Scenarios



Primary Highway System Scenarios

Performance projections for Primary Highway System pavements are shown in Figure 4-6. The figure incorporates results for the Non-Interstate NHS pavements illustrated in Figure 4-5, as well as other state-owned pavements. As shown in the figure, conditions, measured in PCI, are expected to decline slightly and then remain relatively constant for the 200 percent scenario. Conditions are expected to improve for the 175 and 200 percent scenarios. For the 75 and 100 percent scenarios, conditions are predicted to decline slightly and then stabilize.

Local Collaboration

Iowa DOT works in partnership with local agencies to promote good pavement management practices for locally-owned pavement, including the locally-owned pavement on the NHS. The Iowa DOT participates in and is the primary funding source for the Iowa Pavement Management Program (IPMP) at Iowa State University's Center for Transportation Research and Education. IPMP has been supported by Iowa DOT since 1996, and its role is to support local agencies in the collection and management of pavement data, as well as with modeling and analysis tools. IPMP focuses on local agency needs and is a technical resource for pavement management. Since 2013, the Iowa DOT has expanded pavement data collection efforts to collect pavement condition data on all paved roads in Iowa. Data is shared, free of charge, with counties, cities and planning agencies through IPMP and is available for their use.

The Iowa DOT coordinates with MPOs and local agencies in the establishment of pavement performance targets for the non-Interstate NHS system, which includes segments of roadways that are owned by local jurisdictions.

Targets

Federal regulation 23 CFR Part 490.107 requires that 2 and 4-year targets be set for bridges and pavements on the NHS. These targets are the expected performance of the assets based on the federally required measures given the funding availability and investment choices made by Iowa DOT. Performance targets are measured using FHWA's performance measures for asset condition.

Iowa DOT submitted 2 and 4-year targets to FHWA in September 2018. Baseline performance and 2-year target are not required for Interstate pavements for the first reporting period. Also note that the calculation methodology for Non-Interstate NHS pavement condition in the first reporting period is based solely on IRI and does not include the other metrics. This means that the baseline condition, which uses the modified approach based on IRI, is different from the current condition reported in Chapter 2, which is based on the complete performance measure. Table 4-1 shows a partial reproduction of that submission.

Desired State of Good Repair

As discussed in the previous section, Iowa DOT's desired SOGR for the Interstate and non-Interstate primary systems has been defined in terms of average BCI for bridges and average PCI for pavements. For the purpose of developing the TAMP, Iowa DOT performed additional calculations to determine the good/fair/poor conditions, measured using FHWA performance measures, for NHS pavements resulting from these average condition indices. The process used to predict the FHWA measures based on PCI is discussed in Chapter 3.

Table 4-1. NHS Asset Performance Targets

	Baseline (2017 data)	2-Year Target	4-Year Target
% of NHS bridges in Good Condition	48.9%	45.7%	44.6%
% of NHS bridges in Poor Condition	2.3%	3.7%	3.2%
% of Interstate Pavement in Good Condition	n/a	n/a	49.4%
% of Interstate Pavement in Poor Condition	n/a	n/a	2.7%
% of Non-Interstate NHS Pavement in Good Condition	50.9%	48.8%	46.9%
% of Non-Interstate NHS Pavement in Poor Condition	10.6%	13.2%	14.5%

For bridges, the predictions from the NBI Optimizer include both BCI and predictions of deck, superstructure and substructure ratings. Thus, the NBI Optimizer results include the data required to calculate good, fair and poor conditions. The results from the 200 percent scenario were used to establish the desired SOGR.

For pavement the predictions from the dTIMS PMS include predictions of average distresses and PCI, but do not include the specific measures or level of aggregation required for direct calculation of FHWA's good, fair and poor measures. Thus, Iowa DOT performed a supplemental analysis of existing pavement conditions to determine the good, fair and poor conditions predicted to result from each PCI value. The results of this analysis were used to predict good, fair and poor conditions for each management section for the investment scenarios described previously. The results for the 200 percent scenario were used to determine the desired SOGR.

Desired SOGR is expressed using FHWA's performance measures for asset condition. Based on the calculations described above, Iowa DOT's desired SOGR for NHS bridge and pavements is as follows:

- For NHS bridges, the desired SOGR is at least 46.8 percent of bridges (measured in terms of deck area) in good condition and no more than 6.5 percent in poor condition.
- For Interstate pavements, the desired SOGR is at least 58.8 percent of pavements (measured in terms of lane miles) in good condition and no more than 0.7 percent in poor condition.
- For non-Interstate NHS pavements, the desired SOGR is at least 39.4 percent of pavements in good condition and no more than 9.5 percent in poor condition.

Gap Assessment

Condition Gap Assessment

FHWA defines a performance gap as "the gaps between the current asset condition and State DOT targets for asset condition, and the gaps in system performance effectiveness that are best addressed by improving the physical assets." Iowa DOT tracks the gap between current performance and desired state of good repair; and the gap between 10-year projected performance and desired state of good repair. 10-year projected performance is the predicted asset condition assuming current funding levels are continued.

Note that current performance uses 2018 data and is consistent with the values presented in Chapter 2 Inventory and Condition. The condition gap assessment is expressed using FHWA's performance measures for asset condition.

The gap analysis for NHS bridges is shown in Table 4-2. There is no current condition gap for NHS bridges, but there are projected gaps. At the end of the 10-year period of the TAMP, the percent of NHS bridges in poor condition will exceed the desired SOGR by 6.2% and the percent of NHS bridges in good condition will be 11.2% less than the desired SOGR. These projected condition gaps could be addressed with an additional $1.4 billion in stewardship funding for bridges over the 10-year period of the TAMP.

Table 4-2. NHS Asset Performance Targets

	Good	Poor
Desired State of Good Repair	46.8%	6.5%
Current Performance	48.9%	2.3%
10-Year Projected Performance	35.6%	12.6%
Current Gap	No gap	No gap
Projected Gap	11.2%	6.2%

The gap analysis for Interstate pavement is shown in Table 4-3. There are current and projected condition gaps for Interstate pavements. At the end of the 10-year period of the TAMP, the percent of Interstate pavement in poor condition will exceed the desired SOGR by 0.1% and the percent of Interstate pavement in good condition will be 9.8% less than the desired SOGR.

Table 4-3. Interstate Gap Assessment

	Good	Poor
Desired State of Good Repair	58.8%	0.7%
Current Performance	51.7%	0.5%
10-Year Projected Performance	48.9%	0.8%
Current Gap	7.1%	No gap
Projected Gap	9.8%	0.1%

The gap analysis for Non-Interstate NHS pavement is shown in Table 4-4. There are current and projected condition gaps for non-Interstate NHS pavements. At the end of the 10-year period of the TAMP, the percent of Non-Interstate NHS pavement in poor condition will exceed the desired SOGR by 3.5% and the percent of Non-Interstate NHS pavement in good condition will be 9.1% less than the desired SOGR.

Table 4-4. NHS Asset Performance Targets

	Good	Poor
Desired State of Good Repair	39.4%	9.5%
Current Performance	31.1%	3.1%
10-Year Projected Performance	30.3%	13.0%
Current Gap	8.3%	No gap
Projected Gap	9.1%	3.5%

These projected condition gaps could be addressed with an additional $1.8 billion in stewardship funding for pavements over the 10-year period of the TAMP.

Other Gap Assessments

The TAMP focuses on asset condition and SOGR. Iowa DOT discusses other potential gaps in related planning efforts. Several Iowa DOT planning efforts and documents involve analysis of the transportation system, with the aim to improve its performance in areas aligned with national goals, including safety, infrastructure condition, system reliability, freight movement, and reduced congestion. Some of the strategies and projects identified in these plans will likely result in modifications to NHS pavements and bridges, though not necessarily within the 10-year timeframe of the TAMP. If all the strategies discussed below were implemented immediately, they would likely impact the gap between existing and desired pavement and bridge condition on the NHS by expanding NHS pavement and bridge assets, or by expending funding that may have otherwise been used to improve NHS pavement or bridge conditions. The intent, however, is that these strategies will be implemented over a longer period, and tactics to minimize their impact on the performance gap for pavement and bridge condition will be utilized. This would include tactics such as performing work when other pavement and bridge needs are being addressed and funding non-condition needs from sources other than funds targeted towards NHS condition improvement. Over time, if pavements and bridges on the NHS expand due to these strategies, their life-cycle costs and asset management needs will need to be incorporated into the State's overall asset management strategy.

The State Long-Range Transportation Plan (SLRTP), adopted in 2017, includes analysis and strategies for the various modes of transportation in the state. For highways, this includes considerations related to capacity, mobility and safety, freight, condition, operations, and bridges. Pavement and bridge needs on the NHS are anticipated to be addressed primarily through asset management as described in the TAMP. Other SLRTP needs and strategies, which may result to changes to the NHS, include the following.

- Capacity needs were identified for three interurban interstate corridors and for several Interstate, NHS, and other State routes in urban areas. Strategies to address these needs include targeting investment toward areas anticipated to become congested by 2045, and considering targeting anticipatory investments at locations with potential congestion issues beyond 2045. Improvements affecting some NHS routes could include added capacity and/or operational improvements.

- Mobility and safety, or "Super-2" needs, were identified for five U.S. routes across Iowa, all of which are part of the NHS. Strategies to address these needs include targeting investment toward improvements such as wider paved shoulders, turn lanes, passing lanes, limited access, and geometric improvements. These improvements are largely anticipated to be opportunistic, and are likely to occur at spot locations when other pavement, bridge, or safety issues are being addressed.

- The operations analysis focused on prioritizing interstate corridors from an operations perspective, and implementing appropriate transportation system management and operations (TSMO) strategies on those corridors.

The analysis included in the State Freight Plan, updated in 2017, identifies important considerations that may lead to changes to some NHS routes to enhance mobility and/or reduce delay. One such consideration is the identification of the Iowa Multimodal Freight Network (IMFN), which includes several NHS routes. This network is meant to recognize corridors that are critical to truck freight in order to protect and enhance their ability to facilitate freight movement. The IMFN may also lead to department policies regarding the design and use of these corridors, and help assist in programming decisions. Another consideration is the identification and prioritization of bottlenecks on the highway system. These locations represent areas that should be considered for further study and possibly for future improvements. A detailed analysis was performed to prioritize the bottlenecks based on their value to the overall system, traffic and infrastructure condition, and travel time performance.

The State Freight Plan identifies several strategies that may result in investments on NHS routes. These include:

- Target investment to address mobility issues that impact freight movements.
- Emphasize the IMFN and utilize designs that are compatible with significant freight movements.
- Right-size the highway system and apply cost-effective solutions to locations with existing and anticipated issues.

Specific investments identified in the Freight Plan include three interstate projects that will improve the condition and performance of the NHS, including a bridge replacement on I-74 over the Mississippi River and interstate reconstruction/realignment work in Council Bluffs and Johnson County.

The 2019-2023 Strategic Highway Safety Plan (SHSP) includes engineering strategies to help address issues with lane departure crashes and to improve intersections. These improvements are being implemented as appropriate throughout the State's highway system, and may include enhancements to NHS routes. Many of these strategies would not necessarily impact the condition of pavements or bridges or the timeframe in which assets are rehabbed or replaced. Strategies to help prevent lane departures include the installation of countermeasures such as centerline rumble strips, shoulder/edgeline rumble strips, curve delineation, shoulder treatments, and median cable barriers. Strategies to help improve intersections include implementing innovative improvements such as roundabouts, reduced conflict intersections, diverging diamond interchanges, and offset turn lanes; traffic signal modifications; intersection lighting; and bicycle/pedestrian intersection improvements.

5. RISK MANAGEMENT

Managing risk is an integral part of asset management. Transportation agencies manage physical assets which are subject to a range of risks, from daily operational concerns to potentially catastrophic asset failures. By anticipating, identifying, and planning for potential scenarios, Iowa DOT can reduce uncertainty and mitigate the effects of risks.

Introduction

This chapter describes the federal requirements pertaining to risk management in TAM, Iowa DOT's existing risk management activities, and Iowa DOT's TAM risk management processes and risk mitigation plan. Additionally, this section summarizes an assessment of NHS pavements and bridges repeatedly damaged by emergency events, consistent with federal requirements.

Federal Requirements

Requirements for consideration of risk in a TAMP are detailed in 23 CFR Part 515. Risk is defined as "the positive or negative effects of uncertainty or variability upon agency objectives" and risk management is defined as "the processes and framework for managing potential risks." (23 CFR Part 515.5).

23 CFR 515.7 (c) mandates that, "A State DOT shall establish a process for developing a risk management plan." Specific requirements for the process are listed below.

- Identification of risks that can impact the condition and performance of NHS pavements and bridges
- Assessment of the identified risks in terms of the likelihood of their occurrence and their impact and consequence if they do occur
- Evaluation and prioritization of the identified risks
- Mitigation plan for addressing the top priority risks
- Approach for monitoring the top priority risks
- Summary of the evaluation of NHS pavements and bridges repeatedly damaged by emergency events

Existing Risk Management Practices at Iowa DOT

Iowa DOT practices formal and informal risk management. A current focus is on resiliency, specifically as related to bridges. In 1980, Iowa DOT started using bridge materials that were more resistant to corrosion (e.g. poly-coated steel, stainless steel). Managing the risk of bridge corrosion helps extend the life of the asset, saving money over time. Iowa DOT also uses a brine / salt combination on bridges, resulting in more effective deicing, greater coverage, and lower usage of salt.

Iowa DOT has a research request to track salt usage by location and cross reference the usage data with bridge inspections and evaluations to measure the impact of the salt policies on specific bridges. Iowa hopes to use this research to become a leader in this area and use less salt than neighboring states as a result of these innovative resiliency practices.

Iowa DOT recently created a Project Management Bureau (PMB) for the Highway Division. The focus of the PMB is on project management and delivery. One of the roles of the PMB is to provide a more comprehensive and risk-based approach to management of large and complex projects. A project manager assigned by the PMB will evaluate and monitor risks and work with the project team to mitigate those risks.

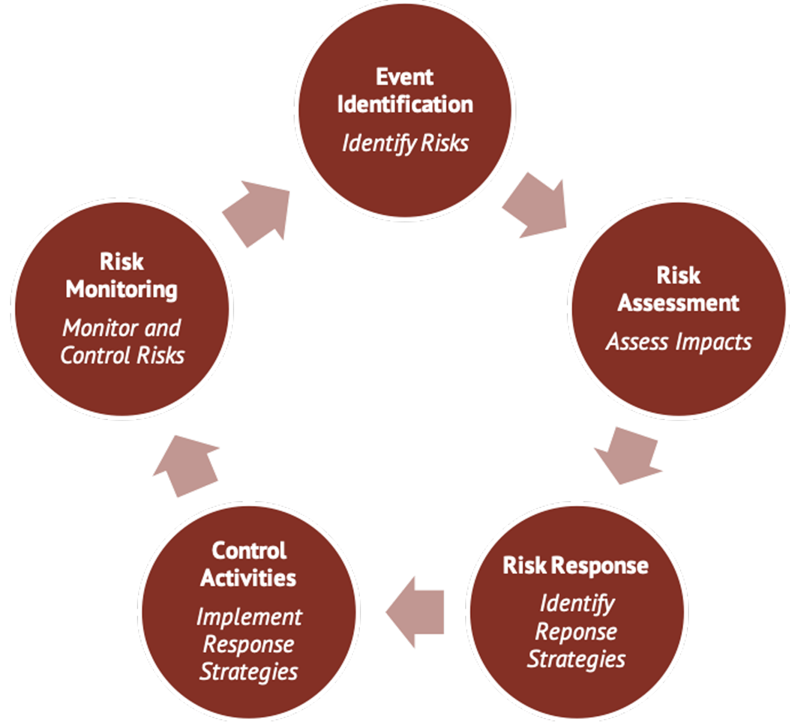
Other risk management practices include a research project to create a resiliency index, materials inspections, and an effort to make projects eligible for federal funding to provide flexibility.

Asset Management Risks

A key part of the asset management planning process is identifying and mitigating TAM risks. The iterative process that Iowa DOT uses to manage its asset management risks is consistent with federal requirements and consists of the following elements, depicted in Figure 5-1:

- Event Identification. Identify events that could impact Iowa DOT's ability to effectively manage its bridges and pavements.
- Risk Assessment. Assess the likelihood of an event happening and the consequences if it were to happen.
- Risk Response. Identify an approach for responding to each of the priority risks.
- Control Activities. Implement the risk response approaches.
- Risk Monitoring. Monitor and respond to possible events, and evaluate the response approaches.

Figure 5-1. TAM Risk Management Process



Identification and Assessment Methodology

Identifying risks is the first step in risk management. To begin the risk identification process, Iowa DOT distributed an online survey to agency staff. The survey asked respondents to identify significant risks that could enhance or constrain Iowa DOT's ability to manage its bridges and pavements.

Iowa DOT compiled the results of the online survey, combined similar risk statements, and presented them for refinement at an asset management risk workshop. The workshop participants refined the risk statements, and then they assessed the likelihood and consequences of each risk, as follows:

- Risk likelihood. Workshop participants cast votes to reflect their assessment of risk likelihood on a scale of one (rare) to five (almost certain). Iowa DOT averaged the votes to determine the overall likelihood score.

- Risk consequence. Workshop participants also cast votes to reflect their assessment of risk consequences on a scale of one (negligible) to five (extreme). Iowa DOT averaged the votes to determine the overall consequences score.

Figure 5-2 illustrates how Iowa DOT combined the likelihood score and the consequences score to determine the relative priority of the risk. Using this approach, the highest priority risk would be almost certain to occur and would have extreme consequences. The lowest priority risk would be rare and would have negligible consequences.

Figure 5-2. Risk Priority Matrix

Likelihood	Consequences				
	1. Negligible	2. Low	3. Medium	4. Very high	5. Extreme
1. Rare	1	2	3	4	5
2. Unlikely	2	4	6	8	10
3. Possible	3	6	9	12	15
4. Likely	4	8	12	16	20
5. Almost certain	5	10	15	20	25

Risk Prioritization

Iowa DOT identified 17 high and medium priority risks; no very high priority risks have been identified. These risks are tracked and managed by the Transportation Asset Management Implementation Team. This group meets weekly, which gives the proper forum to monitor these risks and implement any necessary response approaches.

After assessing and prioritizing the risks at the risk workshop, participants defined a response approach for each risk. The following are Iowa DOT's potential risk response approaches:

- Approaches for responding to risks with negative impacts:
  - Avoid
  - Transfer
  - Mitigate
  - Accept
- Approaches for responding to risks with positive impacts:
  - Exploit
  - Share
  - Enhance
  - Accept

Risks are also labeled according to eight risk areas defined by Iowa DOT. These areas help categorize the risks and mitigation strategies:

- Business Process Improvement
- Capital Planning and Programming
- Communication
- Data Collection
- Management System Improvement
- Organizational Structure
- Research
- Training

Business processes includes operations, management, and support processes. Risks in this area are risks to the activities that constitute the existing business processes at Iowa DOT. Examples include financial forecasting and risk identification and management. Note that certain business processes (e.g. capital planning and programming; data collection) are categorized as separate areas for the purposes of this TAM risk register.

Capital planning and programming includes long-term planning activities such as analysis of relevant trends, evaluation of potential investments, review of other factors, and stakeholder engagement, and short-term programming activities such as selecting projects, identifying funding, and finalizing investments.

Communication involves communicating the asset management progress made by Iowa DOT and educating stakeholders, including state and local lawmakers, users, and institutions. Communication includes messages about shortcomings and needs at Iowa DOT and also messages of success.

Data collection is a key part of the asset management approach at Iowa DOT. Gathering accurate, complete, and current data helps inform and drive the decision-making process.

Management systems include bridge and pavement systems. These systems can collect and store asset inventory and condition data, analyze that data to project future conditions, and recommend asset treatments.

Organizational structure refers to the hierarchy and function of work units within Iowa DOT and how they relate to asset management. Organizational structure issues include staffing levels, roles and responsibilities, and governance.

Research helps support and improve asset management practices and processes at Iowa DOT.

Training is necessary to educate new staff and keep current staff up to date on asset management at Iowa DOT.

Medium and High priority risks are presented in the risk register in Table 5-1.

Risk Mitigation

Iowa DOT also developed mitigation strategies for each high priority risk. Together, the set of risks and mitigation strategies are the foundation of a risk mitigation plan. Iowa DOT's risk mitigation plan is a series of strategies for mitigating the high priority risks identified in the risk register. Groups or individuals take ownership of each strategy and are responsible for implementing the strategy and carrying out the near-term actions by the target date. Iowa DOT's current risk mitigation plan for the highest priority risks is presented in Table 5-2. The mitigation plan is organized by risk area.

Risk Monitoring

Iowa DOT's risk management process does not stop with the development of the risk register. The next steps in the process are to implement the risk strategies, monitor the risks over time, and periodically update the risk register. Through its Asset Management Governance Structure, Iowa DOT identifies an owner for each risk. The owners are responsible for implementing the risk strategies and reporting progress quarterly through Iowa DOT's TAM governance structure. Iowa DOT will update its risk register every two years. As Iowa DOT implements the risk strategies, it is anticipated that, over time, some risks will fall off the priority list. These risks will be replaced with new priorities.

Table 5-1. Priority Risks

#	Area	Risk	Impact Type	Likelihood	Consequences	Severity Level	Risk Response Approach
1	• Data Collection • Organizational Structure	*If* efficiency and accuracy of data collection and access significantly improve, then improved data may be available for decision making.	Positive	Likely/Almost Certain	Medium/Very High	High	Enhance
2	• Capital Planning & Programming • Communication • Training	*If* Iowa DOT is unable to adequately communicate the how and why of asset management (AM), then the program may not be adequately funded or properly implemented.	Negative	Possible/Likely	Very High	High	Mitigate
3	• Capital Planning & Programming	*If* capacity improvement projects on the Interstate Highway System are delayed, then some condition deficiencies on the system may not be addressed.	Negative	Likely	Medium/Very High	High	Mitigate
4	• Organizational Structure	*If* staffing is constrained due to reductions or lack of training, then AM may not be properly implemented.	Negative	Likely	Medium	High	Mitigate
5	• Capital Planning & Programming	*If* population continues to shift to urban areas, then additional funds may be allocated to non-AM needs, decreasing AM funding statewide.	Negative	Possible/Likely	Medium	High	Mitigate
6	• Business Process Improvement • Capital Planning & Programming; Communication	*If* the Iowa Transportation Commission approves future increases to planned stewardship expenditures, then Iowa DOT may be able to maintain existing bridge and pavement conditions.	Positive	Possible	Medium/ High	Medium	Enhance
7	• Research	*If* freeze/thaw cycles occur more frequently, then pavements may deteriorate faster.	Negative	Possible	Medium/ High	Medium	Mitigate
8	• Business Process Improvement • Management System Improvement	*If* Iowa DOT systematically delivers sub optimal bridge and pavement projects, then AM costs may increase and conditions may decrease.	Negative	Unlikely/ Possible	Very High	Medium	Mitigate

Table 5-1. Priority Risks (continues)

#	Area	Risk	Impact Type	Likelihood	Consequences	Severity Level	Risk Response Approach
9	• Business Process Improvement	*If* flooding emergencies occur more often, then the costs of managing the transportation system may increase.	Negative	Possible/Likely	Medium	Medium	Mitigate
10	• Research	*If* Iowa DOT can treat bridges and pavements during the winter with cost-effective, less corrosive materials, then deterioration rates may decrease.	Positive	Possible	Medium/Very High	Medium	Mitigate
11	• Communication • Management System Improvement	*If* Iowa DOT is unable to institutionalize the use of its bridge and pavement management systems, then it may be difficult to identify optimal AM strategies, leading to increased costs and worsening conditions.	Negative	Unlikely/ Possible	Medium/Very High	Medium	Mitigate
12	• Research	*If* asset repairs perform worse than intended, then deterioration rates may increase.	Negative	Unlikely/ Possible	Medium/Very High	Medium	Mitigate
13	• Research	*If* there are advances in vehicle technology, then Iowa DOT's AM costs may decrease over the next 10 years.	Positive	Possible	Medium	Medium	Enhance
14	• Capital Planning & Programming • Communication	*If* funding increases by more than 15 percent, then Iowa DOT may be able to implement additional AM projects.	Positive	Unlikely/ Possible	Medium/ High	Medium	Enhance
15	• Communication	*If* new state or federal regulations are passed, then the cost of AM projects may increase.	Negative	Unlikely/ Possible	Medium	Medium	Mitigate
16	• Communication	*If* the Legislature mandates earmarks into Iowa DOT's 5 year Highway Improvement Program, then AM funding may be reduced.	Negative	Unlikely/ Possible	Medium	Medium	Mitigate
17	• Capital Planning & Programming • Communication	*If* funding decreases by more than 15 percent, then Iowa DOT may implement fewer AM projects.	Negative	Unlikely	Very High	Medium	Mitigate

Table 5-2. Risk Mitigation Plan

Addresses Risk(s)	Area	Strategy	Owner	Near-Term Actions	Current Progress	Target Date
2	Capital Planning and Programming	Address AM in the statewide transportation plan.	Systems Planning	The update of the next statewide long-range transportation plan (SLRTP) will begin in 2020. Staff working on that plan are looking for ways to strengthen ties between the TAMP and the SLRTP.	Our current SLRTP, approved in 2017, has some connections to TAM, including a strong focus on system stewardship.	July, 2020
3	Capital Planning and Programming	Continue to advance the interstate capacity improvement projects.	Project Management, Location & Environment, TAMIT	The Iowa Interstate Improvement Plan for 2040 is nearly finalized. This plan will lay out budgets and schedules for all Interstate capacity projects through 2040, and was developed to prioritize investments in stewardship that will maintain the system in a state of good repair.	In August of 2018, an Interstate Investment Plan workshop was held to serve as the seed for the Plan currently under development.	July, 2019
3	Capital Planning and Programming	Develop corridor plans that identify how AM and capacity improvement projects will be coordinated.	Project Management, Location & Environment, TAMIT	Continue to develop Interstate Plan, look for similar opportunities on other corridors.	The Interstate Plan is the first of such plans. It is targeted for completion in the summer of 2019.	July, 2019
5	Capital Planning and Programming	Evaluate the highway system, and identify priority rural assets that should take precedence if AM funding decreases	Systems Planning, Program Management	Continue to develop tools like the Infrastructure Condition Evaluation (ICE) tool to help identify priority needs on the network. Leverage the framework developed for the SLRTP to help screen needs at a network level.	The 2017 SLRTP breaks down the system into corridors and indicates the range of potential needs identified for each.	Ongoing
2	Communication	Implement a formal communication plan that defines who to communicate with, what to communicate to them, and how to communicate to them.	TAMIT, Strategic Communications and Policy	TAMIT team chair reach out to Strategic Communications team to initiate plan development once the refresh of the TAM Improvement Plan is set in the early fall of 2019.	This has been identified as a gap in the TAM Gap Analysis.	September, 2019
2	Communication	Continue efforts to educate the Iowa Transportation Commission about AM.	TAMIT	Continue to bring TAM information to the Transportation Commission on a regular basis. The TAMIT team has a schedule of monthly presentations through FY 2020.	For FY2019, nearly every month the Commission Workshop included a presentation related to Asset Management. This is anticipated to continue.	Ongoing

Table 5-2. Risk Mitigation Plan (continues)

Addresses Risk(s)	Area	Strategy	Owner	Near-Term Actions	Current Progress	Target Date
1	Data Collection	Continue to implement data collection and analytics enhancements.	TAM Technical Committee	Leverage Strategic Data Business Plan project to assist with decisions about asset data collection and analytics.	Iowa DOT has initiated a Strategic Data Business Plan project to support better asset data coordination and integration.	March, 2020
1	Data Collection	Develop a plan for data and system coordination and integration.	Research & Analytics	Leverage Strategic Data Business Plan project to assist with decisions about asset data coordination and integration.	Iowa DOT has initiated a Strategic Data Business Plan project to support better asset data coordination and integration.	March, 2020
1	Organizational Structure	Continue to form and institutionalize the Asset Management Governance Structure.	TAM Technical Committee (TTC)	Review TTC charter, develop strategic plan for next three years and action items for the next 12 months.	TTC is still in the “forming” stage.	June, 2019
4	Organizational Structure	Develop an AM staffing plan, and include contingency plans in case staffing levels decrease. Examples include reallocating staff or exploring contracting alternatives.	TAMIT	Continue to review staffing needs. Use results of TAM Gap Analysis and Pavement Management Strategic Plan initiative to show existing gaps, opportunities.	In 2018 we had a competitive selection and chose three consultant groups to be available on-call for work related to TAM implementation. So far we have utilized these resources to assist with a number of initiatives. We will also continue to look for ways to make TAM “the way we do business” so it just becomes part of our processes. For example, the project prioritization tool for project scoping.	Ongoing
2	Training	Develop an AM training plan.	TAMIT	TAMIT will initiate plan development once the refresh of the TAM Improvement Plan is set in the early fall of 2019. This will be coordinated with the communication plan.	This has been identified as a gap in the TAM Gap Analysis. We have hosted NHI courses related to Performance Management implementation (Bridge & Pavement).	September, 2019

Summary of Transportation Assets Repeatedly Damaged by Emergency Events

Legislative Context

As part of a separate regulation promulgated by FHWA, state DOTs must perform periodic evaluation of facilities repeatedly requiring repair and reconstruction due to emergency events. According to FHWA, state DOTs "shall conduct statewide evaluations to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events." Evaluation is defined as "an analysis that includes identification and consideration of any alternative that will mitigate, or partially or fully resolve, the root cause of the recurring damage, the costs of achieving the solution, and the likely duration of the solution." Reasonable alternatives are defined as "options that could partially or fully achieve the following:

1. Reduce the need for Federal funds to be expended on emergency repair and reconstruction activities;
2. Better protect public safety and health and the human and natural environment; and
3. Meet transportation needs as described in the relevant and applicable Federal, State, local, and tribal plans and programs."

While the requirement for evaluations is its own rule (23 CFR 667), the FHWA requires that the TAM risk management process include a summary of the evaluations for NHS pavements and bridges.

Methodology

In order to meet this requirement, Iowa DOT digitized the existing hard copy records of the Iowa DOT's Federal Emergency Relief Records. Iowa DOT reviewed 266 NHS records (from 2004 to present) as well as financial records from 1997 to 2004.

The data gathered for this evaluation will be incorporated into the Iowa DOT's Scoping Tool, which is used at the initial stages of the project development cycle. Any locations meeting the criteria set forth in the regulation will be noted in the case that a project encompassing that location is scoped. Since the scoping tool is used to initiate all DOT projects, including the evaluation data as a layer in the scoping tool will prompt the project development team to evaluate locations that have been identified in this analysis, including any future locations as they are added to the dataset. The data underlying this evaluation will be updated as new qualifying events occur, and as required will be screened and analyzed during the environmental process for all highway projects as defined in 23 CFR 771.

Results

Iowa DOT's evaluation of the NHS turned up one location in the state of Iowa that appears to meet the requirements set forth in the regulation. This location will be flagged, and at the time any future projects including this location is scoped, Iowa DOT will ensure that project alternatives that might mitigate the root cause of the recurring damage are identified and considered.

There were another ten locations identified as possibly meeting the regulations. Iowa DOT's ER program coordinator, Brian Pribyl, further reviewed these records and determined that they did not meet the requirements. Most of them were for the same declared disaster event and were either duplicate records or described different locations.

The Iowa DOT is reviewing records for declared disasters on non-NHS routes as well and is preparing to meet the November, 2020 deadline to evaluate all locations potentially meeting the regulation.

6. FINANCIAL PLAN AND INVESTMENT STRATEGIES

The financial plan presents the funding picture at 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.

Introduction

This chapter details Iowa DOT's TAM investment strategy development process and presents the financial plan resulting from this process. The process utilizes the pavement and bridge lifecycle plans developed as described in Chapter 3, as well as the predicted pavement and bridge conditions for the investment scenarios detailed in Chapter 4. The financial plan shows Iowa DOT's planned and estimated available funds for TAM and anticipated expenditures by asset class over the 10-year period of the TAMP resulting from the selected investment strategies. This chapter also provides a summary of asset valuation for Iowa's NHS pavement and bridges.

Federal Requirements

FHWA requires that states include investment strategies as part of their TAMP. FHWA defines investment strategies as "a set of strategies that results from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks." The TAMP must discuss how the investment strategies make progress towards achieving a desired SOGR over the life cycle of the assets in the plan, improving or preserving asset condition, achieving 2-and 4-year state DOT targets for NHS asset condition and performance, and achieving national performance goals. "Desired SOGR" means the desired asset condition over the 10-year period of the TAMP.

FHWA also requires that states establish a process for developing investment strategies as part of the TAMP. The process must describe how investment strategies are influenced, at a minimum, by:

- Life cycle planning
- Performance gap analysis
- Risk management analysis
- Anticipated available funding and estimated cost of future work

In addition to requiring details on investment strategies, FHWA requires each state DOT to include a financial plan that spans at least 10 years and identifies funding and costs over that time in their TAMP. FHWA defines financial plan as "a long-term plan spanning

10 years or longer, presenting a State DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets for asset condition during the plan period, and highlighting how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies." The plan should provide a summary of financial resources and needs for pursuing asset management objectives and achieving performance targets.

FHWA also requires that states establish a process for developing a financial plan as part of the TAMP. The process must produce the items listed below:

- Estimated cost of expected future work to implement the investment strategies of the TAMP, by fiscal year and work type
- Estimated funding levels to address the costs of future work types, by fiscal year
- Identification of anticipated funding sources
- Asset valuation estimate for NHS bridge and pavement assets and the needed annual investment to maintain asset value

Investment Strategies

Investment Strategy Development Process

Iowa DOT's approach to developing its investment strategies is patterned on the guidance provided in *NCHRP Report 898, A Guide to Developing Financial Plans and Performance Measures for Transportation Asset Management (2019*). This guide details a 10-step process for investment strategy development. The output of the process is a high-level financial plan, supplemented with additional details on the investments in the plan and expected outcomes of following the plan. The following paragraphs describe the investment strategy steps, reproduced from NCHRP Report 898, and the specific activities performed by Iowa DOT at each step. This process is performed for all state-owned roads, but this document focuses on results for NHS pavement and bridges. Note the Steps 4 to 7 of the process are iterative. These steps are performed at least once when evaluating alternative investment strategies, and an additional time when finalizing funding levels. The steps in the investment strategy development process are as follows:

- **Step 1: Define Investment Scenarios.** The first step of the strategy development process is to define alternative investment scenarios. NCHRP Report 898 recommends considering at least three alternative scenarios: funding estimated to be reasonably available; funding required to achieve targets; and funding required to maintain asset value. As described in Chapter 4, for its TAMP development, Iowa DOT considered four scenarios for pavement and four for bridge. This included a scenario reflecting expected funding, and scenarios at higher and lower funding levels. The scenario with the highest level of funding (approximately 200% of expected funding) was predicted to achieve Iowa DOT's desired SOGR and minimize lifecycle costs.

- **Step 2: Identify Current and Planned Projects.** The next step in the process is to identify projects that are currently underway or that the agency has committed to perform in the near term. Ideally, the different investments scenarios should account for these ongoing and committed projects. Iowa DOT's Five-Year Program identifies committed projects. The expected funding scenario (as well as scenarios with increased funding) has been defined consistently with the program budgets levels such that the predicted budget is sufficient to fund these projects.

- **Step 3: Use Management Systems to Predict Future Conditions.** The agency next uses its pavement and bridge management systems to predict future conditions for the different investment scenarios. As described in Chapter 3, Iowa DOT uses dTIMS to predict future conditions for pavement and the NBI Optimizer to predict future conditions for bridges. Both of these systems are designed to follow Iowa DOT's lifecycle strategies, subject to budget constraints. Chapter 3 further details the modeling assumptions in each system and how Iowa DOT uses each system to determine the conditions that will result from a given level of funding.

- **Step 4: Perform Initial Budget Allocation.** In this step, the overall budget level identified for the investment scenario is allocated between assets and specific uses. In Iowa DOT's case, this initial allocation is performed within the DOT's management systems. These systems perform an initial allocation following the lifecycle strategies described in Chapter 3.

- **Step 5: Identify Candidate Projects.** Next, it is necessary to determine what work may potentially be performed, given current and predicted future asset conditions. As in the case of Step 4, this step is initially performed within Iowa DOT's management systems using the lifecycle strategies described in Chapter 3. Once funding levels are finalized in Step 8, Iowa DOT revisits this step to determine potential projects to add to the next year of its Five-Year Program.

- **Step 6: Select Projects.** NCHRP Report 898 describes that different approaches may be used in this step to determine what projects to perform for each investment scenario. The selection of projects should incorporate consideration of risk, performance gaps, and the agency's lifecycle strategies. These strategies help achieve and maintain assets in SOGR at minimum lifecycle cost. In Iowa DOT's case, the management systems initially simulate the selection of projects for each scenario as part of the simulation process as described in Chapter 3. Once funding levels are finalized in Step 8 through review of the management system results, Iowa DOT revisits this step to determine potential projects to add to the next year of its Five-Year Program.

- **Step 7: Revise Prediction of Future Conditions.** At this step, the agency may need to revise its predictions of future conditions if Steps 4 to 7 result in a different allocation from that assumed in developing investment scenarios. In this instance, the investments scenarios that were considered remained consistent through the process and no revisions were required in this step.

- **Step 8: Finalize Funding Levels by Use.** At this point, it is necessary to review the investment scenario results to determine how funds will be allocated in the TAM financial plan. For Iowa this determination is made by the Iowa Transportation Commission, as described further in the section below. Once funding levels are finalized, Iowa DOT repeats Steps 4 to 7 to revise the predictions of future condition (if necessary) and determine what specific projects to add to the Five-Year Program based on the TAM financial plan.

- **Step 9: Perform Gap Assessment.** Once funding levels have been finalized, it is necessary to determine the gaps between existing conditions, targeted conditions, expected future condition, and the desired SOGR. Chapter 4 summarizes the results of the gap assessment.

- **Step 10: Document Assumptions and Investment Strategies.** Finally NCHRP Report 898 recommends documenting the assumptions followed as part of the investment strategy development process, and the strategies resulting from the process. This documentation has been prepared through the presentations to the Commission and this TAMP.

Finalizing the Investment Strategy

Regarding the approach to finalizing funding levels (Step 8 above), the Iowa Transportation Commission (Commission) determines how to allocate the funding available through Iowa DOT's Highway Program. The Commission establishes funding levels for the following six major investment categories:

- Stewardship categories
  - Interstate pavement and bridge
  - Non-interstate pavement
  - Non-interstate bridge
  - Safety-specific
- Capacity categories
  - Major interstate
  - Non-interstate

In recent years, the Commission has incorporated recommendations from Iowa DOT staff for the funding levels for the four stewardship categories, and then allocated the remaining funds to the two capacity categories. Iowa DOT recommendations for stewardship funding levels are primarily based on historical funding trends and consideration of the national goals described in MAP-21.

The Commission approves the Five-Year Highway Program in June of each year. The transportation programming process is a continuous, year-round effort. Once the Commission approves the funding for these categories, Iowa DOT allocates the funds to specific projects.

Investing Towards National Goals

The investment strategy development process results in a set of asset investments that supports state and national goals defined in 23 USC 150(b). The selected strategies also help maximize progress towards achieving Iowa's SOGR, and in so doing, help minimize asset life cycle costs to the extent possible given available funding. Table 6-1 summarizes how the selected investment strategies help support national goals.

Table 6-1. National Goals and Related Strategies

National Goal	Related Strategies
Safety. To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.	The TAMP strategies support the goals and objectives of the Iowa Highway Safety Improvement Program and the Iowa Strategic Highway Safety Plan. Implementing these plans will help reduce traffic fatalities and serious injuries.
Infrastructure Condition. To maintain the highway infrastructure asset system in a state of good repair.	Iowa's TAMP investment strategies are aligned with the STIP and constrained by available funding to maintain highway assets as funding permits. Implementing the TAMP investment strategies through the STIP will help maintain highway assets in a SOGR. By following the lifecycle strategies described in Chapter 3, the selected strategies will help Iowa DOT minimize asset life cycle costs to the extent feasible given available funding.
Congestion Reduction. To achieve a significant reduction in congestion on the NHS	Implementing Iowa's TAMP investment strategies will enable more efficient use of available TAM resources, freeing additional resources to dedicate to making progress towards national goals related to congestion reduction.
System Reliability. To improve the efficiency of the surface transportation system.	Any improvement in infrastructure condition will have secondary benefits related to system reliability. Implementing Iowa's TAMP investment strategies will also enable more efficient use of available TAM resources, freeing additional resources to dedicate to making progress towards national goals related to system reliability.
Freight Movement and Economic Vitality. To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.	Any improvement in infrastructure condition will have secondary benefits related to freight movement and economic vitality. Implementing Iowa's TAMP investment strategies will also enable more efficient use of available TAM resources, freeing additional resources to dedicate to making progress towards national goals related to freight movement and economic vitality.
Environmental Sustainability. To enhance the performance of the transportation system while protecting and enhancing the natural environment.	Implementing Iowa's TAMP investment strategies will also enable more efficient use of available TAM resources, freeing additional resources to dedicate to making progress towards national goals related to environmental sustainability
Reduced Project Delivery Delays. To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.	The selected investment strategies do not specifically support this goal. However, in implementing the TAMP Iowa DOT will monitor actual expenditures and compare these with those projected in the TAMP. Supporting the investment strategies in the TAMP will require timely project delivery. Thus, actively monitoring TAMP implementation will help support minimizing delivery delays.

Funding Sources

Iowa DOT forecasts state and federal revenue annually in preparation for the development of its Highway Program. State revenue sources have proven to be stable over time, and actual receipts typically track very closely to forecasted amounts. Iowa DOT estimates future federal funds based on existing funding identified in federal authorization bills. The current authorization, Fixing America's Surface Transportation (FAST) Act, will expire September 30, 2020. The absence of timely reauthorizations and the use of bill extensions lead to uncertainty in forecasting federal funding. Iowa DOT, therefore, uses a more conservative approach for forecasting federal funds than for forecasting state funds.

Iowa DOT's budget comes from three primary sources of funding: the Road Use Tax Fund (RUTF), Transportation Investment Moves the Economy in the Twenty-first Century (TIME-21), and federal funding.

A significant portion of Iowa DOT's funding is provided through the RUTF. The RUTF consists of revenue from annual vehicle registration fees, fees for new registration, state fuel taxes and other miscellaneous fees. These funds are allocated by law to Iowa DOT and Iowa's cities and counties according to a formula. After off-the-top allocations, 47.5% of the RUTF is distributed to the Primary Road Fund (PRF), which is dedicated to the construction and maintenance of the Primary Highway System. In 2019, Iowa DOT anticipates $672 million in funding from the RUTF will be allocated to the Primary Road Fund (PRF).

In 2008, the Iowa Legislature increased transportation funding and created a separate funding stream, titled TIME-21, by increasing registration fees for motor vehicles and trailers. This revenue is dedicated primarily to maintenance and construction of certain primary highways in the state (60 percent), but also of secondary roads (20 percent) and municipal streets (20 percent). In 2019, Iowa DOT anticipates receiving $133 million in TIME-21 funding.

Other state revenue sources include items such as reimbursements from other states on border bridge maintenance and improvements, revenue from sales of excess ROW, PRF investment income, reimbursements from cities and counties, liquidated damages from contractors, reimbursements from insurance claims (e.g. bridge hits) and various other fees and income to the PRF. In 2019, Iowa DOT anticipates receiving $25 million in funding from other sources.

The Federal Government collects transportation funding and disperses it to the states through its Highway Trust Fund. The Highway Trust Fund is funded primarily by a motor fuel tax and fees charged to heavy vehicles. In 2019, Iowa DOT anticipates receiving $357.2 million in federal highway funding.

However, these funding sources are not all available for TAM. Iowa DOT has non-discretionary funding that cannot be used TAM purposes. This value is subtracted from the total available funding to calculate available TAM funding.

Table 6-2. Summary of Funding Sources for TAM ($M)

Source	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Federal Funds	357	389	366	366	366	366	366	366	366	366
State Funds (subtotal)	829	848	854	863	863	870	870	870	870	870
PRF	672	688	694	703	703	710	710	710	710	710
Time-21	133	135	135	135	135	135	135	135	135	135
Other	25	25	25	25	25	25	25	25	25	25
Non-discretionary & line items (excluding TAM Contract Maintenance)	-467	-493	-488	-500	-511	-523	-523	-523	-523	-523
Total	**720**	**744**	**731**	**729**	**718**	**713**	**713**	**713**	**713**	**713**

Based on funding requirements and historical averages, Iowa DOT anticipates about 75% of this funding to be available for asset management uses. Over the 10-year period of the TAMP, funding sources are expected to total approximately $7.2B, as shown in Table 6-2. Note that Iowa's state fiscal year runs from July 1 to the following June 30 and is numbered for the calendar year in which it ends. All years in this chapter are represented as fiscal years; for example, 2019 represents July 1, 2018 – June 30, 2019.

Funding Uses

This section shows Iowa DOT's projected asset management expenditures over the 10-year period of the TAMP, organized by asset and by work type. These expenditures draw on the funding sources described previously. These estimates were developed based on current funding, historical work type distribution, projected available funding, anticipated projects, and engineering judgement. Note that projected funding uses slightly exceed funding sources; Iowa DOT over-programs to account for any potential delay or suspension of projects. This helps mitigate project development risks. Table 6-3 shows a summary of funding uses for TAM.

Spending on NHS assets in Iowa is not currently tracked as a separate item. Funding estimates for NHS bridge and pavements were developed using assumptions based on work type history. Table 6-4 presents projected NHS TAM expenditures over the 10-year period of the TAMP. A discussion of projected performance and the funding gap required to achieve a desired SOGR is included in Chapter 4.

Table 6-3. Summary of Funding Uses for TAM ($M)

Use	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Bridge	**245**	**213**	**210**	**263**	**167**	**200**	**230**	**245**	**260**	**275**
Maintenance	1	1	1	1	1	1	1	1	1	1
Preservation	6	5	5	6	5	6	6	6	6	6
Rehabilitation	39	28	28	32	25	32	35	37	40	42
Replacement	140	133	133	152	119	153	163	176	188	201
Construction	59	46	43	72	17	8	25	25	25	25
Pavement	**472**	**506**	**511**	**388**	**535**	**478**	**459**	**444**	**429**	**414**
Maintenance	30	30	30	24	36	28	27	26	25	24
Preservation	12	14	14	12	17	13	13	12	12	11
Rehabilitation	84	102	104	83	124	96	93	89	85	81
Replacement	197	226	232	184	273	214	206	197	187	178
Construction	149	134	131	85	85	127	120	120	120	120
Statewide Contract Maintenance	0*	24	24	24	24	24	24	24	24	24
Other**	24	37	29	24	18	19	25	25	25	25
Total	**741**	**780**	**774**	**699**	**744**	**721**	**738**	**738**	**738**	**738**

* Included in the figures above as specific projects have already been identified. **Other TAM spending on assets including but not limited to signs, lighting, and culverts.

Table 6-4. Summary of NHS Funding Uses for TAM ($M)

Use	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
NHS Bridge	**149**	**209**	**168**	**237**	**132**	**131**	**164**	**165**	**175**	**180**
Maintenance	1	2	1	1	2	1	1	2	2	2
Preservation	3	3	3	5	5	2	3	3	3	3
Rehabilitation	18	15	19	17	21	46	50	50	55	55
Replacement	84	144	111	142	86	78	80	85	90	95
Construction	43	45	34	72	18	4	30	25	25	25
NHS Pavement	**364**	**403**	**402**	**303**	**367**	**311**	**306**	**321**	**336**	**351**
Maintenance	21	16	16	16	16	16	16	16	16	16
Preservation	10	10	4	4	5	5	10	10	10	10
Rehabilitation	72	123	95	111	124	112	115	120	125	130
Replacement	159	133	209	127	188	121	125	130	135	140
Construction	102	121	78	45	34	57	40	45	50	55
Total	**513**	**612**	**570**	**540**	**499**	**442**	**470**	**486**	**511**	**531**

Asset Valuation

FHWA requires state DOTs to include an estimate of asset value for NHS pavements and bridges. The financial plan process must also calculate the investment needed to maintain asset value. Iowa DOT uses a replacement value methodology to estimate asset value. The asset values are calculated by multiplying the inventory unit by the unit replacement cost. Given how Iowa DOT estimates asset value, asset values do not change as a function of asset condition. Thus, no investment is required to maintain asset value. Asset values for Iowa DOT's bridges and pavements are included in Tables 6-5 and 6-6.

Iowa DOT estimates that it would cost more than $36 billion to replace bridges and pavements on the primary highway system and nearly $29 billion to replace NHS bridges and pavements. This cost is significant and reinforces the need for Iowa DOT to maintain its existing assets effectively in order to minimize expensive reconstruction activities.

Table 6-5. Bridge Asset Valuation

System	Deck Area (sq. ft)	Unit Replacement Cost	Value
All State-Owned	45,437,130	$325	$14,767,067,250
State-Owned NHS	33,350,027	$350	$11,672,509,450
Other NHS	927,412	$250	$231,853,000

Table 6-6. Pavement Asset Valuation

System	Lane Miles	Unit Replacement Cost	Value
All State-Owned	23,625	$900,000	$21,262,887,000
State-Owned NHS	16,400	$1,000,000	$16,400,300,000
Other NHS	405	$1,000,000	$405,000,000

7. PROCESS IMPROVEMENTS

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. Process improvements are the stepping stones to the next iteration of the TAMP. By identifying, maintaining, and updating a list of process improvements, Iowa DOT will have a roadmap for future advances in TAM practice.

Introduction

This chapter supplements the discussion of current asset management practices in Iowa with key process improvements that will serve as a guide to enable Iowa DOT to continue maturing TAM practices. Not only must Iowa DOT update the TAMP every four years, but also it is good practice to maintain a list of process improvements. The TAMP is a living document that will evolve to reflect changing TAM practices and processes.

Federal Requirements

FHWA requires that a state DOT update its TAMP and development processes every four years. FHWA recommends that state DOTs conduct periodic self-assessments of TAM capabilities (23 CFR 515.19(d)). Based on the results of the self-assessment, the State DOT should conduct a gap analysis to determine which areas of its asset management process require improvement. In conducting a gap analysis, the State DOT should:

- Determine the level of organizational performance effort needed to achieve the objectives of asset management;
- Determine the performance gaps between the existing level of performance effort and the needed level of performance effort; and
- Develop strategies to close the identified organizational performance gaps and define the period of time over which the gap is to be closed.

TAM Process Improvements

Development of Initiatives

This TAMP describes Iowa DOT's existing asset management practices. With an eye toward the future, Iowa DOT conducted an asset management self-assessment and identified a series of initiatives for enhancing asset management. The self-assessment effort consisted of the following activities:

Step 1: Gap analysis survey. Over 30 Iowa DOT staff members completed an online gap analysis survey based on one provided in the American Association of State Highway and Transportation Officials' (AASHTO's) Transportation Asset Management Guide, Volume I. Participants were asked to rate the degree to which Iowa DOT practices align with the state-of-the-art in asset management.

Step 2: In-depth interviews. Several staff members participated in a series of face-to-face interviews. The objective of these interviews was to discuss existing practices in more detail.

Step 3: Self-assessment workshop. The objective of this workshop was to discuss and prioritize the gaps and to discuss options for addressing them. The workshop was an all-day event in which senior staff discussed Iowa DOT's asset management vision and goals and identified initiatives for asset management improvement.

Step 4: Development of an implementation plan. The results of the assessment are documented in an Asset Management Implementation Plan.

Additional Initiatives

The following process improvement initiatives were developed independent of the TAM self-assessment effort.

Pavement

The Iowa DOT is continuously improving the pavement management process. Current process improvement efforts include developing a scoping and project prioritization application. This application will include pavement management software recommendations and a pavement score. It will also include scores for bridges, safety, economics, and traffic volume that will be used to prioritize projects. The application will allow users to access pavement data to assist in project decision-making. In addition, a straight-line diagramming tool is being

List of Initiatives

The following process improvement initiatives were developed as part of the TAM self-assessment effort:

- **Implement an asset management governance structure. Iowa DOT has already made progress on this item as described in this TAMP.**
- **Develop an asset management communications plan that describes how Iowa DOT will communicate with key stakeholders regarding asset management. The plan, which is already under development, will address the strengths, weaknesses, opportunities, and threats to implementing TAM.**
- **Develop an asset management training plan that identifies who needs asset management training and defines a training strategy for each group.**
- **Develop asset management procedures for each asset class. The goal of this initiative is to advance each asset class into a mature state so that Iowa DOT can eventually incorporate all assets into its performance-based planning framework.**
- **Develop a maintenance quality assurance program to apply to the assets managed by Iowa DOT's Districts. This effort focuses on assets beyond bridges and pavements. The goal of the effort is to understand the performance of Iowa DOT's maintenance operations and relate outcomes to expenditures.**
- **Develop an asset management data governance strategy to identify the data and analytical capabilities required to support asset management practices and define an approach to meet these needs in the most efficient and effective manner.**
- **Develop a formal risk management process to enable Iowa DOT to formally consider risks in investment decisions.**
- **Develop procedures for managing bridges and pavements throughout their whole life and for incorporating whole-life costs into Iowa DOT's decision-making process.**
- **Develop a method for performing risk-based tradeoffs between investments in bridges and pavements in order to optimize budget allocations.**

implemented. This data visualization tool will display pavement information in conjunction with other highway system data, leveraging Iowa DOT's robust linear referencing system. These efforts will more readily place pavement data in the hands of decision-makers.

Pavement management systems and the modeling software are an evolving process. The modeling efforts have limitations: there are time lags between data collection, data availability, and analysis; the models do not perfectly predict future conditions, treatment costs are estimates, treatment selection lengths may not be practical or economical, and local knowledge of pavements is not represented in the model. In addition, the Iowa DOT considers other factors such as traffic, system classification, and a need for funding flexibility when making project selections. Because of these issues, engineering judgment is needed when reviewing the pavement management output and developing projects. The Iowa DOT strives to have a practical, low-cost approach to pavement management and continues to work to improve its pavement management system with better models and better aligned project recommendations.

Iowa DOT is working to customize its pavement management software program so it can better understand the relationship between funding and future conditions. Until this tool is available for use, Iowa DOT is using an interim pavement model for planning purposes. As Iowa DOT continues to enhance its pavement management system, it will be able to estimate the remaining service life of its pavements and incrementally improve pavement strategies to maximize pavement investment.

Additional improvements could include performing LCP with longer analysis periods to provide decision-makers and the public with better information, inclusion of traffic and/or truck volume in pavement recommendation analysis, decentralized access to PMS data and analysis tools, and additional training for Iowa DOT staff.

A technical group is reviewing the pavement management software in order to improve the software prediction models. This group seeks to improve deterioration curves as well as condition and other measurements in order to better model and forecast pavement conditions. This group includes members from all six districts as well as central office staff in order to have a shared understanding of the pavement management system and broad involvement in enhancements.

Work is also being performed to track the pavement management software recommendations and final project treatment selection. This will allow for feedback on project selection and decision making. The feedback can be used to improve performance models and project selection. The goal is to improve the correlation between the recommendations from the pavement management software and the projects selected for programming.

Iowa DOT also is working to institutionalize a TAM Governance Structure. One aspect of TAM Governance is the development of a Pavement Management Team, a group of engineers and subject matter experts from the Districts and central office, as well as external partners such as FHWA and Iowa State University, charged with continual improvement of Iowa DOT's pavement management system. This team has been chartered and is actively working on developing and improving pavement management practices.

Bridge

As development of the BrM program progresses, Iowa DOT will be using an optimization and prioritization system developed by Infrastructure Data Solutions, Inc. (IDS). This system uses historic NBI data to create deterioration models for approximately 3200 bridge structures on the state highway system. This system does not model culvert deterioration. Border bridges are also excluded from this modeling due to their unique sizes and design characteristics. A twenty-year program is developed with this software based on funding limits and target condition values. With this information, management can be informed of future funding needs and bridge condition changes.

Once the BrM program is fully functional, deterioration modeling and project planning will be done with BrM. The BrM program will be able to provide more detailed project types than the current IDS software. The Bridges and Structures Bureau is partnering with the Bridge Engineering Center at InTrans to develop BrM.

The Bridges and Structures Bureau is part of the Michigan pooled fund study on big bridges. This project has developed new elements for the BrM to use with big bridges. These new elements may be incorporated into border bridge inspections, if they are approved by AASHTO.

Iowa DOT completed a study to assess the exposure conditions of transportation infrastructure under climate change and extreme weather events as part of the FHWA Climate Change Resilience Pilot Program. The pilot focused on the Cedar River and South Skunk River Basins and developed an innovative methodology for generating stream flow scenarios. The project was the only one of the pilots to link climate projections of precipitation with future streamflow projections to enable vulnerability assessment under climate change scenarios. Multiple bridge and highway assets in the river basins have proven to be vulnerable and will only become more vulnerable in the future as frequency of precipitation and flooding events continues to increase.

In addition to the pilot project, Iowa DOT is pursuing additional research to expand its understanding of resilience by analyzing the criticality or consequences of the vulnerability of our infrastructure at the system level by determining a resiliency index to incorporate a risk-based analysis into TAMP and to aid in project prioritization. The vulnerability assessment tool will benefit Iowa DOT by enhancing safety, increasing efficiency for closures and follow up maintenance, and providing a basis for risk-based asset management. The project is expected to improve existing procedures and define alternatives for assessing the hazards, exposure conditions, sensitivity, and vulnerability of assets.

Financial Sustainability

As bridges and pavements deteriorate, work is required to fix them. As the backlog of required work increases, the value of the assets decreases. This decrease is further impacted by inflation, which increases the cost of the required work. This loss of value can be offset by investing in the assets. Over the long term, if the investment levels keep up with the loss of value due to deterioration, then a transportation system is considered financially sustainable. If, however, the system loses value over time, it is unsustainable. Because bridge and pavement conditions are expected to deteriorate over the next 10 years, Iowa DOT considers its highway system to be financially unsustainable.

Iowa DOT is working to develop a more detailed approach for assessing financial sustainability. Part of this effort is to develop an improved asset valuation approach. The goal of this effort is to better understand and communicate the long-term financial implications of the expected budget levels. One outcome of this effort would be the ability to present condition gaps in terms of dollar funding.

Cross Asset Resource Allocation

In the future, Iowa DOT plans to use bridge and pavement management systems and other resources to better link asset performance with funding levels, as well as to evaluate risk and whole-life cost. As these tools improve, Iowa DOT will be better able to inform the Commission and other stakeholders of the relationship between funding and future performance levels. In the past, Iowa DOT has used similar tools for specific asset classes but rarely in a general fashion to describe investment tradeoffs across assets and programs.

Incorporate TAMP Development into Annual Processes

The first TAMP was a unique effort because it required a number of processes to be executed for the first time: specific data gathering, projecting future conditions, and summarizing funding by asset, work type, and system. Iowa DOT intends to incorporate the TAMP development process into its annual processes, making data gathering and other related processes part of normal business operations, rather than a one-time, nonrepeatable effort.

Other Improvements

- Determining the Optimal Steady State Asset Conditions
- Develop Communication Plan
- Tracking Maintenance Costs
- LCCA for Bridges
- Develop a Training Plan
- Risk Workshop