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 a brief overview of Iowa, provides summary information on asset inventory, outlines how Iowa Department of Transportation (DOT) assesses asset condition, and describes the current condition of Iowa's bridges and pavements. Assets in this chapter, and throughout the Transportation Asset Management Plan (TAMP), are broken out to show both the state-owned system and the National Highway System (NHS). The NHS includes both state-owned and locally owned assets.

Federal Requirements

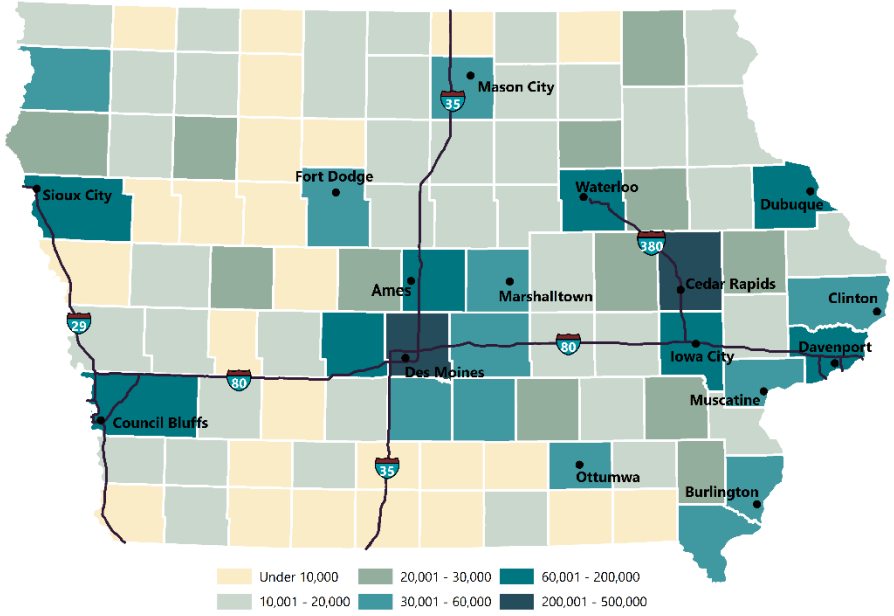
A state's TAMP must contain a description of asset inventory and condition of NHS bridges and pavements. In reporting conditions for pavements and bridges on the NHS, the TAMP must include the federally defined condition performance measures detailed in 23 CFR 490. These requirements describe measures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

2.1 Iowa Overview

Iowa's demographic and economic landscape provides important context for asset management planning for the highway system. Iowa is a predominately rural state. Population by county and population change from 1990-2020 are shown on Figures 2.1 and 2.2. Over half the state's population and jobs are located in just 10 of its 99 counties. Increasing urbanization is expected to continue in the future, which puts additional pressure on maintaining urban highway systems to keep them operating smoothly for commuter and freight traffic. At the same time, maintaining the rural highway system is critical for continuing to move people and goods throughout the state.

Figure 2.1: Iowa's population by county, 2020

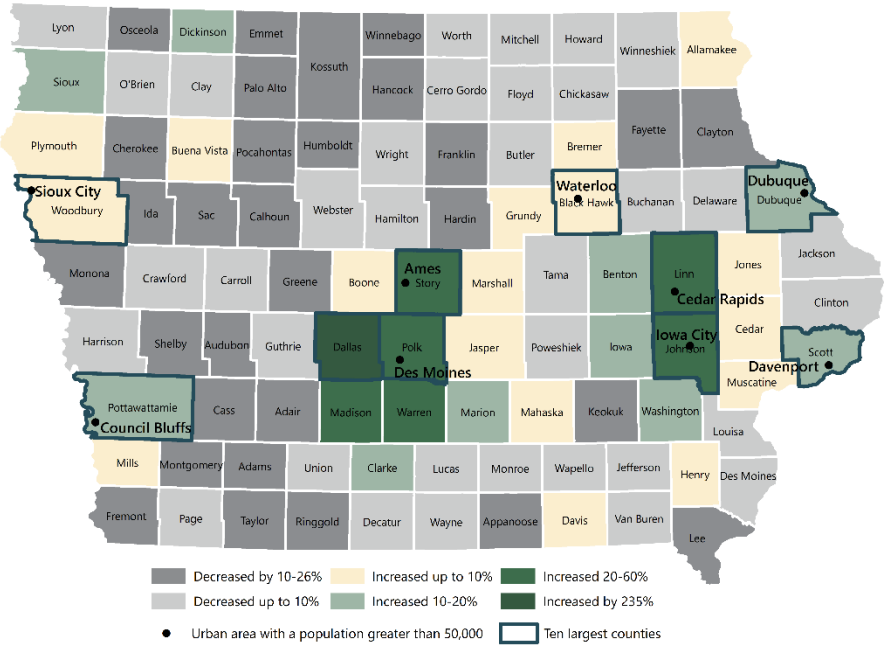
The state's population continues to concentrate in its urban areas.



Source: U.S. Census Bureau

Figure 2.2: County population change, 1990-2020

Over half the state's population and jobs are now located in just 10 counties.



Source: U.S. Census Bureau

Iowa's population and employment are expected to continue to grow, but at a slow pace. Slow growth could make it more difficult for transportation revenues to keep up with the growing maintenance and operational needs of the state's transportation system. Most travel in Iowa is by personal vehicle. According to the U.S. Census Bureau, over 81% of Iowans drive themselves to work and 8% carpool. Public transit, rideshare, walking, and bicycling are important modes, especially in urban areas and for those that may lack a vehicle, be unable to drive, or choose not to drive. However, the majority of travel is anticipated to continue to be by personal vehicle, reinforcing the need to efficiently maintain the state's highway system.

Iowa's traditional employment sectors have changed over time, with service sector growth outpacing manufacturing and farm jobs. However, the farm and manufacturing sectors still account for the largest percentage of jobs in 54 of Iowa's counties. These industries can have a major impact on the roadway system, as heavy trucks and equipment can cause operational and maintenance issues. Iowa is a producer state, meaning it exports more goods than it imports, and agricultural output continues to increase. This growth has a corresponding impact on Iowa's transportation system. While several modes are critical for freight movements, the vast majority involve a truck for at least a portion of the journey, reinforcing the importance of the highway system.

2.2 System Summary

Iowa's transportation system includes many physical assets; the most important in terms of cost and extent are bridges and pavements. Highways are the backbone of Iowa's transportation system, providing service to all areas of the state. Iowa's roadways range from eight-lane Interstates, four-lane divided facilities, and multi-lane urban streets to paved secondary roads, municipal streets, and gravel roads. Iowa's bridges provide crossings of thousands of streams, rivers, railroads, roadways, and trails. These bridges range from 20-foot structures to multi-span major river crossings. This combination of roadways and bridges has created an extremely accessible network that provides a high level of mobility throughout the state. Almost the entirety of the state's land area is within ten miles of a primary (state-owned) highway.

Bridges and pavements in this TAMP are classified by the following systems; how they overlap and the relative proportions of each are shown in Figure 2.3.

- **National Highway System (NHS)**: a system of roadways that the federal government has designated as essential for national connectivity. The NHS includes all Interstates. The NHS in Iowa is shown in Figure 2.4.
- **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 by federal functional classification (FFC) in Figure 2.5.

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 comprise 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.

Most vehicle-miles traveled (VMT) occur on the Interstate System and other state-owned roadways. Over the last 30 years, Interstate and other primary highways have accounted for 62% of the VMT on Iowa's roadway system, with secondary and municipal highways and roadways accounting for the remainder. Commodity movements by truck in Iowa are heavily concentrated on the Interstate System and portions of the non-Interstate NHS; overall, state-owned roadways accounted for over 91% of large truck VMT in 2019, with the Interstate System alone carrying over 53%.

Figure 2.3: Pavement and bridge assets included in the TAMP, showing relative proportions of the NHS and the Primary Highway System
Less the 3% of the NHS in Iowa is owned by local entities.

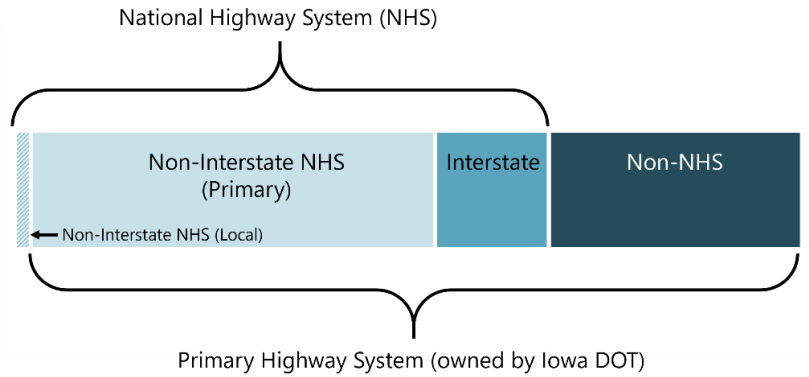


Figure 2.4: National Highway System (NHS) in Iowa

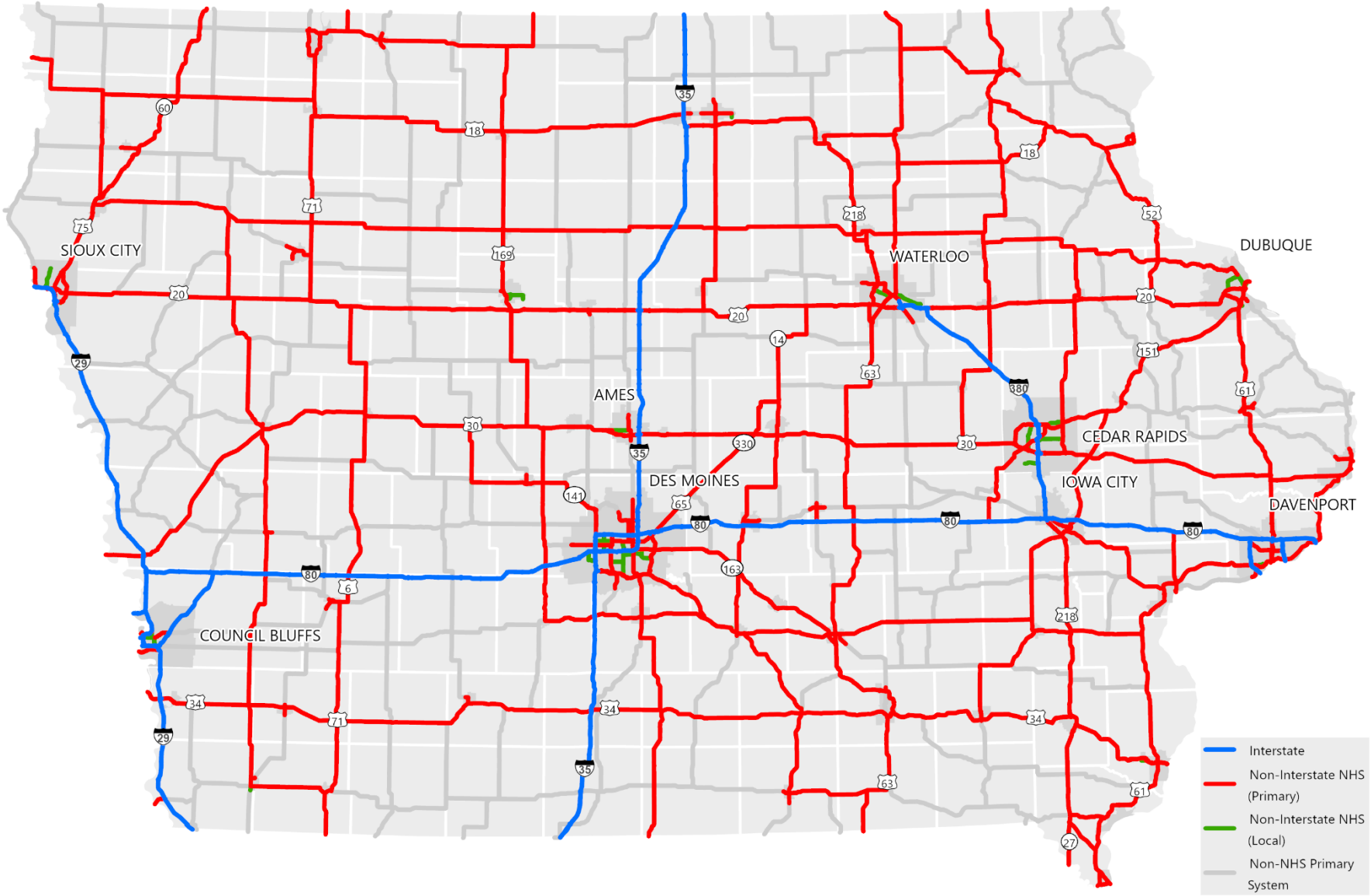
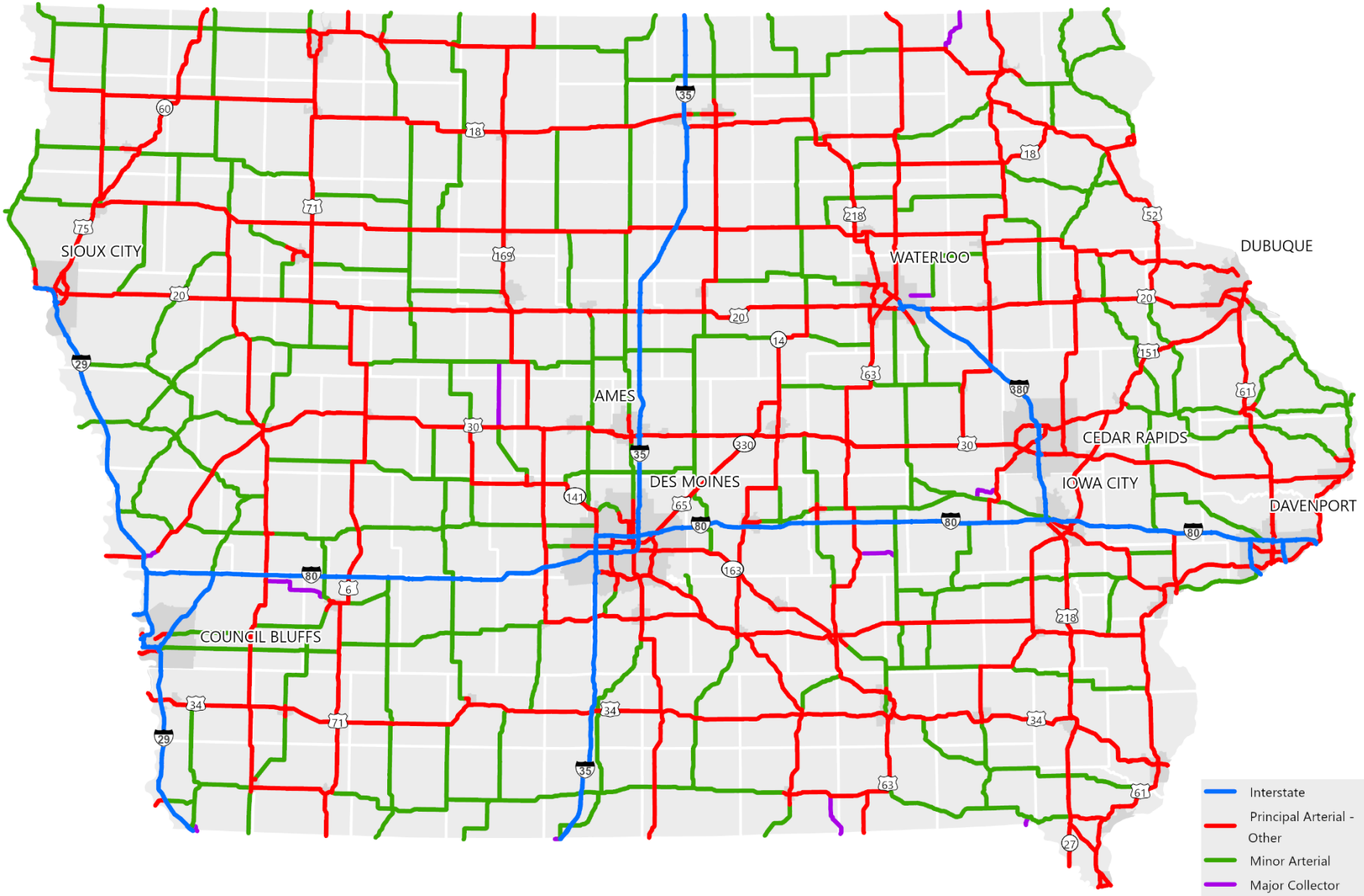


Figure 2.5: Iowa Primary Highway System by federal functional classification (FFC)



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 FHWA and required for use in the TAMP. Iowa DOT also tracks state performance measures on the Primary Highway System for bridges and pavements.

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 Monitoring 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. Local owners of NHS assets in Iowa are listed in Table 2.1.

Table 2.1: Local NHS asset inventory

Planning Agency	Jurisdiction	Number of Bridges	Bridge Deck Area (ft^2)	Pavement Lane Miles
RPA 10	Benton County	-	-	0.2
INRCOG	Black Hawk County	-	-	0.5
RPA 16	Des Moines County	-	-	1.0
DMATS	Dubuque County	-	-	1.3
RPA 16	Henry County	-	-	0.6
CMPO	Linn County	2	16,099	8.1
AAMPO	Story County	-	-	0.6
RPA 5	Webster County	-	-	1.9
AAMPO	City of Ames	1	14,058	15.7
BSRC	City of Bettendorf	-	-	0.5
RPA 8	City of Camanche	-	-	0.6
INRCOG	City of Cedar Falls	-	-	10.0
CMPO	City of Cedar Rapids	2	93,505	63.0
DMAMPO	City of Clive	1	9,496	4.8
MAPA	City of Council Bluffs	6	321,493	31.7
BSRC	City of Davenport	1	2,986	3.3
DMAMPO	City of Des Moines	10	287,482	74.3
DMATS	City of Dubuque	6	60,629	34.4
INRCOG	City of Elk Run Heights	-	-	5.7
INRCOG	City of Evansdale	2	12,681	3.8
RPA 5	City of Fort Dodge	1	4,441	25.6
MPOJC	City of Iowa City	1	16,936	-
CMPO	City of Marion	1	18,724	16.6
RPA 1	City of Marquette	-	-	0.4
RPA 2	City of Mason City	-	-	2.0
RPA 1	City of McGregor	-	-	0.4
RPA 16	City of Mount Pleasant	-	-	1.4
DMAMPO	City of Pleasant Hill	2	7,329	2.3
INRCOG	City of Raymond	1	1,702	2.3
DMATS	City of Sageville	-	-	3.0
SIMPCO	City of Sioux City	3	32,948	20.9
DMAMPO	City of Urbandale	2	8,025	29.6
INRCOG	City of Waterloo	5	82,078	35.6
RPA 16	City of West Burlington	-	-	5.5
DMAMPO	City of West Des Moines	1	7,304	33.6
Total		**48**	**997,917**	**441.2**

2.3 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 lines. 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 otherwise be unsafe or 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 or minor isolated deficiencies and may only require preventative maintenance. 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 (by deck area)
- Percentage of NHS bridges classified in poor condition (by deck area)

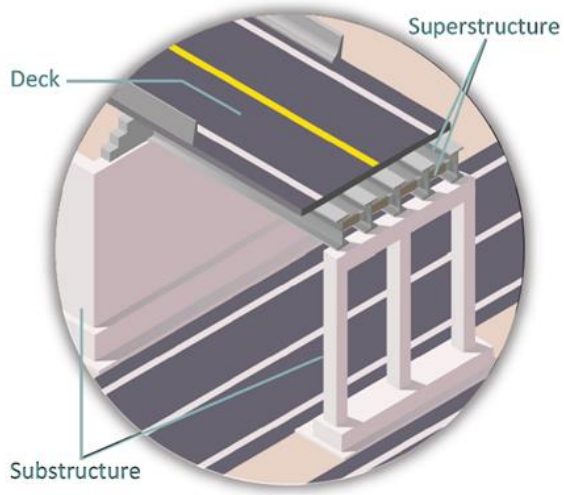
Note that if a bridge is not in good or poor condition, it is deemed to be in fair condition.

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. The NBIS requires each bridge owner to provide a specific set of NBI items to FHWA annually. Iowa bridge inspection 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) for each component. 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 2.6. 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 2.6: 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. 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 Condition

Iowa has 23,799 bridges and Iowa DOT is responsible for maintaining 4,195 of these bridges, including bridges on the National Highway System (NHS) and state highways. Local governments throughout the state maintain the remaining bridges. A small number of bridges owned by local governments are on the NHS and these assets are included in the TAMP. A summary of Iowa DOT and NHS 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.

Table 2.2: Bridge inventory and condition

Owner	System	Count	Deck Area (ft²)	Good	Fair	Poor	BCI<50
Iowa DOT	NHS	2,600	34,081,466	49.0%	48.7%	2.3%	77
	Non-NHS	1,595	12,255,071	49.8%	49.4%	0.8%	39
	Total	**4,195**	**46,336,537**	**49.2%**	**48.9%**	**1.9%**	**116**
Other	NHS	48	984,324	32.1%	60.6%	7.3%	
	Total	**48**	**984,324**	**32.1%**	**60.6%**	**7.3%**	
All	NHS	2,648	35,065,790	49.4%	48.2%	2.4%	
	Total	**4,243**	**47,320,861**	**48.9%**	**49.1%**	**2.0%**	

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

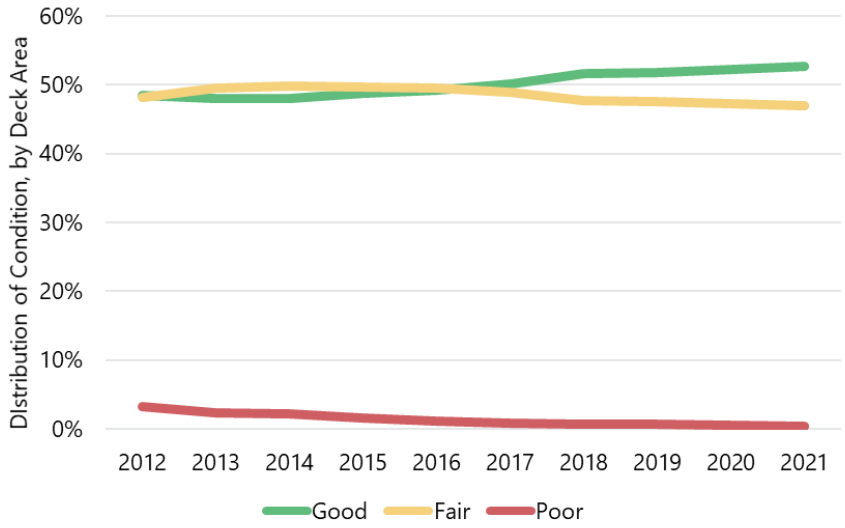
Bridge Condition History

Iowa DOT's bridges are in relatively good condition overall, and recent trends show that overall conditions are generally stable. Although the number of poor bridges has been decreasing over the past decade, it 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.

Figure 2.7 shows 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 good condition has increased.

Figure 2.7: Primary Highway System bridge condition history

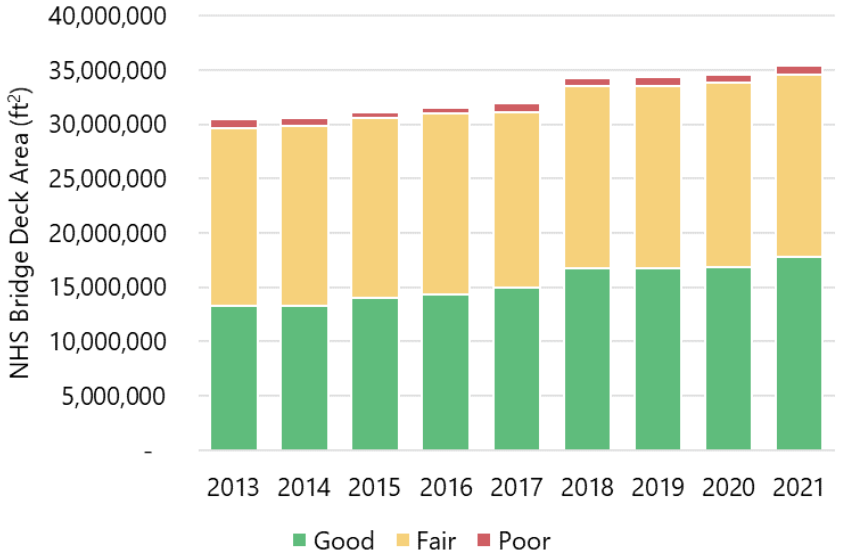
Condition has stayed relatively stable over the past decade.



The NHS has also seen a slight uptick in deck area in good condition over recent years, and its amount of deck area in poor condition has remained relatively flat. Figure 2.8 shows bridge condition on the NHS in recent years by bridge deck area. As shown, the amount of bridge deck area on the NHS has increased by 16.4% from 2013 to 2021. This is primarily due to new structures often being up to two times larger than the structures they are replacing. This impacts performance metrics as a bridge replacement will result in more square feet being added to the 'good' inventory than the amount of square feet removed from the 'fair' or 'poor' inventory.

Figure 2.8: National Highway System bridge condition history

While condition has stayed relatively stable, the amount of deck area on the system has increased over time.

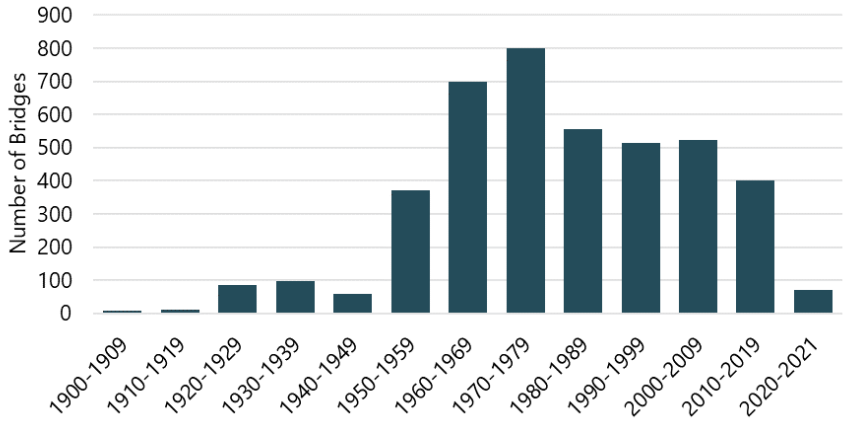


Bridge Age

The average age of Iowa DOT's bridges is 41 years. About 35% of the bridges are over 50 years old, and the average age of bridge structures is going up. In seven years, the average age of bridges on the Primary Highway System will be 50 years old. This is the common age used to describe how long a bridge should last, though the average age of bridges being replaced on Iowa DOT's system is 64 years. Figure 2.9 shows the age distribution of the bridges on the Primary Highway System by their decade of construction.

Figure 2.9: Primary Highway System bridges by decade of construction

Due to the large number of bridges built in the 1960s and 1970s, a 'wave' of bridge replacement needs is approaching.

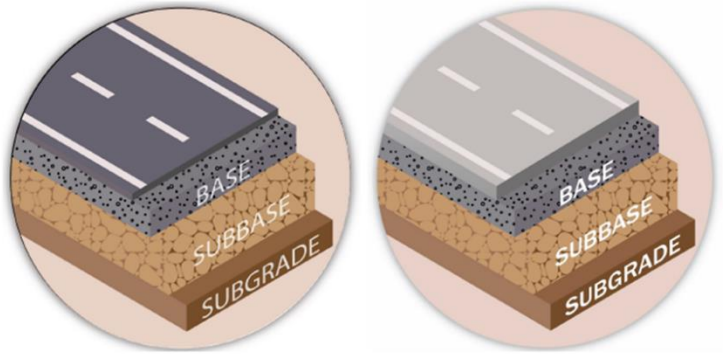


2.4 Pavement

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, which increases user costs. Iowa DOT's pavements represent a mixture of asphalt pavement, concrete pavement, and composite pavement (asphalt over concrete or concrete over asphalt). Just over half of the network is composite pavement. The vast majority of the state's composite pavement is asphalt over concrete; the small amount of composite pavement that is concrete over asphalt is currently classified as a concrete pavement for the purpose of management.

A typical asphalt pavement structure and a typical concrete pavement structure is shown in Figure 2.10.

Figure 2.10: Asphalt pavement structure (left) and concrete pavement structure (right)



Pavement Performance Measures

Federal

FHWA has established the following four performance measures for NHS pavement condition based on lane miles.

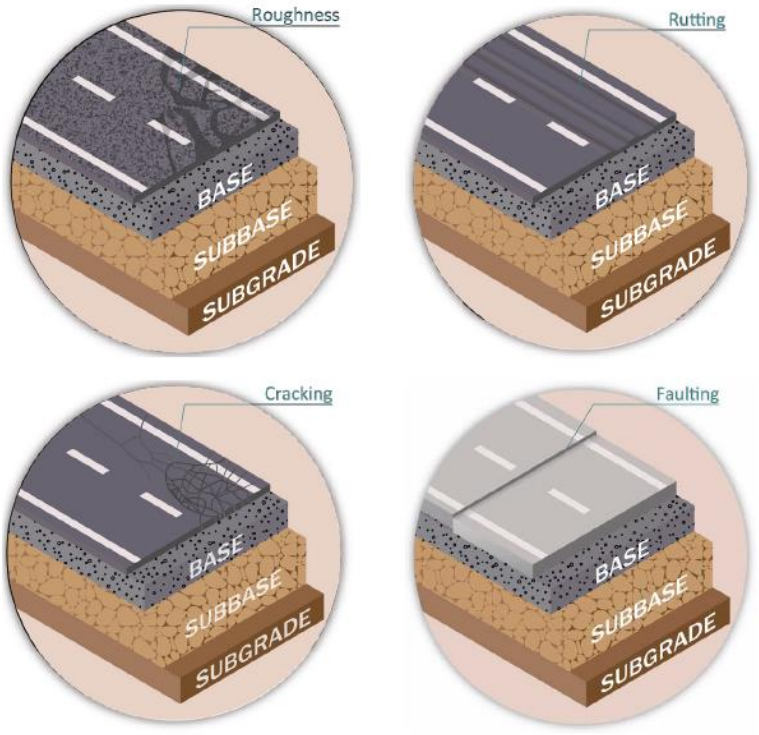
- Percentage of pavements on the Interstate System in good condition
- Percentage of pavements on the Interstate System in poor condition
- Percentage of pavements on the NHS (excluding the Interstate System) in good condition
- Percentage of pavements on the NHS (excluding the Interstate System) in poor condition

Each of the performance measures is 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 and composite pavements 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 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 2.11.

Figure 2.11: Pavement condition metrics



For each of the pavement condition metrics, FHWA has established thresholds for good, fair, and poor condition. Conditions are assessed using these threshold criteria for each 1/10-mile 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.

Table 2.3: FHWA pavement condition metric 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). The 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

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

Pavement Inventory and Condition

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 23,825 of these lane miles. Iowa DOT-owned highways are known as the Primary Highway System. As noted in Chapter 1, the emphasis for management of the Primary Highway System is stewardship of the existing system. In some cases, the primary highway pavement inventory is expected to grow in a limited and strategic manner 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 on the table.

Table 2.5: Pavement inventory and condition

Owner	System	Lane Miles	Good	Fair	Poor	Average PCI
Iowa DOT	Interstate	3,479	58.8%	40.8%	0.4%	81
	Non-Interstate NHS	12,426				74
	Non-NHS	7,920	28.2%	69.2%	2.6%	71
	Total	**23,825**				**74**
Other	NHS	441				
	Total	**441**				
All	Interstate	3,479	58.8%	40.8%	0.4%	81
	Non-Interstate NHS	12,867	37.9%	58.4%	3.7%	
	Non-NHS	7,920	28.2%	69.2%	2.6%	71
	Total	**24,266**				

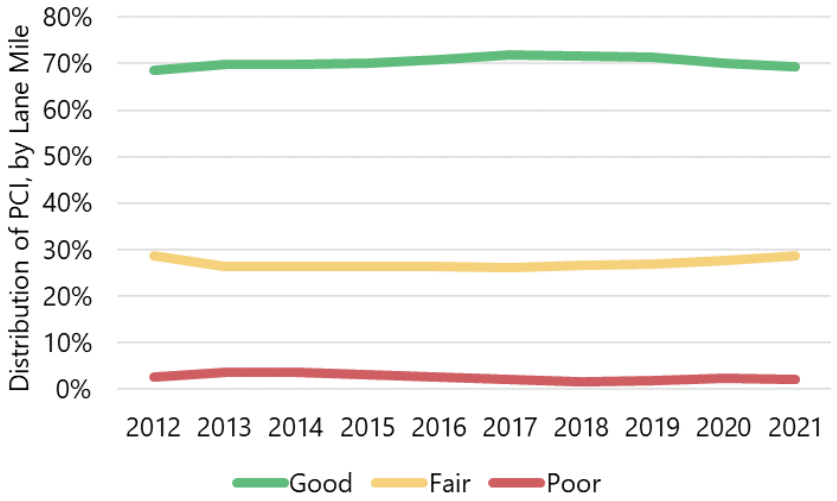
Note: there are more than 200,000 lane miles of pavement in Iowa that are not owned by Iowa DOT and are not on the NHS. Those assets are not included in the TAMP.

Pavement Condition History

Figure 2.12 shows the distribution of good, fair, and poor non-Interstate Primary Highway System pavements based on PCI over the past decade. Conditions on the network have fluctuated slightly from year to year, but have remained relatively stable overall.

Figure 2.12: Non-Interstate Primary Highway System pavement condition history

Condition has stayed relatively stable over the past decade.

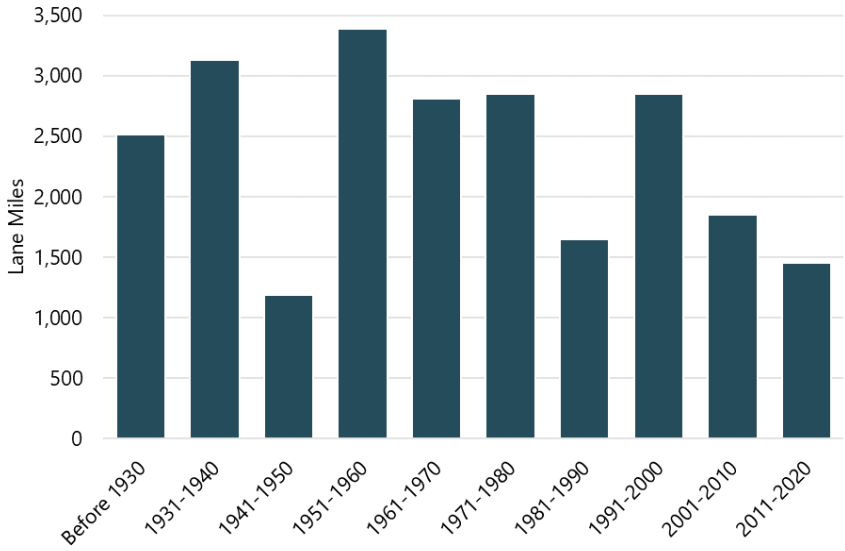


Pavement Age

The pavements of the Primary Highway System are aging. Over half 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, with about 20% of the system's lane miles having had three or more resurfacings. As pavements age these treatments become less effective, and eventually pavement replacement will be required. Figure 2.13 shows the age distribution of the pavements on the Primary Highway System by their decade of construction.

Figure 2.13: Primary Highway System lane miles by decade of construction

Nearly a third of the system's pavements are over 80 years old, increasingly requiring more signficant rehabilitation or reconstruction.



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