4. INFRASTRUCTURE ANALYSIS AND RECOMMENDATIONS

Tools for improvement

The planning and design of bicycle and pedestrian accommodations is an exercise in incorporating these modes into a transportation system that has—for the last 100 years—been built almost exclusively for automobiles. In the past five to ten years, significant advancements have been made in the United States in terms of the design of innovative accommodations and better understanding the nature of and opportunity for increased bicycle and pedestrian travel.

This chapter includes an analysis of existing conditions and recommendations intended to facilitate the development of consistent and interconnected bicycle and pedestrian networks through standardized design and comprehensive system planning. Also included are tools to aid in the selection of appropriate accommodation types for any given context and basic methodologies for effectively planning networks to increase access for non-motorized road users in a safe and equitable way. The recommendations are applicable on the local, regional, and state levels and identify the roles of various agencies.

This chapter is organized into four parts:

1. **Assessing the System** – an analysis of the existing roadway and multi-use trail network.
2. **Pedestrian Planning and Design** – planning and design considerations and guidance for accommodating pedestrians.
3. **Bicycle Planning and Design** – planning and design considerations and guidance for accommodating bicyclists.
4. **Facility Selection** – guidance on the selection of an appropriate bicycle or pedestrian facility based on traffic volumes and speeds.

4.1 Assessing the system

Infrastructure for bicycling and walking has two basic forms—Iowa's road network and multi-use trails (MUTs). Rural roads and city streets form a widespread and interconnected network in Iowa, providing access to every city and practically every destination in the state. For this reason, accommodating bicyclists and pedestrians on roads and streets is of utmost importance. MUTs can provide direct connections, a higher level of comfort for users compared to on-road bikeways, and outstanding recreational opportunities. However, while many people prefer MUTs, by their very nature they cannot connect the majority of destinations.

According to the 2017 *Iowa in Motion 2045* (Iowa's long-range State Transportation Plan), there are currently more than 3,000 miles of bicycle and pedestrian facilities, excluding standard sidewalks. The majority of these miles of infrastructure (1,990 miles or more than 62 percent) are in the form of multi-use trails while the remainder is in some form of on-road bikeway (bike lanes, paved shoulders, wide sidewalks, etc.). However, it is important to recognize that while only 835 miles of on-road bikeways have been identified, there are more than one hundred thousand miles of roads in Iowa on which bicycling is permitted.

Roadway system overview[1]

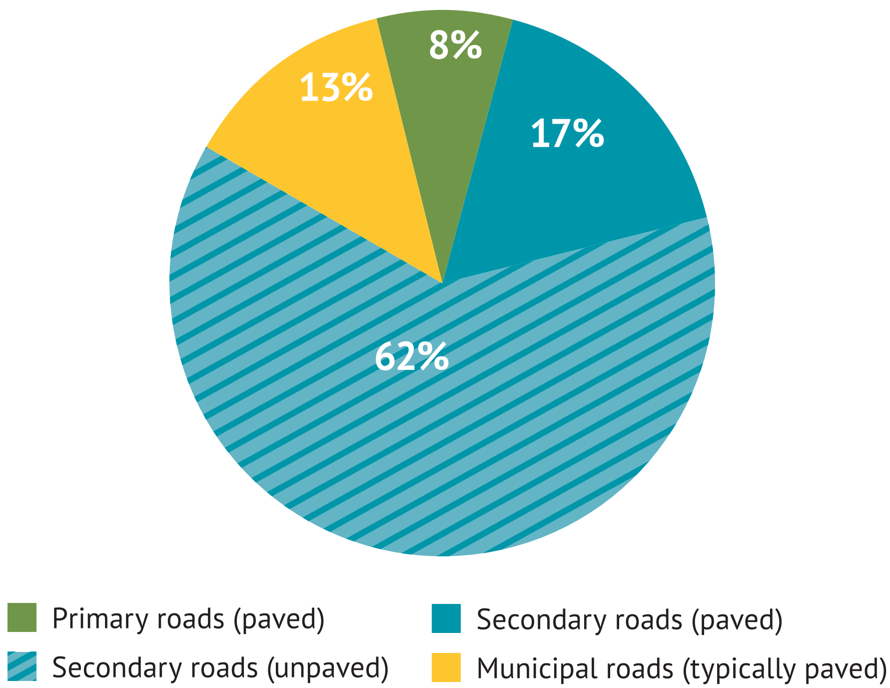
Iowa contains 114,880 total centerline miles of roadway (42,492 miles are paved). The state's roadway system is classified according to three main categories—primary roads, secondary roads, and municipal roads.

Primary roads include Interstate, US, and State Highways, totaling 9,403 miles. In general, the traffic volumes of these roadways make them poorly suited, or at least challenging, for bicycling. However, infrastructure improvements—such as wide paved shoulders—can accommodate bicyclists that choose to use these roads. While it is unlikely that primary roads will become major routes for bicyclists, short segments of US and State Highways can be used to close gaps between bikeways along lower-volume roads where alternatives do not exist. Examples include "Main Street" segments in small municipalities or a two-mile segment of primary road to connect bikeways on two low-traffic secondary roads. From a pedestrian perspective, sidewalks along primary roads are very important, especially if these roads provide direct access to businesses and other destinations. It is important to note that Iowa does not allow bicyclists or pedestrians to use the Interstate Highway System or four-lane divided roadways with posted minimum speed limits[2].

Secondary roads include County Trunk and Farm-to-Market Roads, totaling 89,818 miles. Iowa's secondary roads system provides great opportunities for bicycling and walking. This system, which includes 19,057 centerline miles of paved roads, forms a grid across the state, connecting cities large and small. These roads typically have lower volumes of traffic and are therefore well-suited for many bicyclists, even when paved shoulders are not present (see the On-Road Bicycle Compatibility Rating section later in this chapter).

Municipal roads include local city streets and rural roads, totaling 15,037 miles. These roads are locally-controlled and maintained, either by cities or counties. Streets within cities are typically paved and provide good opportunities for on-road bicycling (especially where they serve as alternative routes to higher-volume primary and secondary roads).

Figure 4.1: Miles of roadway by type



1 Roadway system mileage figures from *Iowa in Motion 2045*.

2 Iowa Code § 321.285.

Traffic volume

Traffic volume contributes to the overall level of stress of a roadway for all modes of transportation. It is also a major factor in determining the suitability of a roadway for on-road bicycling. The majority of Iowa's 42,492 miles of paved roads have low to low-moderate volumes of daily traffic—83 percent (35,116 miles) have fewer than 2,500 AADT[3]. Of the 19,057 miles of paved secondary roads, 18,595 miles or 97.6 percent have fewer than 2,500 AADT. Just over 65 percent (27,646 miles) of all roads have less than 1,000 AADT (see Figure 4.2 and Figure 4.3).]

Figure 4.2: Total miles of paved roadway by AADT[4]

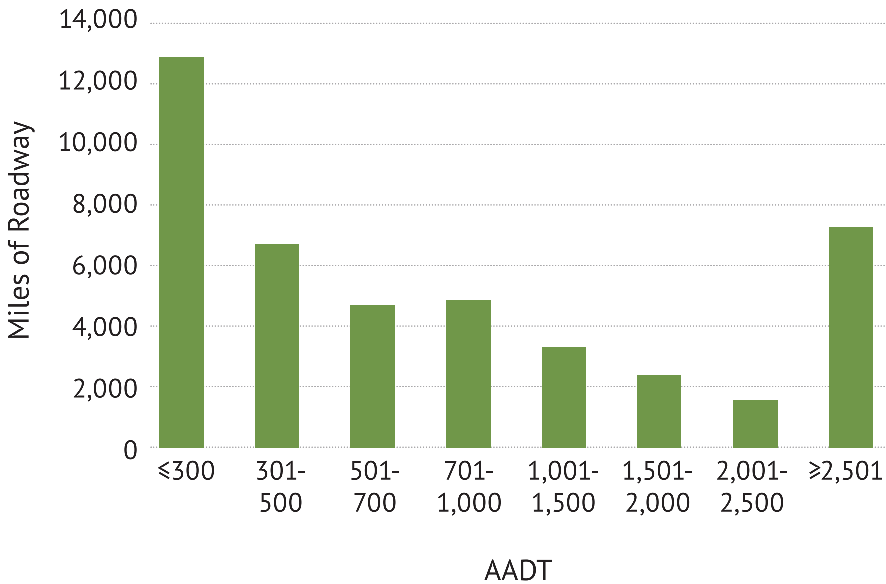
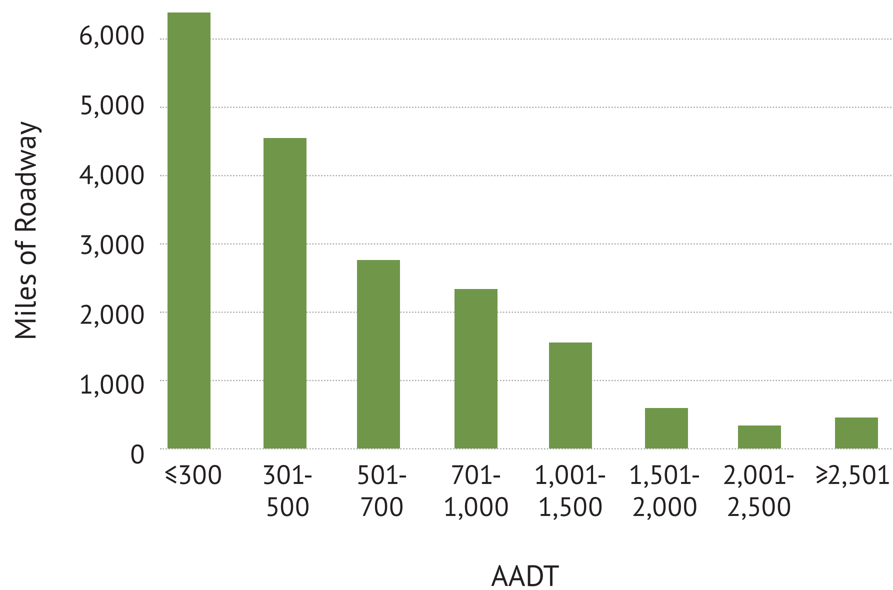


Figure 4.3: Miles of paved secondary roadway by AADT[4]



3 Annual Average Daily Traffic – the total volume of traffic on a roadway per year, divided by 365.

4 Data source: Iowa DOT's RAMS database (2018 data).

Multi-use trail system overview

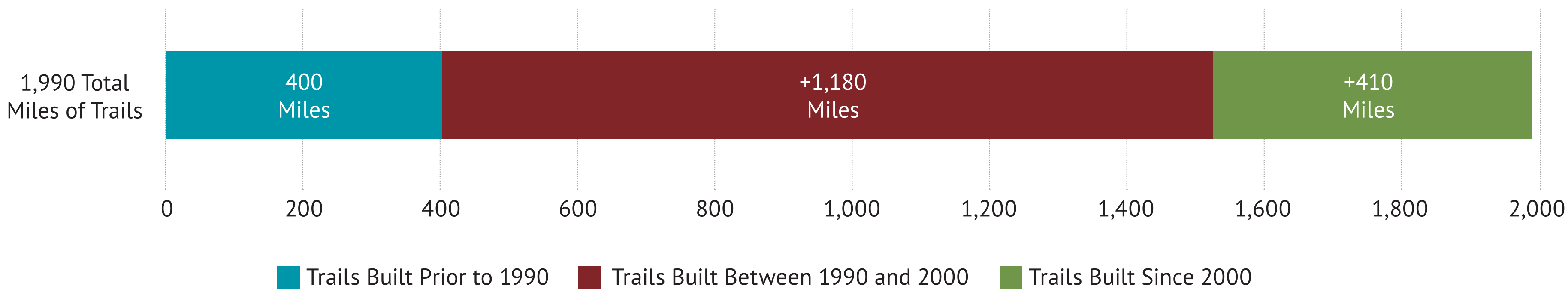
According to the 2017 *Iowa in Motion 2045,* there are currently approximately 1,990 miles of multi-use trails (MUT) across the state. The majority of miles of trail were constructed in the period between 1990 and 2000, which roughly coincides with the period between the State's two major trail plans.

MUTs built since 2012 utilizing any form of state or federal funding have been built in accordance with American Association of State Highway and Transportation Officials (AASHTO) standards updated in 2012[4]. Namely, MUTs are 10 feet wide and designed for use by bicyclists and pedestrians. Future MUTs utilizing state or federal funding will also be built to these standards. However, lower standards were in place prior to 2012 and the minimum width required for state and federal funding eligibility was 8 feet (although 10 feet was often recommended and constructed). MUTs that are only 8 feet wide are more challenging for bicyclists and pedestrians to share.

National trails

There are three national trails that cross Iowa—the coast-to-coast American Discovery Trail goes east to west from Davenport to Council Bluffs, the Mississippi River Trail parallels the eastern border of the state, and the Lewis and Clark trail follows the Missouri River from Sioux City south to the Missouri Border. The word "trail" in this case is a route designation; each of these corridors were developed using a combination of multi-use trails and on-road bikeways. Iowa's three national trails are in varying stages of completeness.

Figure 4.4: Miles of trail built over time[6]



5 *Guide for the Development of Bicycle Facilities, 4th Edition.*

6 "Trails Built Prior to 1990" and "Trails Built Between 1990 and 2000" figures come from *Iowa Trails 2000.* The "Trails Built Since 2000" figure was derived from the mileage of existing trails figure (1,990).

Trails: facility type versus route designation

In Iowa, the word "trail" is used to refer to several distinct concepts:

1. A multi-use trail – a paved path that is separated from the roadway and intended for use by bicyclists and pedestrians. These may be within the right-of-way of a roadway or may be unrelated to any roadway, such as a path along a creek or river. These can be used for transportation and recreation.
2. An unpaved trail – nature trails, mountain bike trails, and other unpaved paths that are primarily used for recreation.
3. A route designation – terminology used to identify a bicycle and pedestrian corridor that may include multi-use trails, sidewalks, and on-road bikeways. An example of this usage is the term "Mississippi River Trail."

It is important to recognize the distinction between the various meanings of this term. In order to differentiate, the use of the word "trail" on its own is avoided in this document.

4.2 On-road bicycle compatibility rating

During the past 20 years a significant amount of research has been conducted on what bicyclists consider to be important for their level of comfort on roadways. This is often referred to as "bicycle level of service" (BLOS). Bicyclists uniformly indicate that level of service for them is dictated by variables affecting their safety (including speed, separation from motor vehicle traffic, and volume and size of passing vehicles). A model used by the Wisconsin Department of Transportation (WisDOT), and now several other states, was developed with rural roadways in mind.

Background

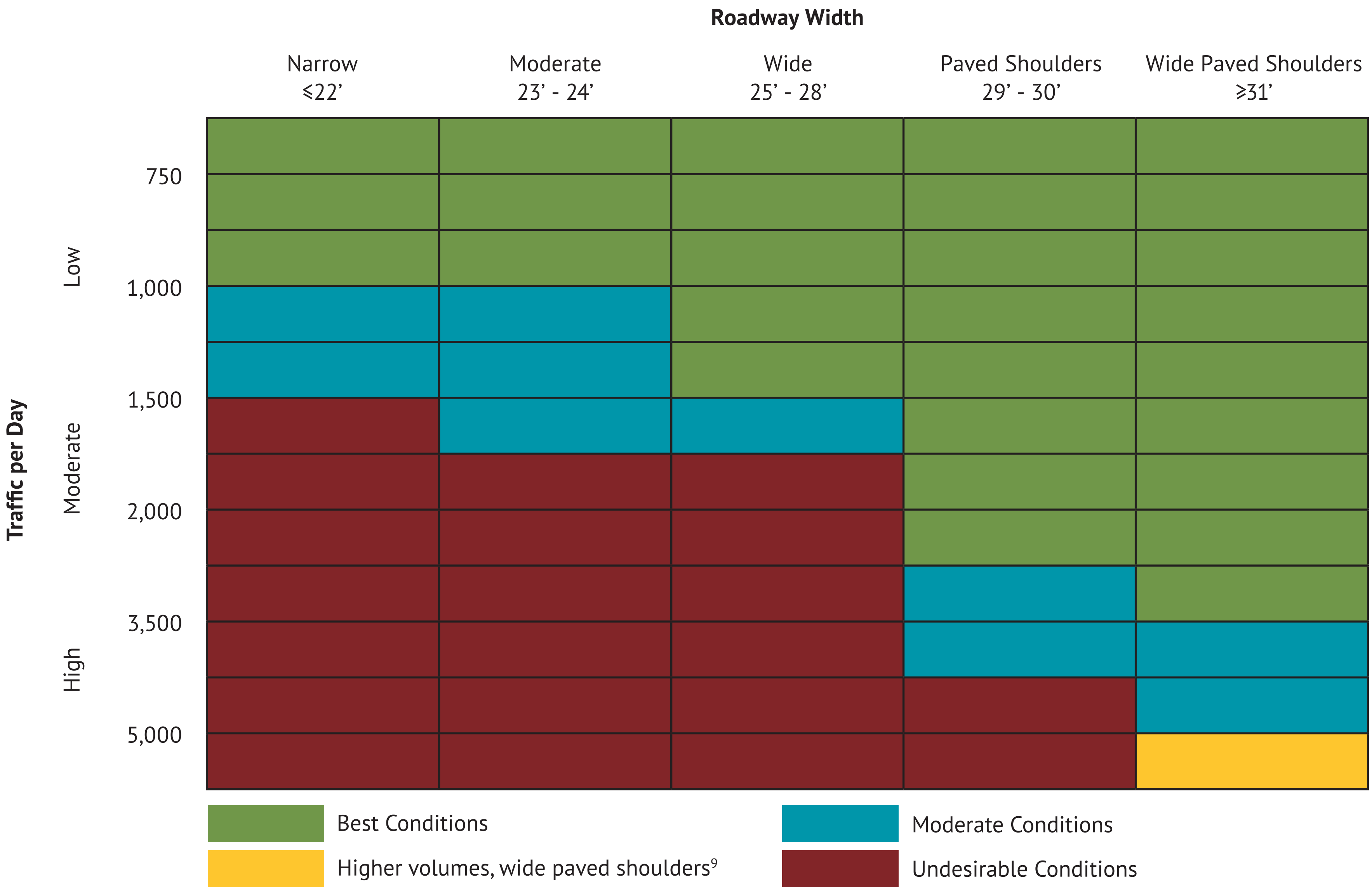
WisDOT has been using this bicycle level of service model since 1982. The model was designed to be sensitive to the conditions of low and moderate volume rural roadways, much like Iowa's secondary road system. The model was based on the probability of a conflict between bicyclists and passing vehicles, based on research performed as part of a National Cooperative Highway Research Program (NCHRP) study.[7] Very few rural roads with low volumes of traffic have enough width to allow three vehicles (two passing motorists and a bicyclist) to comfortably share the same linear space. The statistical probability of motor vehicle/bicycle conflict has a major impact on the suitability of a roadway for shared use and overall safety. The model was made sensitive to volumes based on earlier research conducted for warranting passing lanes on highways. Using and modifying that formula, a bicyclist can expect to encounter nine times as many conflicts on a road with 1,500 vehicles per day as compared with a road that has 500 vehicles. On a road with 5,000 vehicles, the conflicts would be one hundred times as great as on a road with 500 vehicles per day.

Methodology

This bicycle compatibility rating assessment was performed for all paved rural Primary and Secondary roadways as part of the existing conditions assessment. The assessment does not include roads and streets in cities and metro areas because the model was not designed to account for the numerous impacting factors present in these environments, such as multiple lanes and number of driveway crossings. The model uses factors including average daily traffic volume, roadway width, percent yellow center line, and percent truck traffic. Based on a combination of these factors, roadway segments are rated "good," "moderate," or "poor." A generalized explanation of the methodology is displayed in Table 4.1.

7 Glennon, John C. Design and traffic control guidelines for low-volume rural roads. Washington, D.C.: Transportation Research Board, National Research Council, 1979. Print.

Table 4.1: Generalized bicycling conditions for rural roadways[8]



8 *Wisconsin Rural Bicycle Planning Guide*. Wisconsin Department of Transportation. April 2006. 15.

9 Not used for this analysis.

Analysis

When applied to Iowa's primary and secondary road systems, the results are generally positive. 26,447 miles of paved rural roadways were evaluated (not including Interstate highways). 16,964 miles of roadway (more than 64 percent) were rated as "good" by the On-Road Bicycle Compatibility Rating. When considering only the primary and secondary roadway system (state and county highways, excluding Interstate highways), the majority receiving a "good" rating are part of the secondary road system (roughly 7,324 out of 9,664 miles). The major contributing factor for the good ratings these roads receive is the very low volumes of traffic (AADT) present.

By Iowa DOT District

The distribution of ratings by district is shown in Figure 4.6. All districts are relatively consistent in terms of the number of lane miles of "poor" rated roads. This generally mirrors the number of lane miles of primary roadways (excluding Interstate highways) in each district. Primary roads without paved shoulders are generally not very compatible with on-road bicycling due to their high traffic volumes. In contrast, the numbers of lane miles of "good" rated roads varies significantly across districts, and roughly parallel the presence of paved secondary roads. Districts 2 and 3, which cover the northern portion of the state and contain greater shares of paved secondary roads than other districts, have larger numbers of "good" rated lane miles. Districts 5 and 6, on the other hand, have the lowest proportion of "good" rated roads as well as the lowest proportion of paved roads.

Figure 4.5: Miles of primary and secondary paved rural roadway (excluding Interstate highways) by on-road bicycle compatibility rating

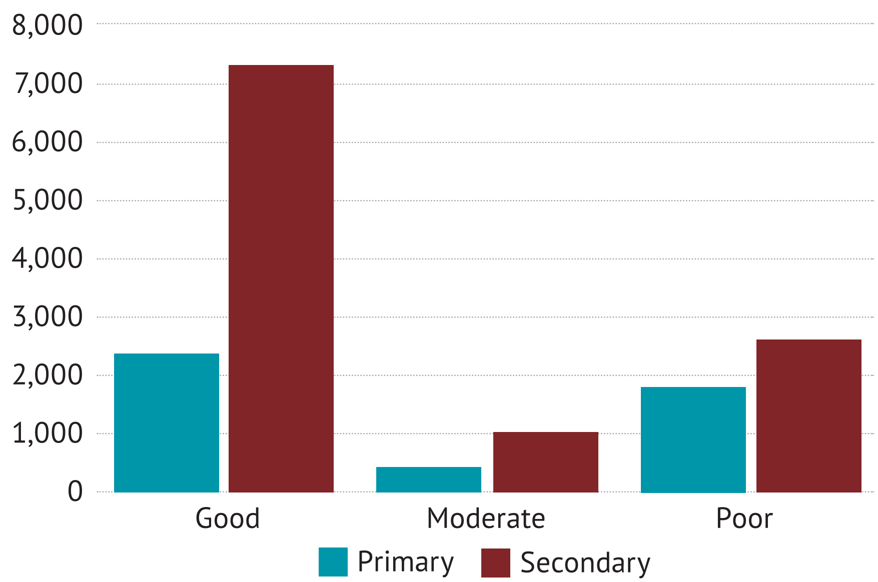
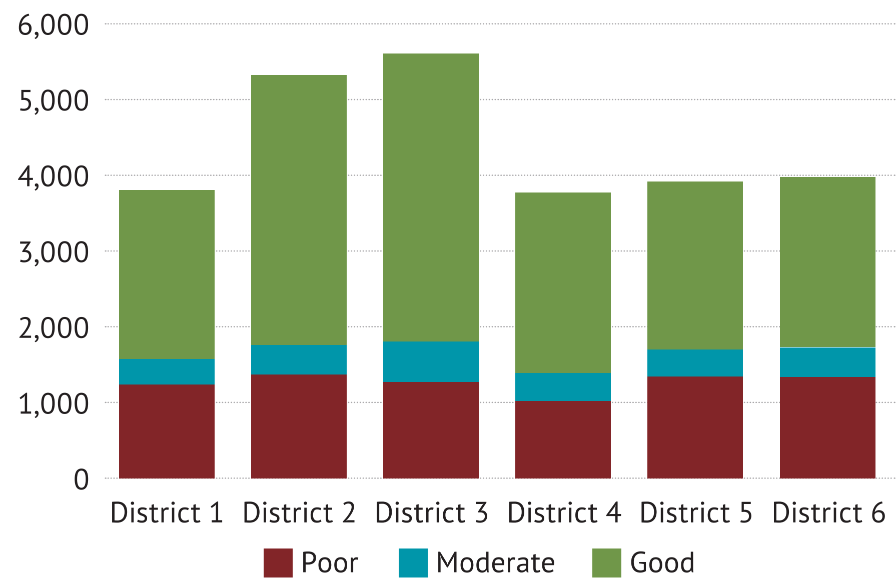


Figure 4.6: Miles of paved primary and secondary rural roadway by on-road bicycle compatibility rating by district

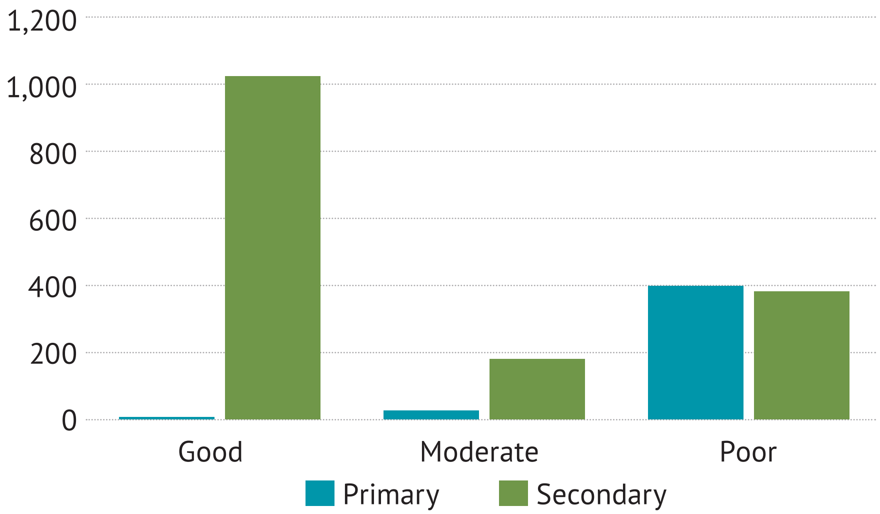


Surrounding metro areas

One of the most important issues highlighted by this analysis is the fact that roadways surrounding metro areas are often not very compatible for on-road bicycling due to the high volumes of traffic they carry. Figure 4.7 illustrates the ratings of rural roads up to two miles outside of Metropolitan Planning Organization (MPO) planning area boundaries but outside of incorporated city limits. Compared to Figure 4.4, nearly all primary roads receive "poor" ratings. This means that access to "good" rated roads from major population centers is limited.

It is logical—yet a challenge nonetheless—that roads surrounding population centers have the highest levels of traffic (a major contributing factor for the compatibility rating) and are in proximity to the highest concentrations of current and would-be bicyclists. While 63 percent of the roads in the metro area peripheries are rated "good" or "moderate," these roads do not tend to provide continuous connections in and out of most cities. Rather, they are discontinuous and interrupted by segments of "poor" rated roads. There are a number of implications, including the fact that access to "good" rated rural roads is greatly limited for city-dwellers and intercity connectivity is likewise inadequate. Figure 4.8 reinforces this point by illustrating the area accessible by bike from Cedar Rapids if "poor" rated roads are avoided. It is apparent that without the Cedar Valley Nature Trail (running north to Waterloo and south to Ely), access outside of the metro area would be highly challenging. In addition to Cedar Rapids, MUTs help several other metro areas—including Council Bluffs, Des Moines, Dubuque, and Waterloo—partially overcome this challenge by providing a low-stress way for bicyclists to reach the "good" rated rural roads.

Figure 4.7: Miles of primary and secondary rural roadway in the periphery of MPOs (up to two miles outside of their boundaries) by on-road bicycle compatibility rating

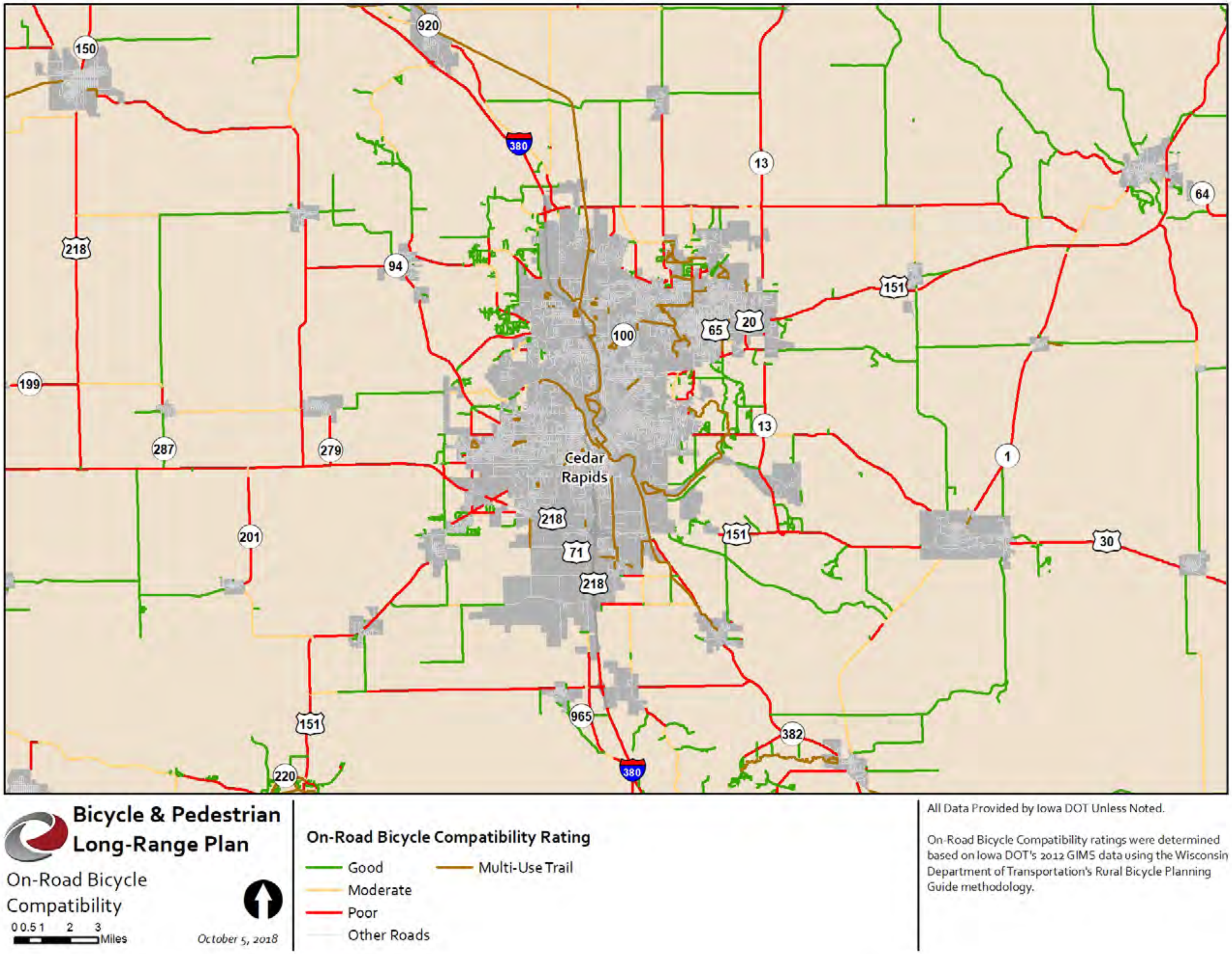


Perhaps a greater problem is that transportation options are limited for people living in the periphery of metro areas. This is especially challenging for people accessing the random residences and businesses built along primary and secondary roads and to new neighborhoods built with multiple access points. Without suitable accommodations (such as wide paved shoulders), these roads will likely never be considered "bike friendly."

It should not be assumed that these issues are unique to the Cedar Rapids area. Rather, each of the large metro areas in Iowa faces the same challenge. Indeed, some have even poorer conditions for bicycling along metro area periphery roads and do not have the benefit of a separated path leading to low-traffic rural roads.

Furthermore, the problem of poor access to suitable roads for bicycling is not limited to roads within the metro area peripheries. Conditions along the majority of metro area arterial streets in Iowa are poor for bicycling due to high volumes of traffic, traffic speeds, and lack of adequate space for bicyclists (by way of bike lanes, wide outside lanes, sidepaths, etc.). However, within cities there are typically low-traffic parallel streets that can be used by bicyclists, so access to destinations is not eliminated but may be limited. In addition, many cities are retrofitting accommodations into their primary streets to improve mobility (see Chapter 1).

Figure 4.8: On-road bicycle compatibility for the Cedar Rapids metro area.



4.3 Crash analysis

Crashes are an unfortunate reality for all modes of travel, including bicycling and walking. After falling significantly during the recession, the number of bicycle and pedestrian-related crashes, serious injuries, and fatalities has increased since 2014. In Iowa, thousands of crashes and hundreds of fatalities occur each year as a result of collisions involving motorists. Fatal bicycle-involved crashes comprised about 1.5 percent of all fatal crashes between 2008 and 2017. Considering the 0.5 percent mode share for bicycling (according to the American Community Survey Journey to Work data; see Chapter 1), this is significant. Pedestrians in Iowa are at risk too; fatal pedestrian-involved crashes comprised 6.7 percent of all fatal crashes between 2008 and 2017. Every year, there are an average of 430 pedestrian-related crashes and 21 pedestrian-related fatal crashes.

For this analysis, crashes were analyzed based on the *Iowa Crash Analysis Tool* (ICAT) dataset for a five-year period from 2013 to 2017. There are at least three limitations to this analysis:

- This dataset only includes reported crashes. Many minor crashes (those that do not result in a major injury, fatality, or property damage exceeding $1,000) are not reported.
- This dataset only includes crashes involving a motor vehicle. Bicyclist loss of control, collisions with debris, crashes between multiple bicyclists, and crashes between bicyclists and pedestrians—no matter how severe—are not included in this data.
- Without an accurate and up-to-date estimate of pedestrian and bicycle miles traveled or trips taken data, it is impossible to determine accurate crash rates.

The following summarizes the analysis of crashes occurring during a five-year period from 2013 to 2017 involving motorists and bicyclists (1,811 crashes) and motorists and pedestrians (2,317 crashes).

Bicycle crash analysis

Over the five-year period (2013-2017), a total of 1,811 bicycle-related crashes occurred. The number of crashes varied somewhat over this period and averaged 362 per year. Of these crashes, 25 resulted in fatalities (1.4 percent of all crashes) and 181 resulted in major injuries[10] (10.0 percent percent of all crashes). The majority of crashes resulted in minor or possible injuries, with very few resulting in no injuries.

The following additional statistics provide additional insight into bicycle-related crashes.

Age

- People ages 5 through 24 represent 27.4 percent of the population, yet bicyclists of this age are involved in 47.2 percent of all bicycle crashes.
- People ages 10 through 14 represent only 6.6 percent of the population, yet bicyclists of this age suffer 20 percent of all bicycle-related fatalities.
- People ages 55 through 69 represent 17.8 percent of the population yet suffer 36 percent of all bicycle-related fatalities. 649 bicycle crashes over the five-year period involved child bicyclists (infants to age 17). This equates to 35.1 percent of all crashes. Five bicycle fatalities occurred within this age group—slightly more than one percent of child bicycle crashes (and approximately 20 percent of all bicycle fatalities).

Figure 4.9 illustrates bicyclist crashes and fatalities by age.

10 "Major injury" is defined as any injury other than a fatal injury which prevents the injured person from walking, driving, or from performing other activities which he/she performed before the accident.

Location

- The vast majority of bicycle-related crashes occur in urban areas (94 percent). This is likely due to the increased number of bicyclists in these areas as well as the increased number of conflict points present in cities.
- The majority of bicycle crashes resulting in fatalities occur in rural areas (64 percent). This is also typical, in part due to the higher speeds at which vehicles travel in rural areas.
- Over 60 percent of all bicycle-related crashes occurred at intersections and driveways, as did more than 55 percent of combined fatalities and major injuries.

Figure 4.10 illustrates rural versus urban bicycle crashes by severity.

Road type

- A total of 74 percent of all bicycle-related crashes occur along municipal streets and roads. Just fewer than 71 percent of combined bicycle-related fatal and serious injury crashes occur on these roads.
- Secondary roads see only 5.3 percent of all bicycle-related crashes but are the location of 14.5 percent of all major bicycle-related fatal and serious injury crashes. Crashes on rural roads are very unlikely, but when they do occur, they are 3.7 times more likely to result in a major injury or even a fatality.

Seasonality

Most bicycle crashes occur during the summer and early fall months of June and September. This is typical across the country and is assumed to be a result of fewer people riding during the cold winter months.

Figure 4.9: Bicycle crashes by age of bicyclist

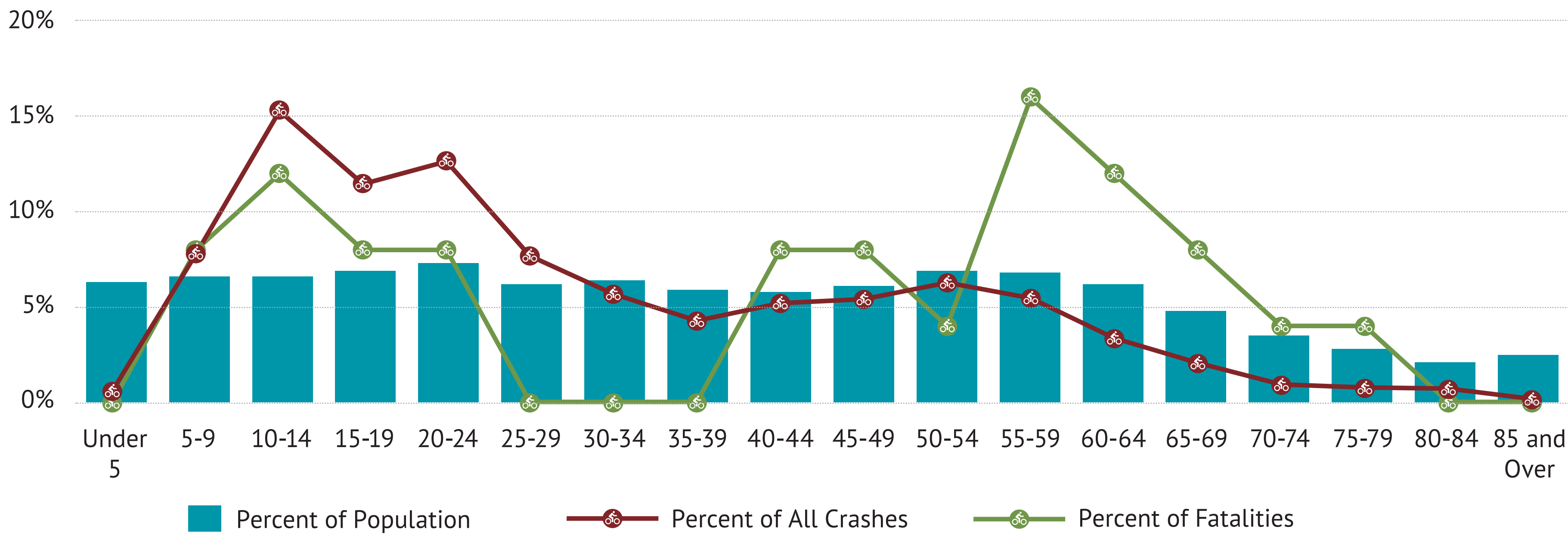
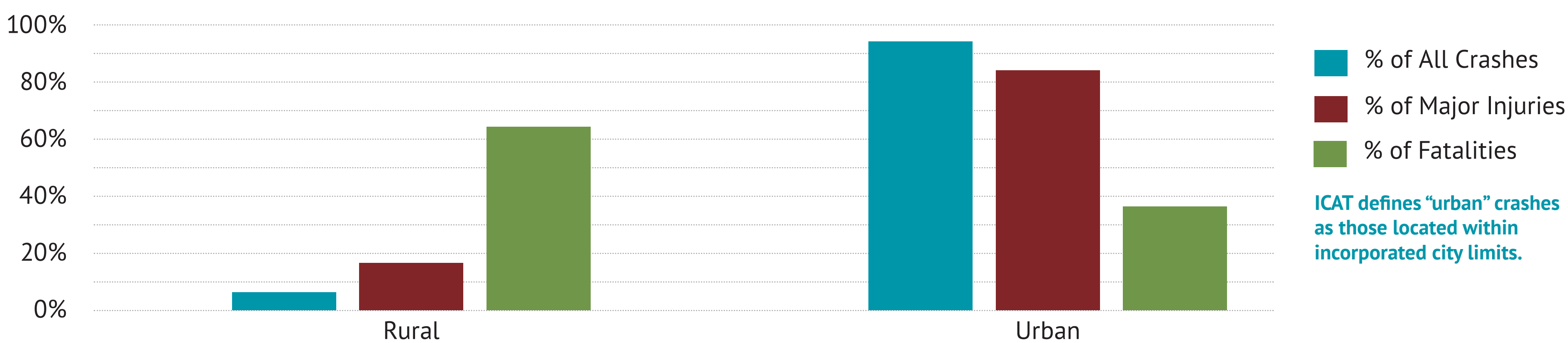


Figure 4.10: Rural versus urban bicycle crashes



ICAT defines "urban" crashes as those located within incorporated city limits.

Pedestrian crash analysis

Over the five-year period from 2013 to 2017, a total of 2,317 pedestrian-related crashes pedestrians occurred. The number of pedestrian-related crashes varied somewhat over this period (first increasing, then declining in 2017). On average, there were 463 crashes per year. Of these crashes, 115 (5 percent) resulted in fatalities and 371 (16 percent) resulted in major injuries. The majority of crashes resulted in minor or possible injuries, with very few crashes resulting or no injuries. Compared to bicycle crashes, pedestrian crashes tend to result in a higher rate of major injuries and fatalities.

Age

- People ages 5 through 24 represent 27.4 percent of the population yet pedestrians of this age are involved in 39.4 percent of pedestrian-related crashes.
- People ages 50 through 74 represent 26.9 percent of the population yet pedestrians of this age suffer 49.1 percent of all pedestrian-related fatal crashes.
- 572 pedestrian crashes over the five-year period involved child pedestrians (ages 0 to 17). This equates to 25.6 percent of all pedestrian-related crashes. Fatalities occurred in 5.1 percent of all child-related pedestrian crashes.

Figure 4.11 illustrates pedestrian crashes and fatalities by age.

Location

- The vast majority of pedestrian-related crashes occur in urban areas (93.1 percent). Higher levels of pedestrian activity and higher levels of motor vehicle traffic are likely the major contributing factors.
- A disproportionate amount of fatal pedestrian crashes occur in rural areas (31.3 percent). While only 3.7 percent of all rural pedestrian-related crashes are fatal, nearly 23 percent of urban pedestrian-related crashes are fatal.

Figure 4.12 illustrates rural versus urban pedestrian crashes by severity.

Road type

- A total of 74.1 percent of all pedestrian crashes occur along municipal streets and roads. Just fewer than 50 percent of fatal crashes occur on these streets and roads.
- Interstate Highways are the site of 2.6 percent of all pedestrian crashes but 13.9 percent of the fatal crashes.
- Secondary roads are the site of 4.4 percent of all pedestrian crashes and 10.4 percent of fatal crashes.

Time of day

Time of day plays a major role both in terms of total number of crashes and in terms of the severity of crashes. The greatest numbers of crashes occur in the four-hour period between 2:00 and 5:59pm (31.2 percent of all crashes). However, this period only accounts for 18.2 percent of fatal crashes.

Figure 4.11: Pedestrian crashes by age of pedestrian

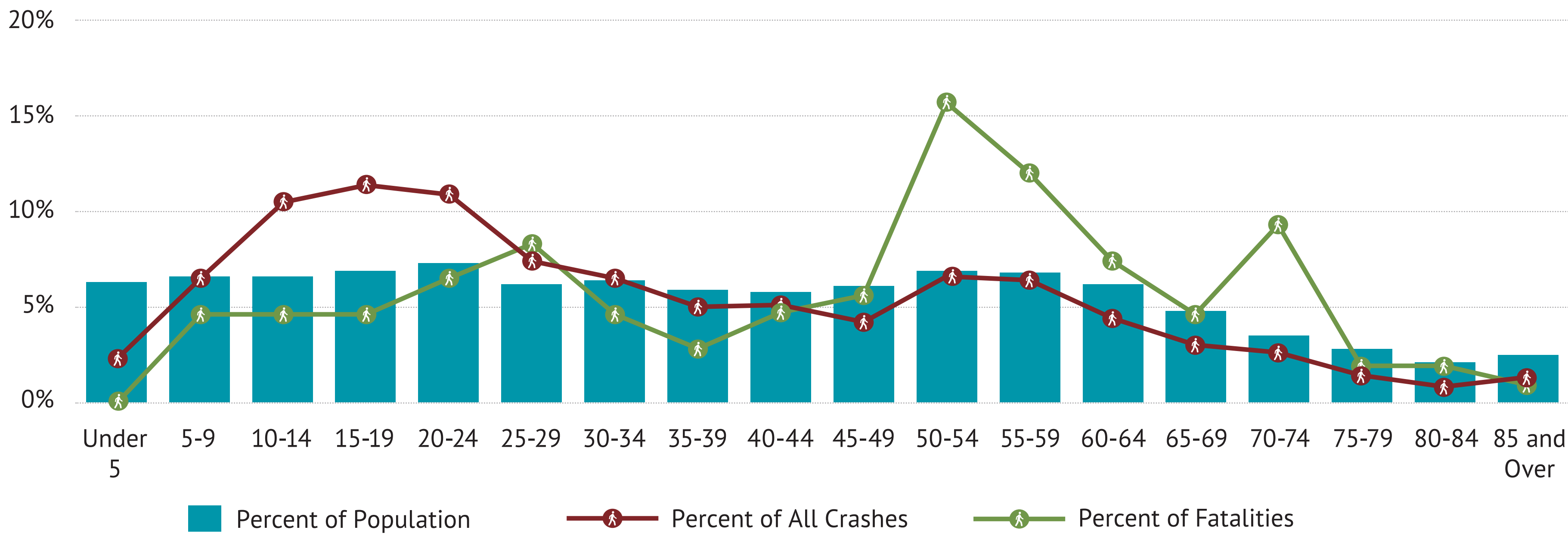
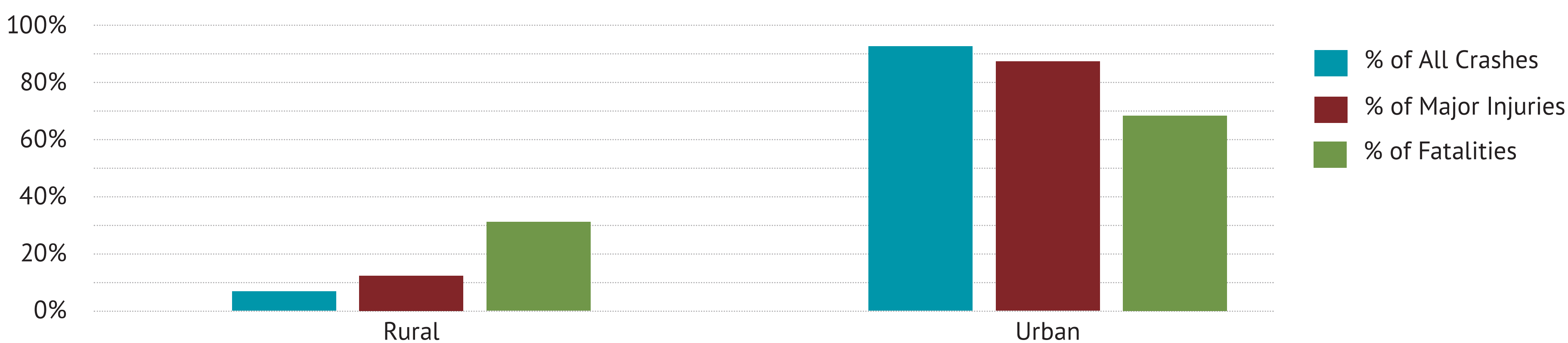


Figure 4.12: Rural vs urban pedestrian crashes



Note: The percentages of All Crashes do not total 100 percent because 35 crashes (1.5 percent of the total) were not classified as rural or urban in the ICAT database.

4.4 Summary of infrastructure opportunities and challenges

There are numerous opportunities and challenges that impact the ability for bicyclists and pedestrians to travel safely and comfortably within the state. Since many of the challenges are also opportunities—and since many of these issues affect bicyclists and pedestrians alike—they are not categorized in this analysis. The most significant of these issues are discussed below.

Grid of secondary roads – Iowa has an extensive secondary road system (county roads and farm-to-market roads). As previously discussed, the roads within this system tend to have low volumes of traffic. They also form a grid, which provides access to almost every corner of the state (see Figure 4.13). However, a significant portion of the secondary road system is unpaved, which tends to coincide with topography (see Figure 4.14: Roads with Grades 1 percent or Greater4). Areas with rolling hills tend to be less agriculturally-productive, which means less tax revenue is generated and less money is available to pave county roads. Regardless, Iowa's secondary road system is one of the most significant opportunities in the state for bicyclists.

Traffic volume – The majority of Iowa's rural roads (83 percent of all non-Interstate paved rural roads and 95 percent of paved secondary roads)—are considered to have low to moderately-low volumes of traffic (below 2,500 AADT). Traffic volume is a significant contributing factor in determining whether a road is suitable for bicyclists (in addition to other factors; see the On-Road Bicycle Compatibility Rating section later in this document). The low-traffic-volume nature of many roads in the state is a significant opportunity for bicyclists. Conversely, the high traffic volume of some roads, especially those in metro areas, results in high levels of stress for bicyclists and can create major barriers for bicycle connectivity. In addition, high-volume roads are often uncomfortable for pedestrians, even if they are well-protected from the nearby traffic.

Pavement width and lack of paved shoulders – Whether or not a road of any given traffic volume is suitable for bicyclists is a factor of that road's total pavement width (including paved shoulders, if present). Many of Iowa's roads are generally narrow—more than 71 percent of the secondary road system is 22 feet wide or less. The majority of Iowa's paved roads (primary and secondary) lack paved shoulders, which have many benefits including reducing single vehicle run-off-road crashes (SVROR) and providing a place for bicyclists. The lack of paved shoulders also affects pedestrians, who may otherwise use paved shoulders in rural areas where sidewalks do not exist.

Rumble strips – The placement of rumble strips within paved shoulders minimizes the usefulness of said shoulders for bicyclists. Moving to a practice of constructing "rumble stripes" (milled rumble strips with the lane edge line placed over them) would still provide a countermeasure for run-off-the-road crashes while increasing the usefulness of the shoulder for bicyclists.

Rural intersection design – As previously mentioned, rural intersections are quite challenging for pedestrians due to their lack of crosswalks, curb ramps, or pedestrian signals. The geometric design of many rural intersections also makes crossings exceedingly long for pedestrians and often allow motor vehicle drivers to turn at higher speeds, which impacts the safety of bicyclists.

Wide, high-traffic roads in cities – Many US and State Highways that pass through cities take on additional roles, including service as primary thoroughfares. Quite often, these roads end up with many thousands—or even tens of thousands—of motor vehicles. Consequently, they often are designed as four- or even six-lane roads. These end up posing major barriers for pedestrians and bicyclists needing to cross the road, due to long crossing distances, lack of median refuges, and the stresses of high traffic volumes without adequate gaps in traffic. Accommodating bicyclists along these roads is also difficult since bike lanes or separated multi-use trails (sidepaths) are often warranted, yet right-of-way is typically very limited and often the corridor itself is constrained by adjacent land uses.

Level of multi-use trail development – Over the past two decades, Iowa has developed an extensive multi-use trail system. These trails provide many opportunities for transportation and recreational biking and walking. However, due to the expense of MUT construction and difficulty in acquiring right-of-way for new trails, the system has many gaps that decrease its connectivity. In addition, the expense of MUT maintenance and limited funding sources may discourage communities from constructing trails on their own or in partnership with DOT. According to the Rails-to-Trails Conservancy, maintenance costs average more than $2,000 per mile per year. Local communities are typically responsible for maintaining MUTs, even when they are constructed within DOT right-of-way.

While MUT trail development will and should continue in the future, it is unlikely that MUTs alone will be able to provide a statewide system for bicyclists and pedestrians.

Unpaved road network– Iowa has an extensive network of unpaved roads—gravel or earthen—totaling approximately 73,000 miles across the state. Many of these roads are classified as "Level B" roads by the counties, which mean they receive a very low level of maintenance and are used on an "at your own risk" basis. Iowa's unpaved road network provides an opportunity for gravel road bicycling, a small yet growing form of bicycle riding and racing. This sport could encourage and support tourism and related economic development opportunities. A number of gravel road races and rides have occurred over the last few years and many have originated in Grinnell, which has become the de facto center of gravel road bicycling in Iowa.

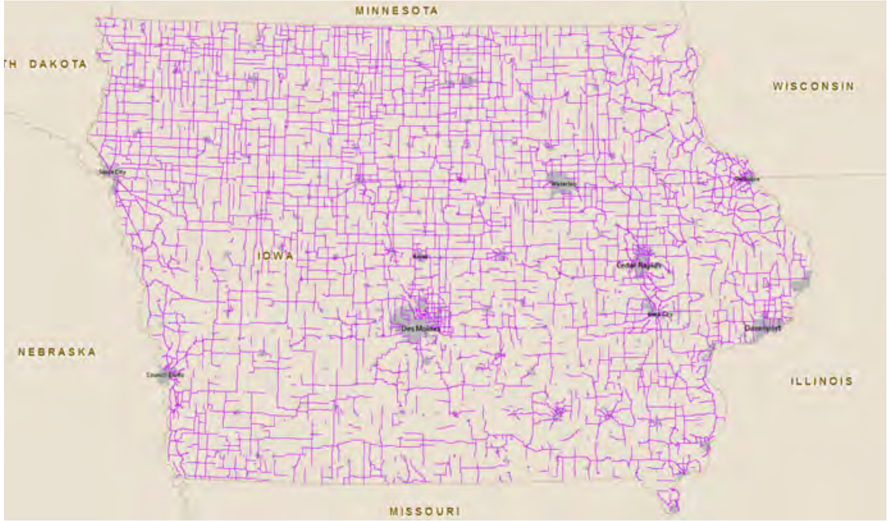


Figure 4.13: Paved Secondary Roads

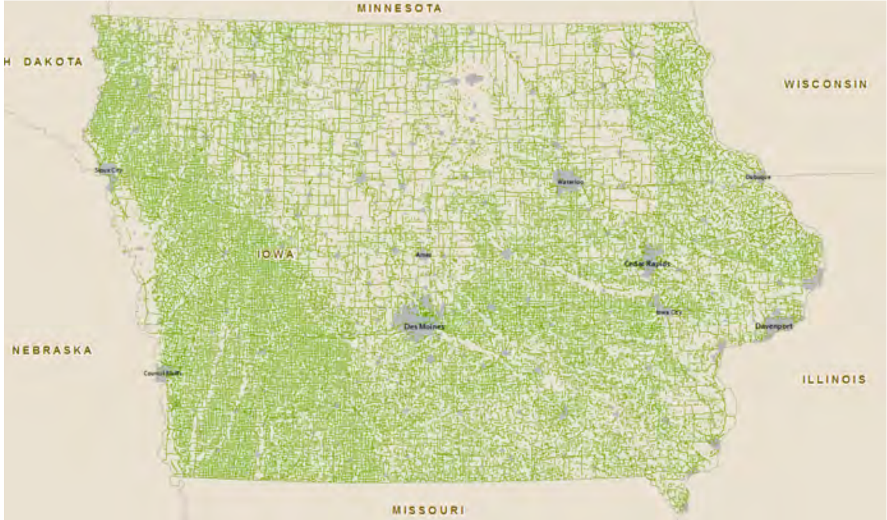


Figure 4.14: Roads with Grades 1 percent or Greater

Pedestrian planning and design

The vast majority of pedestrian travel occurs within urban areas, especially where comfortable and accessible infrastructure is present and when development patterns are dense and diverse (such as small town main streets, big city downtowns, walkable "town center" developments, etc.). While some people make commuting trips by foot, more often people walk for utilitarian and leisure trips—going shopping or out to eat, heading to the park or school, visiting a neighbor, or simply for exercise and recreation. In reality, walking trips often occur between driving and bicycling trips (e.g., people biking or driving to a shopping area and walking from store to store). In addition, walking is a primary mode of transportation for many people in Iowa out of necessity because they do not always have access to a motor vehicle (17 percent of households have only one motor vehicle and 2.6 percent do not have any).

4.5 Walking in rural contexts

While the focus of pedestrian transportation planning is decidedly urban, it is important to consider pedestrian mobility in rural areas, especially in the urban/suburban periphery. While rural pedestrian travel constitutes a fraction of total pedestrian trips, it still occurs in several ways:

- Walking for exercise – Rural roads are often the only place for rural residents to walk or jog.
- Short to moderate walks at the edge of communities – It is not uncommon for people to walk from just outside an urban area into a city. So-called "cow paths" are often seen as evidence of pedestrian use and demand.
- Walking to rural destinations – Nearby gas stations, neighbors' homes, places of employment, and rural schools are all destinations to which rural residents might walk rather than drive.

Current conditions

Dedicated pedestrian infrastructure in rural areas is practically non-existent and it is estimated that very few pedestrians venture along roads well outside of cities. However, it is somewhat common for pedestrians to walk along semi-rural roads on the outskirts of cities and suburbs to get between their homes and retail establishments or to visit neighbors. People will often walk in rural areas for exercise and recreation as well.

Although not ideal facilities, paved and granular shoulders may be used by pedestrians and can provide improved margins of safety for occasional use. However, pedestrians using shoulders may encounter several challenges, including rough surfaces, debris, and barriers such as narrow bridges. They must also walk facing traffic, which on occasion (largely depending on pedestrian's route) might be impractical. It can be safely assumed that roadway shoulders do not meet accessibility requirements for pedestrians with disabilities.

In addition, intersections along rural roads can be quite challenging, even though most intersections typically have low traffic volumes. Firstly, they do not include crosswalks, curb ramps, or pedestrian signals. Secondly, the geometric design of many rural intersections makes crossings exceedingly long.

Accommodations approach

The Complete Streets Policy will necessitate considering the need for pedestrian accommodations in rural areas. In most cases, no formal accommodation will be warranted due to the lack of nearby commercial and residential development. In these cases, paved shoulders—although not designed as pedestrian facilities—can benefit rural pedestrians. It is unlikely that paved shoulders can satisfy federal accessibility requirements (the Americans with Disabilities Act), and without crosswalks and pedestrian signals they do little to improve intersection safety for pedestrians. However, if the context or demand does not warrant a sidewalk or multi-use trail, yet there is evidence of some pedestrian use and the choice is between paved shoulders or nothing at all, paved shoulders are preferable. This is not to say that the rural context will never warrant true pedestrian accommodations; in fact, it is probable that unique factors will dictate that formal accommodations (sidewalks, multi-use trails, intersection improvements, etc.) are necessary on occasion.

4.6 Walking in urban and suburban contexts

In order to achieve this plan's goal for increased pedestrian travel, attention must be primarily focused on urban and suburban pedestrian accommodations. This entails accommodating linear movement along streets and other corridors (via sidewalks and multi-use trails) as well as providing safe and comfortable opportunities to cross major streets. Each organization responsible for planning or designing transportation infrastructure should carefully consider the nature and purpose of pedestrian trips and improve access accordingly.

Current conditions

Transportation infrastructure—especially Interstate Highways, expressways, and railroads—can pose major barriers for pedestrian mobility in cities and suburbs. Iowa DOT has built a number of bicycle and pedestrian overpasses and other crossings to help minimize these barriers. The inclusion of overpasses varies across the state, but is generally considered a primary part of major expressway projects in the more populated regions, such as the Des Moines area. Speeds are lower in cities making streets more suitable for walking along and across. The increased presence of sidewalks also improves pedestrian comfort and safety.

In general, sidewalks are present along primary and secondary roads within cities. In many of Iowa's cities, a US or State Highway serves as the primary thoroughfare, and often is designated as "Main Street" by the local municipality. In these situations, wide sidewalks are typically provided in the downtown commercial area and standard sidewalks are provided along other primary and secondary roads.

The presence of sidewalks along the frontage roads of Interstate Highways in cities and metro areas varies depending on several factors. If an Interstate Highway generally follows the grid of local streets, such as is the case with I-380 in Cedar Rapids, sidewalks are usually present along frontage roads. In instances where the Interstate Highway cuts across the grid—such as I-235 through downtown Des Moines—sidewalks are only present in certain locations where development fronts the frontage road. Many Interstate Highways run along the suburban, car-dominated periphery of metro areas and lack sidewalks (I-80 in Davenport is an example).

The presence of sidewalks along primary and secondary roads tends to mirror the presence of sidewalks along city streets.

Over the past few years, Iowa DOT has been making a concerted effort to meet accessibility compliance requirements as mandated by FHWA. As a result, new or replaced curb ramps and sidewalks have been installed along a number of primary and secondary roads across the state.

Accommodations approach

The approach to increasing pedestrian accommodations has several components and is opportunity-driven; that is, the vast majority of accommodations should be provided as part of larger street and highway projects. The approach includes five components:

1. The Complete Streets Policy calls for the inclusion of pedestrian facilities when urban and suburban streets that are on the state highway system are reconstructed or newly constructed. In addition, cities, counties, and regional agencies are strongly encouraged to adopt and implement similar Complete Streets policies.
2. When streets are resurfaced, existing sidewalks, crossings, and curb ramps must be made compliant with federal accessibility standards in most cases. Replacing entire lengths of sidewalks may not be required, depending on the project.
3. For streets that have high levels of pedestrian demand or disproportionate levels of pedestrian crashes, yet are not going to be reconstructed or subject to 3R activities for a significant period of time, communities are encouraged to provide short-term solutions, such as adding sidewalks or improving intersections as stand-alone projects.
4. Opportunities to develop standalone pedestrian connections (such as multi-use trails that serve transportation purposes or sidewalks that connect cul-de-sacs to nearby thoroughfares) should be sought. Projects that help improve pedestrian access and connectivity should be prioritized for funding.
5. When areas within cities are newly developed or redeveloped, municipal codes should require sidewalks to be provided along public rights-of-way.

However, pedestrian planning should not always be project-driven; rather it should occur in an ongoing manner on a community-wide basis (see “Planning the Network” later in this section).

4.7 Planning pedestrian networks

The inclusion of pedestrian accommodations in larger street and road projects is important, but planning for pedestrian access and connectivity on a broader scale is essential in establishing a highly-functional walking environment. This is especially true in urban and suburban areas, where pedestrian trips are far more frequent. Urban/suburban pedestrian plans should typically be oriented around areas of high activity, because people are far more likely to walk in areas where there are many destinations. The Iowa DOT recommends that cities, counties, and regional agencies work cooperatively to plan local and regional pedestrian networks based on the following guidelines:

- The foundation of a pedestrian network is areas of high activity (e.g., main streets, commercial corridors, downtowns, high-density residential areas, mixed-use zones, etc.) as well as any residential or commercial development within the surrounding 1/4 to 1/2 mile (the typical distance people are willing to walk). Such areas will likely quickly spring to mind for planners familiar with their jurisdictions; however, high activity areas can be quantitatively identified based on population density, density and diversity of destinations, and density of intersections (a measure of street network connectivity). Each local network plan should include continuous sidewalks along both sides of every street in high activity areas.
- Longer-distance connections are also important, especially for people without cars. Network plans should connect high-activity areas to each other and to neighborhoods via multi-use trails and sidewalks along streets. Areas closer to each other are more likely to generate pedestrian trips.
- In lower-demand areas, especially where high-activity areas are few or less apparent, sidewalks should be prioritized on collector and arterial streets.

- Once the network is established, the plan should identify gaps in the sidewalk network, sidewalks that are not compliant with federal accessibility guidelines, and streets/intersections with high instances of pedestrian crashes and/or high traffic volumes.
- Finally, solutions for improving network safety, accessibility, and connectivity should be developed and prioritized.

Rural pedestrian network planning is also valid, especially in the form of regional and intercity multi-use trail plans or in areas where longer-distance walking might be more likely (such as city-to-city walking trips along the Missouri or Mississippi Rivers). In these cases, network planning will take a “point-to-point” approach by identifying opportunities to connect distinct destinations or parallel a natural feature or transportation corridor. Chapter 5: Statewide Network Recommendations outlines the vision for a statewide multi-use trail system, upon which counties, regional agencies, and multi-jurisdictional partnerships can build.

4.8 Pedestrian facilities

Pedestrian infrastructure is primarily provided in the form of sidewalks or multi-use trails. However, there are many unique treatments that can be implemented to improve the pedestrian experience, encourage more walking, and decrease the number of crashes that occur. The following summarizes the most common facilities and treatments and provides key design guidance. However, designers should consult the latest version of the Iowa DOT Design Manual or the Iowa Statewide Urban Design and Specifications (SUDAS), as well as national standards and guidelines, which are listed at the end of this section.

Sidewalks

Sidewalks are the most common pedestrian facilities and are typically located within public right-of-way, adjacent to property lines. Sidewalks provide dedicated space for pedestrians with vertical and/or horizontal separation between motor vehicles and pedestrians.

The presence of sidewalks on both sides of the street corresponds to approximately an 88 percent reduction in “walking along road” pedestrian crashes.

Basic design parameters

The standard width for a sidewalk is 5 feet with 4 feet permitted to avoid obstructions (or the current standard as specified in the Iowa DOT Design Manual or SUDAS). Sidewalks should be wider at schools, transit stops, downtowns, main streets, and anywhere else higher volumes of foot traffic occurs.

Multi-use trails and sidepaths

A multi-use trail (MUT) is a two-way facility physically separated from motor vehicle traffic and used by pedestrians, bicyclists, and other non-motorized users. The cost of MUTs typically greatly exceeds the cost of sidewalks and on-road bikeways since they often require right-of-way acquisition and drainage changes.

Basic design parameters

The minimum width for a MUT is 10 feet and 8 feet is acceptable for short distances under physical constraint (or the current standard as specified in the Iowa DOT Design Manual or SUDAS). Additional width can be provided to accommodate high volumes and separated parallel paths can be provided to reduce conflicts between bicyclists and pedestrians. MUTs must be designed with bicyclists in mind (e.g., designing curves based on an 18 mile per hour design speed).

Curb ramps

Curb ramps provide transition between sidewalks and crosswalks and must be installed at all intersection and midblock pedestrian crossings, as mandated by federal legislation (1973 Rehabilitation Act and ADA 1990). All newly constructed and altered roadway projects must include curb ramps. Agencies with more than 50 employees are required to have a transition plan in place to address the staging of the curb ramp upgrades.

Basic design parameters

The design parameters of individual curb ramps are relatively complex and are explicitly stated in the Iowa DOT Design Manual. Separate curb ramps should be provided for each crosswalk at an intersection rather than a single ramp at a corner for both crosswalks. The separate curb ramps improve orientation for visually impaired pedestrians by directing them toward the correct crosswalk.

Marked crosswalks

Marked crosswalks include a variety of facility types intended to increase the safety of pedestrians crossing streets and roads. In addition to pavement markings, crosswalks may include signals/beacons, warning signs, in-street signage, and raised platforms. Marked crosswalks are most important on multi-lane streets, areas of high pedestrian traffic (downtowns, universities, etc.), and midblock crossings.

Basic design parameters

Some crosswalk striping patterns are more effective than others. Ladder, zebra, and continental striping patterns are understood to be the most visible to drivers. FHWA provides extensive guidance on when to provide marked crosswalks (see Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines, 2005).

Pedestrian refuge islands

Raised islands located along the centerline of a street or road, as roundabout splitter islands, or as "pork chop" islands where right-turn slip lanes are present provide refuge for pedestrians and allow multi-stage crossings of wide streets. They can be provided at intersections or at midblock crossings. At unsignalized intersections and midblock crossings, refuge islands allow pedestrians to negotiate one direction of traffic at a time. They also permit multi-stage crossings at intersections with signals, which can allow shorter signal phases but may encourage noncompliance with pedestrian signals.

Basic design parameters

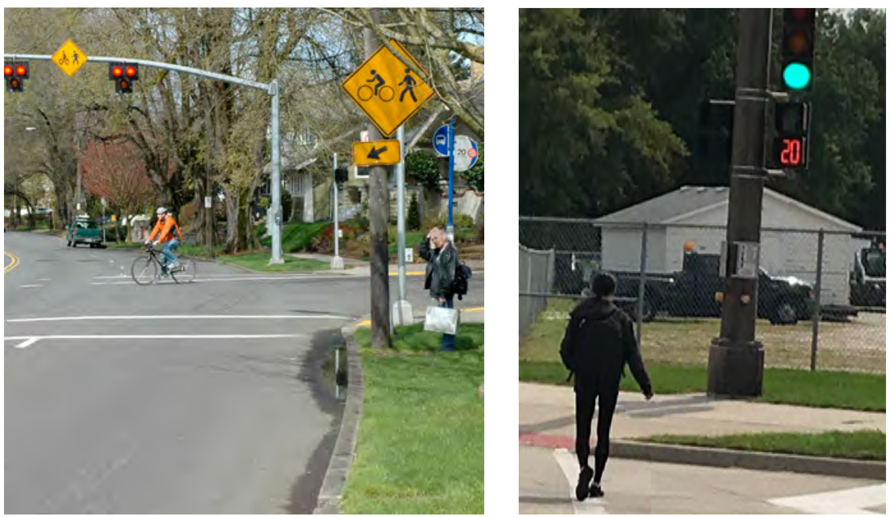
The minimum width is 6 feet (or the current standard as specified in the Iowa DOT Design Manual or SUDAS), but 8 feet is recommended to accommodate higher pedestrian volumes, bicyclists, and wheelchair users. Curb ramps with detectable warnings are required, as are five foot by five foot landing areas if a grade change occurs.

Pedestrian signals

Pedestrian signals control the flow of foot traffic through intersections and across roads. They include traditional walk/don't walk signals, rapid-flash beacons, hybrid or HAWK signals, and other illuminated traffic control devices. Pedestrian signals reduce pedestrian crashes, especially when leading pedestrian intervals and/or countdown signals (shown in the image) are incorporated.

Basic design parameters

The absolute minimum walk time (illuminated walking figure or "WALK" text) is 7 seconds, but in most cases should be longer. Signal timing should allow pedestrians to cross the entire street in one cycle. Two-stage crossings may be implemented in situations where non-compliance would otherwise result (such as crossing wide, multi-lane roads). The use of continually-flashing beacons should be avoided; rapid-flash beacons, traditional traffic signals, or HAWK signals are preferred.



HAWK signal (left) and a pedestrian countdown signal (right).

Pedestrian facility design guidelines and resources

The following manuals and guidelines should be referenced when designing pedestrian facilities and treatments:

1. The Iowa Department of Transportation Design Manual;
2. The Iowa Department of Transportation Bridge Design Manual;
3. Iowa Statewide Urban Design and Specifications (SUDAS);
4. Manual on Uniform Traffic Control Devices (Federal Highway Administration);
5. Guide for the Planning, Design, and Operation of Pedestrian Facilities (American Association of State Highway and Transportation Officials);
6. Public Rights-of-Way Accessibility Guidelines (United States Access Board);
7. Designing Walkable Urban Thoroughfares: A Context Sensitive Approach: An ITE Recommended Practice (Institute of Transportation Engineers);
8. Urban Street Design Guide (National Association of City Transportation Officials);
9. FHWA Pedestrian Safety Guide and Countermeasure Selection System (PedSafe); and
10. FHWA Bicycle and Pedestrian Information Center.

Bicycle planning and design

Bicycling is a varied activity that serves many purposes. Traditionally, bicycle trips have been categorized as either recreation or transportation, but this greatly oversimplifies things. People ride bicycles to make short trips to stores, school, and a variety of other destinations. They commute to work by bicycle. They go on recreational rides on rural roads or local multi-use trails. Some people make long multi-day trips to another city or state or ride hundreds of miles in a single day for recreational purposes. Some ride alone while others carry children or even a week's worth of groceries in trailers or on cargo bicycles. Quite often, trips serve both recreation and transportation purposes.

There is also a wide range in the types of people who bicycle. There is no minimum or maximum age for riding a bicycle and people of all abilities ride for leisure and mobility (often on tricycles, which are significantly wider than the standard bicycle). There is also variability in how comfortable people are mixing with motor vehicle traffic, with some only willing to bicycle on multi-use trails while others are comfortable on high-traffic urban arterial streets. Bicycling is truly one of the most varied modes of transportation and adequately accommodating it requires identifying solutions that benefit the majority of current and potential bicyclists and the different types of trips they make.

4.9 Bicycling in rural contexts

People who bicycle in rural areas are generally experienced interacting with motor vehicle traffic. They also tend to ride longer distances and are better equipped—literally and figuratively—for the rigor of riding in less-populated areas with higher-speed traffic. There are some exceptions to this, however, so it cannot be assumed that all rural bicyclists are comfortable mixing with anything more than minimal traffic.

Current conditions

Conditions for bicyclists on paved rural roads vary depending on traffic volumes and the presence and design of paved shoulders. While motor vehicle speeds, road geometry, and truck traffic also factor in, a rule of thumb is that most experienced adult bicyclists are comfortable using paved roads without paved shoulders (i.e., mixing with motor vehicle traffic) if traffic volumes are below 1,000 to 1,500 AADT. Above this AADT threshold, paved shoulders are increasingly important. American Association of State Highway and Transportation Officials (AASTHO) 2012 standards dictate a minimum effective paved shoulder width (clear pavement between the rumble strip and edge of pavement) of 4 feet (5 feet if adjacent to a curb, barrier, or railing) for use by bicyclists.

Most of Iowa's paved roads—including roads with traffic volumes exceeding 1,500 AADT—do not have paved shoulders. Lower volume roads and higher volume roads that were constructed prior to current standards typically have earthen or granular shoulders. Some of these roads do have paved shoulders, but they are typically between 2 and 4 feet in width and usually have a 12 to 16-inch milled rumble strip placed 6 to 12 inches from the lane edge line. As a result, few existing paved shoulders provide the 2012 AASHTO minimum usable (or effective) width of 4 feet.

Current standards include installing milled rumble strips within new and retrofitted paved shoulders. The current standard design dictates a 12-inch wide rumble strip placed 6 inches from the lane edge line for all roads other than Interstate highways. Many of the paved shoulders recently built along Iowa roads are the default width of 4 feet or narrower, in some cases. The placement of rumble strips on 4-foot shoulders reduces the usable or effective shoulder width to 2 feet 6 inches or less, which is less than the 2012 AASHTO minimum effective width of 4 feet. In other words, many of the new paved shoulders in Iowa are inadequate for bicyclists according to 2012 AASHTO standards. However, when Iowa DOT installs 6-foot wide shoulders with rumble strips (required for roads with traffic volumes exceeding 5,000 AADT), the effective width for bicyclists is an adequate 4 feet 6 inches.

In summary, bicyclists need 4 feet of usable or effective paved shoulder width (not including rumble strips) when traffic volumes exceed 1,000 to 1,500 AADT, but Iowa DOT's current standards only provide 4 feet of effective paved shoulder width on roads with traffic volumes between 3,000 and 5,000 AADT and 2 feet for roads with volumes less than 3,000 AADT.

It bears mentioning that most of the Iowa DOT District offices do not regularly sweep, blow, or otherwise clean paved shoulders of rocks, glass, tire shreds, or small debris. However, if a District office receives a complaint, they typically send a sweeper or blower out to clean up the shoulder. Based on comments received from District staff and other stakeholders, it seems that cyclists rarely file official complaints or requests for maintenance.

Accommodations approach

The Complete Streets Policy will necessitate considering the need for bicycle accommodations in rural areas. However, context is important. On very low-traffic rural roads, very little accommodation is needed other than perhaps wayfinding and regulatory signage (e.g., "Bikes May Use Full Lane"), which is relatively inexpensive. On higher-traffic roads, paved shoulders will be required. Along with adopting the Complete Streets Policy, the Iowa DOT will need to revise its Design Manual to better accommodate bicyclists using paved shoulders. Selecting the appropriate bicycle accommodation type should be based on context (traffic volume, speed, etc.). The facility selection matrices provided later in this chapter provide guidance in this process.

4.10 Bicycling in urban and suburban contexts

Many people think of urban bicycle trips as primarily "commuting" trips (bicycling to and from work). However, as reported by the 2009 National Household Travel Survey (NHTS) for Iowa, nearly twice as many bicycling trips are made for utilitarian purposes (shopping, visiting friends, social events, etc.) than for getting to work. These utilitarian trips are often multi-destination and frequently involve children. This relates to motor vehicle trips, of which the NHTS reports approximately 80 percent are for utilitarian (non-work-related) purposes. Bicycling for utilitarian purposes also has the greatest room for growth. Furthermore, enabling more people to make non-journey-to-work trips by bicycle instead of by car has the ability to significantly reduce motor vehicle traffic congestion and emissions (according to the NHTS, 42 percent of car trips in Iowa are 2 miles or less—this distance is easily covered by bicycle).

Current conditions

Transportation infrastructure—especially expressways and railroads—can pose major barriers for bicycle mobility in cities and suburbs. Iowa DOT has built a number of bicycle and pedestrian overpasses and other crossings to help minimize these barriers. The inclusion of overpasses varies across the state, but is generally considered a primary part of major expressway projects in the more populated regions, such as the Des Moines area. Speeds are lower in cities making streets more suitable for biking along and across.

Urban bicycle infrastructure varies from community to community. In general, urban sections of primary, secondary, and municipal roads do not have shoulders—rather, travel or parking lanes are adjacent to the curb and gutter, sometimes with minimal offsets. In some cities—specifically those that have made concerted efforts to improve conditions for bicycling—dedicated bike lanes and other types of facilities are present.

However, a lack of bike lanes does not necessarily indicate poor conditions for bicycling. Low-volume streets, such as those commonly found in cities with gridded street networks, are often ideal for bicycling. Some low volume streets are ideal for bicycle travel and are candidates for designation as "bicycle boulevards." A bicycle boulevard is a low stress street, typically with traffic calming elements such as traffic circles, speed humps, curb extensions, and chicanes, where bicyclists are drawn away from the high-volume streets.

Bicycle accommodations in the form of bike lanes can be found on primary and secondary roads in some cities, typically where the local municipality has requested accommodation from Iowa DOT or the county.

Accommodations approach

Thinking of urban bicycling in terms of utilitarian trips indicates the need to reconsider the approach to providing accommodations and planning bicycling networks. With a focus on commuting bicycle trips and recreational riding, the traditional approach to bicycle accommodation in urban areas has been to guide bicyclists to low-traffic streets and multi-use trails. However, when considering the utilitarian purpose of bicycling, it is important to also provide adequate accommodations along streets on which destinations are located, even on streets with higher traffic volumes. Context-sensitive bicycle accommodations (such as buffered bike lanes) will need to be provided to ensure a low- to moderate-stress bicycling experience along higher-traffic streets.

The approach to increasing bicycle accommodations in urban and suburban contexts has several components and is opportunity-driven; that is, the vast majority of accommodations should be provided as part of larger street and highway projects. The approach includes four components:

1. The Complete Streets Policy calls for the inclusion of context-sensitive bicycle facilities when urban and suburban streets that are on the state highway system are reconstructed or newly constructed, unless extenuating circumstances make doing so unfeasible. In addition, cities, counties, and regional agencies are strongly encouraged to adopt and implement similar Complete Streets policies.

2. Selecting the appropriate bicycle accommodation type should be based on context (traffic volume, speed, etc.). The facility selection matrices provided later in this chapter provide guidance in this process.

3. For streets that have high levels of bicyclist demand or disproportionate levels of bicyclist crashes, yet are not going to be reconstructed or subject to 3R activities for a significant period of time, communities are encouraged to provide short-term solutions as stand-alone projects, such as retrofitting bike lanes, adding shared lane markings and measures to reduce motor vehicle speeds, or designating low-traffic parallel streets as bike routes.

4. Opportunities to develop standalone bicycle connections (such as multi-use trails that serve transportation purposes or connecting cul-de-sacs to nearby thoroughfares) should be sought. Projects that help improve bicycle access and connectivity should be prioritized for funding.

However, bicycle planning should not always be project-driven; rather it should occur on a community-wide basis (see “Planning the Network” later in this section).

Equity

It is important to consider equity in the transportation system. Planning and building bicycle infrastructure often results in some neighborhoods being underserved compared to others. Many lower-income people bicycle (or walk) out of necessity, whether because they lack access to a motor vehicle or are poorly served by transit. However, lower-income neighborhoods are often underserved in many ways, including bicycle infrastructure. Furthermore, post-war neighborhoods, which tend to have very car-dependent development patterns, are also often underserved by bicycle networks. Providing adequate bicycle accommodations in underserved areas not only increases equity, it also can help encourage people to drive less and bicycle more.

4.11 Planning bicycle networks

Bicycle networks should be continuous, connect seamlessly across jurisdictional boundaries, and provide access to destinations. Destinations for utilitarian trips are constant, irrespective of trip mode (especially in urban areas). In other words, anywhere a person would want to drive for utilitarian purposes is a potential destination for bicycling. This is especially true in urban areas. As such, planning connected low-stress bicycle networks is not achieved by simply avoiding motor vehicle traffic. Rather, planners should identify solutions for lowering stress along higher-traffic corridors so that bicycling can be a viable transportation option for the majority of the population.

The Iowa DOT recommends that cities, counties, and regional agencies work cooperatively to plan local and regional bicycle networks based on the following guidelines:

- First and foremost, it is strongly recommended that each jurisdiction adopts a Complete Streets policy similar to the Iowa DOT's Complete Streets policy outlined in Chapter 6. This will ensure that all streets include adequate, context-sensitive bicycle accommodations.
- The core of a local or regional bicycle network is typically a system of long distance/regional routes along low-stress bikeways. Interconnected multi-use trails often serve as the foundation for this system, but it is also necessary to identify potential connections along streets. Each city should strive to develop a grid of bikeways and each MPO/RPA should develop a network of regional routes that connect surrounding cities.
- Bicycle transportation is dependent on access to local destinations, many of which are located along higher-traffic arterial streets. Adequate, context-sensitive accommodations should therefore be provided along these streets. If continuous accommodations are not feasible, accommodations should be provided to the extent possible and be connected with routes along parallel lower-traffic streets.
- For longer trips or for bicyclists that do not need to access as many destinations, alternative parallel routes along low-traffic streets should be provided. These can be in the form of bicycle boulevards/neighborhood greenways, which prioritize bicycle travel and often include traffic calming, or simply as signed routes.
- Bicycle network plans should strive to make every street bicycle friendly in high-activity areas, such as downtowns, university campuses, etc.
- Each network plan should identify necessary accommodation types (bike lanes, sidepaths, cycle tracks, etc.) for each collector and arterial street based on traffic volumes, speeds, and other factors using the Facility Selection Matrix provided at the end of this chapter. Plans should also consider how accommodations can be implemented (such as through removing unnecessary travel or parking lanes, narrowing lanes, or simply adding pavement markings).

While the Complete Streets Policy will ensure that the inclusion of bicycle accommodations is considered for all rural state highways, there is still much value in rural bicycle network planning on the local and regional levels. As described earlier in this Chapter, rural roads in the urban periphery are the most stressful for bicyclists. Local, countywide, and regional bicycle plans can improve access from cities to low-traffic rural roads by identifying key connecting roads that need accommodations.

For state highways not slated for reconstruction or 3R activities in the near future, network plans can identify where short-term retrofits are needed and warranted. For county roads, which are not subject to the Complete Streets Policy, a rural network plan can identify those roads that need accommodation (whether long-term as part of reconstruction or short-term as retrofits) and can identify potential funding strategies.

Chapter 5: Statewide Network Recommendations outlines the vision for a statewide multi-use trail system as well as a system of interstate bikeways (US Bicycle Routes, the Mississippi River Trail, and the Lewis and Clark Trail), upon which counties, regional agencies, and multi-jurisdictional partnerships can build.

4.12 Bicycle facilities

There is a wide variety of bicycle facilities available, including several types of on-road bikeways and separated multi-use trails. There are also spot treatments and intersection improvements that can be implemented to improve the experience for people bicycling, encourage more walking, and decrease the number of crashes that occur. The following summarizes the most common facilities and treatments and provides key design guidance. However, designers should consult the latest version of the Iowa DOT Design Manual or the Iowa Statewide Urban Design and Specifications (SUDAS), as well as national standards and guidelines, which are listed at the end of this section.

Multi-use trails and sidepaths

A multi-use trail (MUT) is a two-way facility physically separated from motor vehicle traffic and used by pedestrians, bicyclists, and other non-motorized users. This type of facility provides recreational opportunities in addition to transportation. The cost of MUTs typically greatly exceeds the cost of sidewalks and on-road bikeways since they often require right-of-way acquisition and drainage changes. While mostly separated from motor vehicle traffic, MUTs that run parallel to streets and roads (referred to as “sidepaths”) can be high-stress accommodations for bicyclists depending on the design of driveway and street crossings and number of crossings per mile.

Basic design parameters

The minimum width for a MUT is 10 feet, while 8 feet is acceptable for short distances under physical constraint (or the current standard as specified in the Iowa DOT Design Manual or SUDAS). Additional width can be provided to accommodate high volumes and separated parallel paths can be provided to reduce conflicts between bicyclists and pedestrians. The geometric design of MUTs must be based on a typical design speed for bicyclists (typically 18 miles per hour). Sidepaths may not be appropriate where there are many commercial driveway crossings and/or intersections per mile.

Paved shoulders

Paved shoulders benefit all road users. The additional pavement width outside of the travel lanes reduces run-off-road crashes, aids maintenance, and provides space for bicyclists. Pedestrians often use paved shoulders, although they are not designed as pedestrian facilities and typically do not meet accessibility requirements. Additional benefits include reducing pavement edge deterioration, accommodating oversize and maintenance vehicles, and providing emergency refuge for public safety vehicles and disabled vehicles.

Basic design parameters

The minimum functional width for a paved shoulder used by bicyclists is 4 feet (especially if placed between rumble strips and the edge of pavement). On lower-traffic roads, a narrower 3-foot wide shoulder can be provided immediately adjacent to the travel lane if rumble strips are omitted or placed at the outside edge of the shoulder. The width of a paved shoulder is dependent on traffic volumes and speeds.

Bike lanes

Bike lanes are on-road bikeways designated for exclusive use by bicyclists through pavement markings and signs (optional). They are typically applied to arterial and collector streets with moderate traffic volumes and/or speeds. Bike lanes are usually applied on both sides of a street, but can be applied individually as contra-flow lanes on one-way streets or climbing lanes on streets with limited pavement width. Buffers (as shown in the below right image) can be placed between the bike lane and travel lane and/or parking lane to provide additional separation. When placing next to on-street parking, the potential risk of “dooring” exists and should be mitigated by striping wider lanes, door zone pavement markings, or buffers.

Basic design parameters

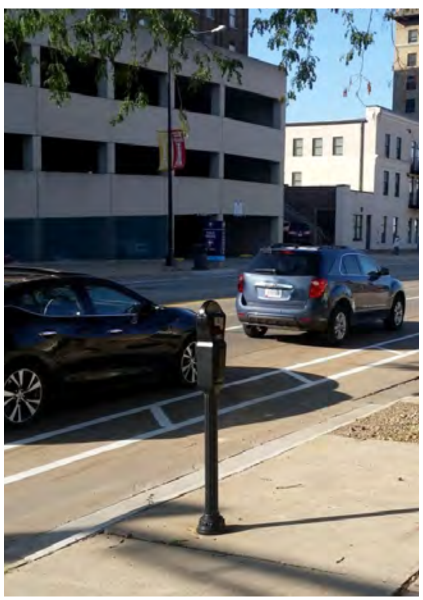
Bike lanes are typically 5 feet wide and have a minimum width of 4 feet not including the gutter (or the current standard as specified in the Iowa DOT Design Manual or SUDAS).

Separated bike lanes

Separated bike lanes, also called cycle tracks or protected bike lanes, are exclusive bicycle facilities separated from motor vehicle traffic and pedestrians by way of physical barriers (curbs, parked cars, medians, etc.). They can be raised or built at road grade and may be two-way, especially on one-way streets (far left image). They are primarily applied to streets with high motor vehicle traffic volumes/speeds but may also be applied to streets with moderate motor vehicle traffic but high bicycle traffic.

Basic design parameters

The design of separated bike lanes is very complicated, especially at intersections and their approaches. A one-way separated bike lane must be at least 5 feet wide and 7 feet wide to allow passing. A two-way separated bike lane must be at least 8 feet wide but preferably 10 or 12 feet wide.



Bicycle boulevards

Bicycle boulevards follow lower volume, lower speed streets designed to prioritize bicycle through travel and calm motor vehicle traffic. They are generally suited for people of all ages and abilities and are relatively easy and cost-effective to implement. Bicycle boulevards may simply include shared lane markings and “bikes may use full lane” signage or can include traffic calming measures such as street trees, traffic circles, chicanes, and speed humps. Intersections should prioritize bicycle movement and minimize stops, where possible.

Basic design parameters

Target speeds are typically around 20 miles per hour; there should be a maximum 15 mile per hour speed differential between bicyclists and vehicles. The preferred motor vehicle traffic volume is up to 1,500 cars per day and the recommended maximum is 3,000 cars per day.

Shared roads and shared lanes

Where traffic volumes and speeds are low, many bicyclists can comfortably share lanes with motor vehicles. In rural areas, no treatments are usually needed, although wayfinding signage is beneficial. On urban streets with moderate traffic volumes, shared lanes usually include shared lane markings (or "sharrows") to indicate preferred bicyclist lane positioning, act as wayfinding aids, and alert drivers to a greater expected presence of bicyclists.

Basic design parameters

In rural areas, shared roads should have traffic volumes below 1,500 ADT. In urban areas, shared lanes should be provided on streets with posted speed limits of 35 miles per hour or less and ADT less than 3,000. Higher speeds and traffic volumes may discourage bicyclists.

Bike routing and wayfinding

Wayfinding is a system of signs and pavement markings that guide bicyclists along preferred routes (which may or may not be numbered) to destinations across cities, regions, and states. Signs may state distance to destinations or include route numbers. Wayfinding generally improves the usefulness of bicycle networks, especially when routes are diverted away from well-known streets.

Basic design parameters

First and foremost, sign design and placement must be according to the Manual on Uniform Traffic Control Devices (MUTCD). Signs should state the direction and distance to important destinations. Distance can be provided in miles or minutes of riding (the latter is recommended only in urban areas). In addition, wayfinding can take the form of route signs, directing bicyclists at each turn. Such wayfinding can enhance the usability of long-distance routes, such as the Mississippi River Trail or planned US Bicycle Routes.

Bikeway intersection pavement markings and signal design

Intersections should be optimized to accommodate bicyclists by enhancing pavement markings and ensuring signals serve the needs of bicyclists. Enhanced pavement markings warn users of potential conflict locations, help define expected behaviors, and encourage turning motorists to yield to bicyclists. Improved signal designs provide adequate time for bicyclists to clear signalized intersections, minimize bicyclist delay, and increase the likelihood that bicyclists will comply with the signal.

Basic design parameters

The selection of specific treatments varies based on factors such as motor vehicle traffic volume, bicycle traffic volume, and intersection geometry. Bicycle-specific signals (far left image) may be used and have received interim approval from FHWA.

Bicycle facility design guidelines and resources

The following manuals and guidelines should be referenced when designing bicycle facilities and treatments:

1. The Iowa Department of Transportation Design Manual;
2. The Iowa Department of Transportation Bridge Design Manual;
3. Iowa Statewide Urban Design and Specifications (SUDAS);
4. Manual on Uniform Traffic Control Devices (Federal Highway Administration);
5. A Policy on Geometric Design of Highways and Streets (American Association of State Highway and Transportation Officials);
6. Guide for the Development of Bicycle Facilities (American Association of State Highway and Transportation Officials); and
7. Urban Street Design Guide (National Association of City Transportation Officials).

4.13 Facility selection

Motor vehicle traffic volume and speed are critical contextual considerations for bicyclist and pedestrian safety and comfort. Proximity to motor vehicle traffic is a significant source of stress, safety risks, and discomfort for bicyclists, and corresponds with sharp rises in crash severity and fatality risks for vulnerable users when motor vehicle speeds exceed 25 miles per hour. Furthermore, as motorized traffic volumes increase, it becomes increasingly difficult for motorists and bicyclists to share roadway space.

Two tools are provided to help planners and engineers determine appropriate types of bicycle and pedestrian accommodations for any given context.

The first tool is a pair of bicycle facility selection matrices that provide guidance on selecting an appropriate facility type based on posted speed limit, traffic volume, and context.

The second tool is a table of context characteristics of common facility types (Table 4.2), which summarizes various attributes of the primary bicycle and pedestrian facility types used in Iowa and provides additional guidance on facility selection.

Bicycle facility selection matrices

Numerous types and widths of bicycle facilities are available and some are more appropriate than others for any given context. To select an appropriate facility based on traffic volume and speed, Figure 4.15 and Figure 4.16 should be consulted. These matrices include preferred and acceptable values for each facility type. Designers should utilize forecast traffic volumes if available. Additionally, designers should default to selecting the preferred facility when possible.

Context characteristics of common facility types table

Table 4.2 provides several pieces of critical information that provide guidance for the selection of appropriate bicycle and pedestrian facility types:

Description – What the facility type is and how it should be applied.

Intended Users – Whether the facility type accommodates bicyclists, pedestrians, or both.

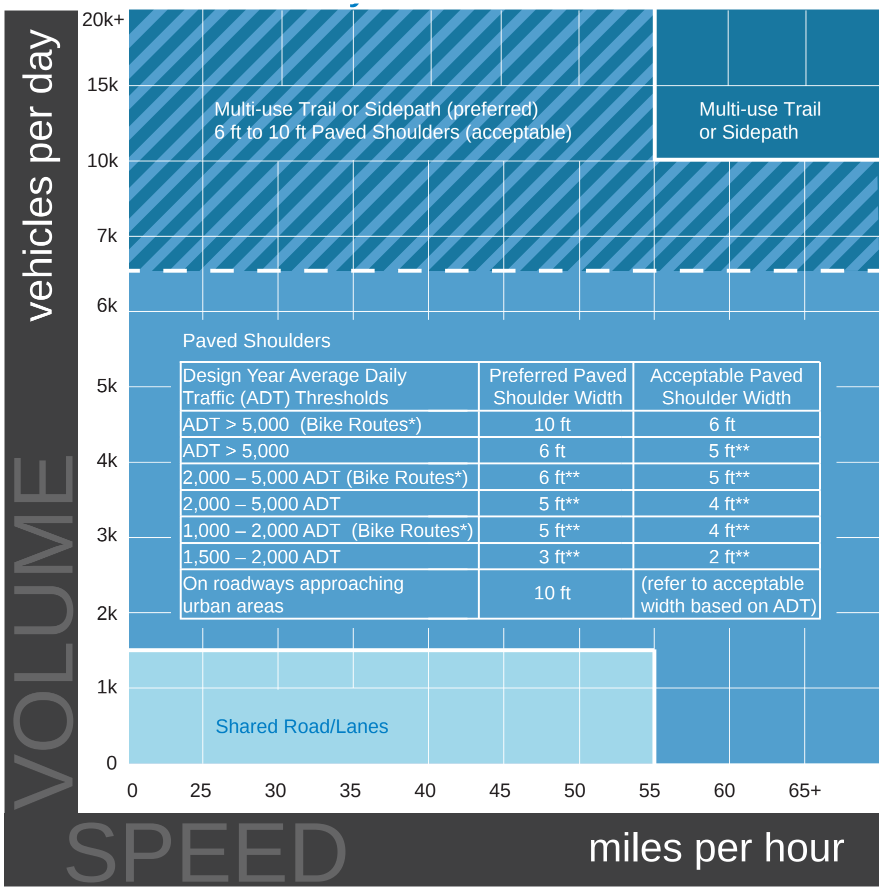
Context – Whether the facility type is appropriate in urban settings, rural areas, or both. Specific mention is made if the facility is appropriate in the urban periphery but not in true urban areas.

Posted Speed Limit – The maximum speed limit with which the facility type is compatible.

Motor Vehicle Traffic Volume – The maximum traffic volume (in average Annual Daily Traffic or ADT) with which the facility type is compatible. These thresholds are generalized. Especially in urban areas, factors such as outside lane width, percent of heavy truck traffic, speed limit, and presence of on-street parking can have significant effects on the appropriateness of a facility. For urban areas, the designer should calculate the Bicycle Level of Traffic Stress (LTS) score to determine whether the facility is appropriate (i.e., receiving a score of LTS 1 or LTS 2).

Other Considerations – Further information regarding the appropriateness of each facility type.

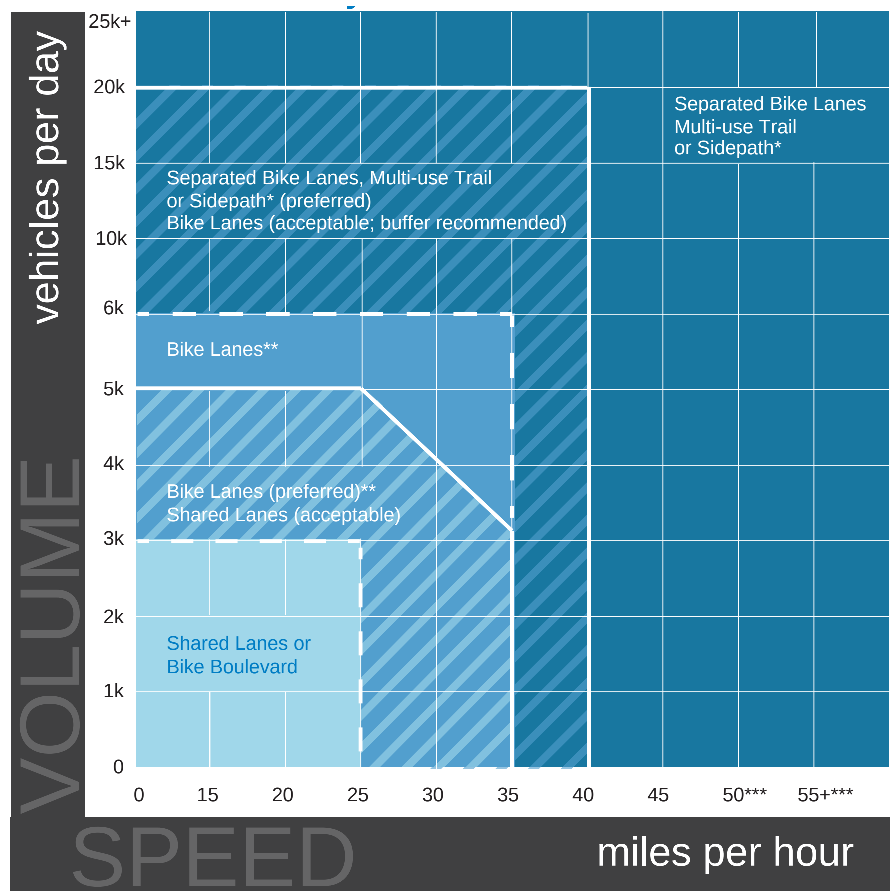
Figure 4.15: Rural facility selection matrix



Design Year Average Daily Traffic (ADT) Thresholds	Preferred Paved Shoulder Width	Acceptable Paved Shoulder Width
ADT > 5,000 (Bike Routes*)	10 ft	6 ft
ADT > 5,000	6 ft	5 ft**
2,000 – 5,000 ADT (Bike Routes*)	6 ft**	5 ft**
2,000 – 5,000 ADT	5 ft**	4 ft**
1,000 – 2,000 ADT (Bike Routes*)	5 ft**	4 ft**
1,500 – 2,000 ADT	3 ft**	2 ft**
On roadways approaching urban areas	10 ft	(refer to acceptable width based on ADT)

*On roadways where a higher level of bicycle traffic is expected (e.g., bike routes identified by cities, counties, RPAs, and MPOs, as well as official US Bicycle Routes and national trails).
**Paved width exclusive of rumble strips.

Figure 4.16: Urban and suburban facility selection matrix



*To determine whether to provide a multi-use trail/sidepath or separated bike lane, consider pedestrian and bicycle volumes or, in the absence of volume, consider land use.
**Advisory bike lanes may be an option where traffic volume < 4,000 ADT
***Speeds 50 mph or greater in urban areas are typically found in urban/rural transition areas.

Table 4.2: Context characteristics for common facility types

	Multi-Use Trails and Sidepaths	Paved Shoulders	Shared Roads/Lanes
Description	Multi-use trails and sidepaths are typically designed as two-way facilities physically separated from motor vehicle traffic and used by bicyclists, pedestrians, and other non-motorized users. The term "sidepath" refers to a multi-use trail along a roadway.	Additional pavement width outside of the travel lanes that reduce crashes, aid maintenance, and provide space for bicyclists and pedestrians (although paved shoulders typically do not meet accessibility requirements for pedestrians).	Shared roads or shared lanes are standard travel lanes shared by bicyclists and motor vehicles. Signage and shared lane markings (also known as "sharrows") should be used on higher-traffic shared roads.
Intended Users	Bicyclists and Pedestrians	Bicyclists	Bicyclists
Context	Urban and Rural	Rural and Urban Periphery	Urban and Rural
Posted Speed Limit*	Urban: Any speed (typically 30 mph or higher) Rural: Any speed (typically 55 mph or higher)	Any speed (typically 45 mph or higher)	Urban: 25 mph or lower (preferred); 35 mph or lower (acceptable) Rural: 55 mph or lower
Motor Vehicle Traffic Volume*	Urban: Any volume (typically 15,000 ADT or greater) Rural: Any volume (typically 6,500 ADT or greater).	6,500 ADT or lower (preferred) Any volume (acceptable) Shoulder width to accommodate bicyclists depends on traffic volume. See Figures 4.14 and 4.15 for guidance on selecting appropriate width.	Urban: 3,000 ADT or lower (preferred) 5,000 ADT or lower (acceptable) Rural: 1,500 ADT or lower
Other Considerations	Sidepaths should be at least 10 feet wide (wider where higher bicycle and pedestrian traffic is expected, e.g., urban areas). Special consideration must be given to the design of roadway crossings to increase visibility, clearly indicate right-of-way, and reduce crashes. Alternative accommodations should be sought when there are many intersections and commercial driveway crossings per mile.	Provides more shoulder width for roadway stability. Shoulder width should be dependent on characteristics of the adjacent motor vehicle traffic. Placement of the rumble strip is critical to providing usable space for bicyclists and pedestrians.	May be used in conjunction with wide outside lanes. Explore opportunities to provide parallel facilities for less confident bicyclists. Where motor vehicles are allowed to park along shared lanes, place markings to reduce potential conflicts with opening car doors. On low speed (<25 mph) low traffic (<3,000 ADT) streets, traffic calming and diversion can be used to slow traffic or create a "bicycle boulevard.

* Speed and traffic volume are interrelated and must be considered together when selecting an appropriate facility for bicyclists. Typically, as speeds increase, the traffic volume threshold for providing separation (e.g., via a multi-use trail or separated bike lanes) decreases. Refer to Figures 4.15 and 4.16 for guidance in considering both variables.

	Separated Bike Lanes	Bike Lanes & Buffered Bike Lanes	Sidewalks
Description	Separated bike lanes, also known as cycle tracks, are physically separated by a vertical element from the adjacent motor vehicle lanes. Buffered bike lanes that do not include a vertical element are not considered separated bike lanes.	4- to 6-foot wide lanes designated for exclusive use by bicyclists. Typically applied to arterial and collector streets where volumes and/or speeds would otherwise discourage bicycling. May include striped buffers (typically 18 inches to 3 feet in width) for further separation.	A pedestrian walkway located within public right-of-way, typically adjacent to property lines. Sidewalks provide vertical and/or horizontal separation between vehicles and pedestrians and are the most common pedestrian facility type.
Intended Users	Bicyclists	Bicyclists	Pedestrians
Context	Urban	Urban	Urban and Urban Periphery
Posted Speed Limit*	Any speed, typically 30 mph or higher	35 mph or lower (preferred) 40 mph or lower (acceptable; buffer preferred above 35 mph)	Any speed
Motor Vehicle Traffic Volume*	Any volume (typically 6,000 ADT or greater)	6,000 ADT or lower (preferred) 20,000 ADT or lower (acceptable; buffer preferred above 10,000 ADT)	Any volume
Other Considerations	Separation can be achieved through a vertical curb, a parking lane, flexposts, plantings, removable curbs, or other measures. Special attention should be paid to intersection treatments. "Protected intersection" design should be incorporated to the extent possible.	Painted buffers are encouraged when roadway width allows, regardless of traffic speeds and volumes. Where on-street parking is adjacent to a bike lane, provide a bike lane of sufficient width to reduce probability of conflicts due to opening vehicle doors and objects in the road. In locations with high on-street parking turnover, consider placing buffers between the parking lane and bike lane. Analyze intersections to reduce bicyclist/motor vehicle conflicts.	Sidewalks should be provided as the default pedestrian accommodation within communities. When retrofitting sidewalks in a community, it is best to first concentrate on busier streets and around places where walking is more common: schools, transit stops, commercial areas, etc. Sidewalks should be a minimum of 4 feet wide in residential areas and 5 feet wide along arterial and collector streets.