APPENDIX C

Purpose and Need Report

US 51 (Stoughton Road) North Study

Purpose and Need

May 24, 2023

CONTENTS

Tables

Figures

List of Acronyms

AADT	average annual daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
DSD	decision sight distance
FAA	Federal Aviation Administration
FDM	Facilities Development Manual
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
HIN	high injury network
LOS	level of service
MEV	million entering vehicles
MPO	metropolitan planning organization
NHS	National Highway System
PCI	pavement condition index
PVRPLA	pavement replacement
RPZ	runway protection zone
SSD	stopping sight distance
TIP	transportation improvement program
TOPS	traffic operations and safety laboratory
TRB	Transportation Research Board
WIS	Wisconsin
WSOR	Wisconsin and Southern Railroad

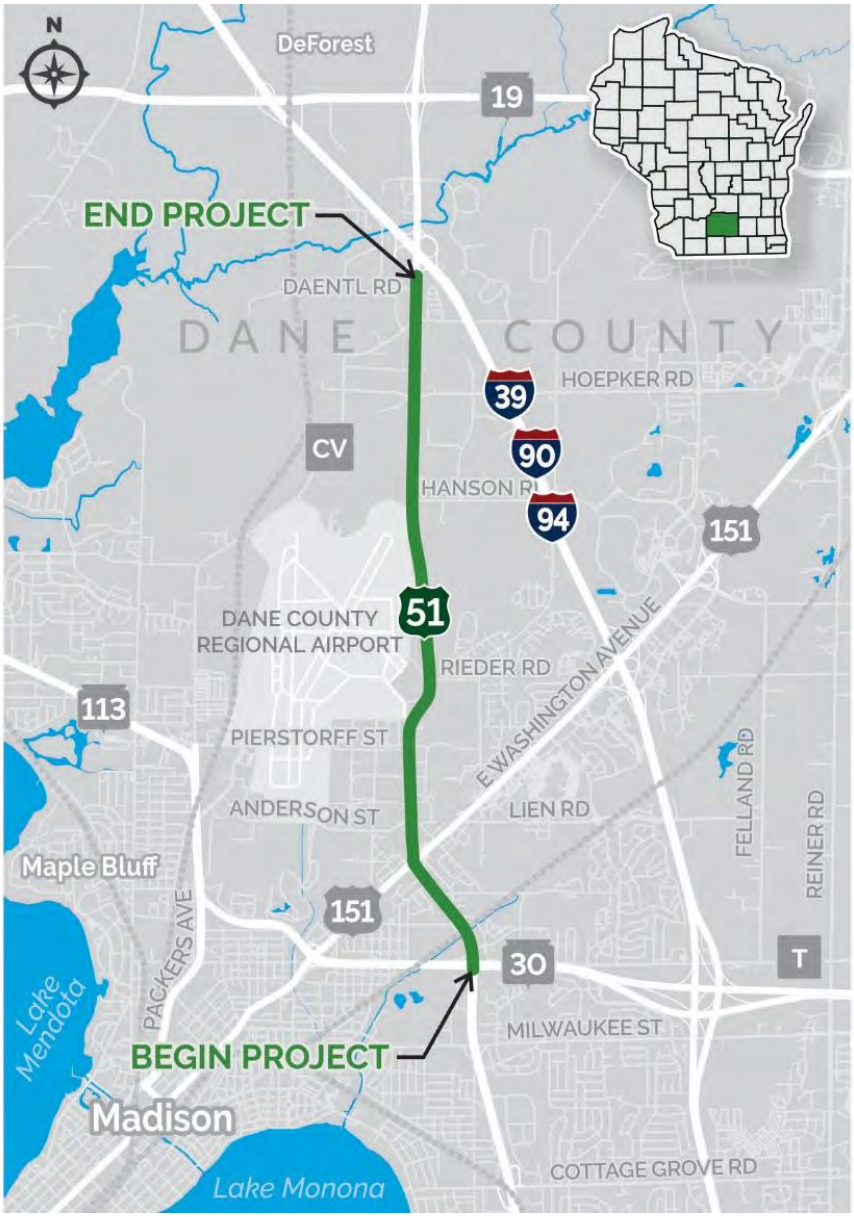
Note: This purpose and need document is built from the best available in-hand data as of the date listed on the title page. Future year no-build level of service information is preliminary, with results pending review by WisDOT. All current findings in the purpose and need are to be considered preliminary.

1.0 Project Description

1.1. Study Location and Description

The Wisconsin Department of Transportation (WisDOT) is evaluating reconstruction of US 51/Stoughton Road, referred to as US 51 hereafter, from WIS 30 in the city of Madison to Interstate 39/90/94 in the town of Burke, a distance of approximately 5.2 miles. The study area is located in central Dane County, Wisconsin. See Figure 1-1: Study Location Map.

Figure 1-1: Study Location Map



US 51 is a primary north-south facility on the east side of Madison, providing access to numerous industrial, residential, and commercial business developments, schools, medical facilities, and recreational areas. US 51 is a National Highway System (NHS) route and identified as a principal arterial. Year 2022 average annual daily traffic (AADT) volumes range from 13,300 to 28,200 vehicles per day within the study area north of WIS 30. Traffic volumes increase to 47,280 vehicles per day south of the WIS 30 interchange.

The number of lanes on US 51 varies throughout the corridor. There are three lanes in each direction from WIS 30 to US 151/East Washington Avenue, two lanes northbound and three lanes southbound from US 151/East Washington Avenue to Anderson Street, and two lanes in each direction from Anderson Street to I-39/90/94.

Speed limits range between 35 mph and 55 mph. Between US 151/East Washington Avenue and Anderson Street (0.3 miles), the speed limit is 35 mph. Between Rieder Road and Hoepker Road (2 miles), the speed limit is 55 mph. Everywhere else along the corridor (2.9 miles), has a 45-mph speed limit. Land use transitions from industrial uses north of Hanson Road to a more urbanized commercial corridor south of Pierstorff Street.

Interchanges are located at both ends of the project, WIS 30 to the south and I-39/90/94 to the north. There are 14 at-grade intersections on US 51 in the study area, including the WIS 30 ramp terminals. The I-39/90/94 ramp terminals are being studied as part of the I-39/90/94 Corridor Study (US 12/18 Madison to US 12/WIS 16 Wisconsin Dells), see Figure 1-2: Adjacent Studies and Projects.

The US 51 (Stoughton Road) North Study is part of the broader US 51 corridor providing regional and statewide transportation mobility throughout Wisconsin. US 51 is one of the busiest north-south routes in the city of Madison serving as a vital arterial highway on the city's east side, providing links to I-39/90/94, US 151/East Washington Avenue and WIS 30.

US 51 is a component of the National Highway System (NHS) throughout the study limits. According to the Federal Highway Administration (FHWA), "the NHS includes the Interstate Highway System as well as other roads important to the nation's economy, defense and mobility." NHS routes are also intended to provide a high level of safety, design, and operational standards. US 51 within the study limits is part of the US 51 "Alternate Interstate Highway Route" which is an alternate route when incidents occur on I-39/90/94 that require the rerouting of traffic.

1.2. Regulation Compliance

The US 51 (Stoughton Road) North Study is consistent with FHWA regulations at 23 Code of Federal Regulations (CFR) 771.111(f). Requirements state:

- The study connects logical termini and is of sufficient length to address environmental matters on a broad scope.
- The study has independent utility and will be a reasonable expenditure of funds even if no additional transportation improvements in the area are made.
- The study does not restrict the consideration of alternatives for other reasonably foreseeable transportation improvements.

1.3. Logical Termini

The proposed improvements connect logical termini and are of sufficient length to address environmental matters on a broad scope. The southern terminus is located at the US 51 and WIS 30 interchange. This location was selected as a logical terminus because of the change in traffic volumes (Year 2022 roadway volumes increase south of WIS 30, from 28,200 to 47,280 vehicles per day). The US 51 (Stoughton Road) South Study limits match this terminus.

The northern terminus is located at the I-39/90/94 interchange. This location was selected as a logical terminus because north of WIS 19, US 51 needs have been addressed through the construction of a five-mile-long freeway section completed in 2015. The triangular area between the I-39/90/94 interchange and WIS 19 is part of the I-39/90/94 Corridor Study analysis area.

1.4. Adjacent Studies and Projects

Adjacent studies and projects in the area require close coordination. There are four ongoing studies/projects that impact the US 51 (Stoughton Road) North Study. The location of these studies and projects are shown in Figure 1-2: Adjacent Studies and Projects.

They include:

- **US 51 (Stoughton Road) South Corridor Study** – This study extends approximately 4.7 miles from Voges Road/Terminal Drive in the Village of McFarland to WIS 30 in the city of Madison. The study is investigating alternatives to improve safety, operations, and infrastructure for all modes of travel and is anticipated to be completed in the fall of 2025.
- **I-39/90/94 Corridor Study** - This study extends approximately 67 miles from the US 12/18 Beltline interchange in the city of Madison to the US 12/WIS 16 interchange in Wisconsin Dells. The study is investigating alternatives that will address existing and future traffic demands, safety issues, and aging and outdated infrastructure. It is anticipated to be completed in the fall of 2024.

- **US 51 Pavement Replacement Project** – This project extends approximately 0.8 miles from the US 151/East Washington Avenue intersection to the Pierstorff Street intersection in the city of Madison. The project will replace the pavement in the northbound lanes of US 51 and replace deficient curb ramps. The project is anticipated to begin in spring 2023 and be completed in fall 2023.

Figure 1-2: Adjacent Studies and Projects

1.5. Consistency with Local and Regional Plans

Several planning documents, including regional plans, citywide plans, neighborhood development plans, and special area plans, have been reviewed to maintain consistency and document planned improvements in and around the US 51 (Stoughton Road) North Study area. These documents include:

- Connect Greater Madison – Regional Transportation Plan 2050
- Regional Transportation Plan 2050
- Greater Madison MPO 2023-2027 Transportation Improvement Program (TIP)
- Vision Zero Madison Action Plan 2020-2035
- City of Madison - Complete Green Streets Guide (2022)
- City of Madison Comprehensive Plan – Imagine Madison (2018)
- Highway 51/19 District Plan (2022)
- Dane County Parks and Open Space Plan – Regional Trails Map
- Dane County Bicycle Map
- City of Madison – Passenger Rail Station Study (2023 in development)
- City of Madison – Transit-Oriented Development (2023 in development)
- Northeast Area Plan – (2023 in development)
- Hawthorne-Truax Neighborhood Plan (anticipated adoption 2023)
- Greater East Towne Area Plan (2022)
- Milwaukee Street Special Area Plan (2018)
- Hiestand Neighborhood Plan (2006)
- Hanson Road Neighborhood Plan (2021)

Potential Amtrak Service

Amtrak is considering expanding passenger rail in Wisconsin with a new station in Madison. Plans for a possible Amtrak expansion to Madison are in their early stages and include potential for up to eight round trip passenger rail trains per day. The route uses the existing Wisconsin Southern Railroad (WSOR) line that crosses US 51 between WIS 30 and Lexington/Commercial Avenue. If future Amtrak service is anticipated, or greater use of the railroad is planned, there may be a need to explore grade-separated options along US 51 at this location. The Railroad Grade Separation Analysis[1] provides additional information.

2.0 Purpose Statement

The purpose of the study is to accommodate existing and future travel demand with a focus on safety issues that affect travel on Stoughton Road.

3.0 Project Need

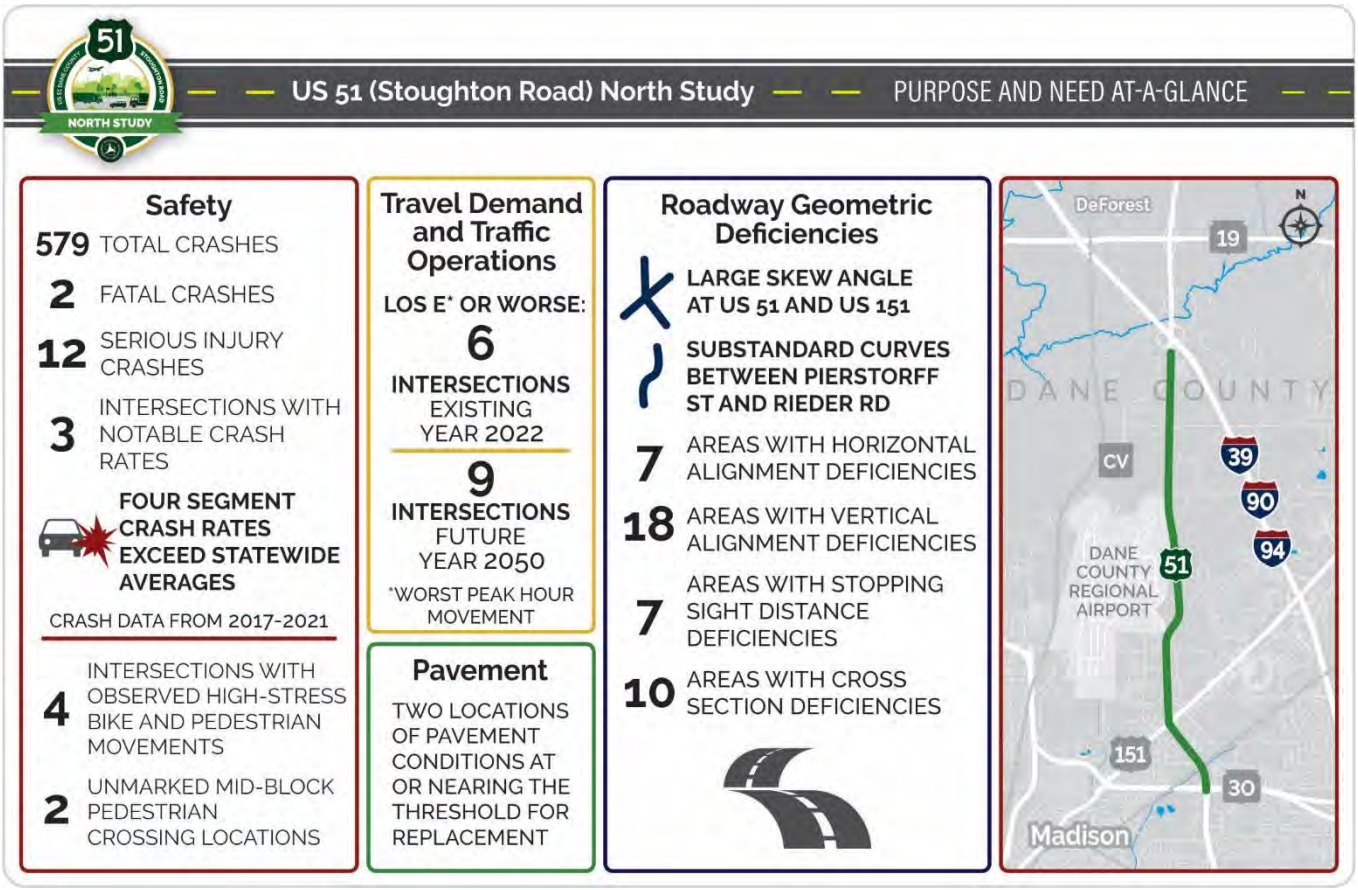
The need for transportation improvements throughout the US 51 (Stoughton Road) North Study corridor is demonstrated through the following factors:

- Safety, including bicycles and pedestrians
- Travel Demand and Traffic Operations
- Roadway and Geometric Deficiencies

A summary of each of these project needs can be found in Figure 3-1: Purpose and Need At-A-Glance. Details for each of the factors will be provided in their respective sections.

[1] *The Railroad Grade Separate Analysis report is in process and will be linked here when a draft version can be shared.*

Figure 3-1: Purpose and Need At-A-Glance



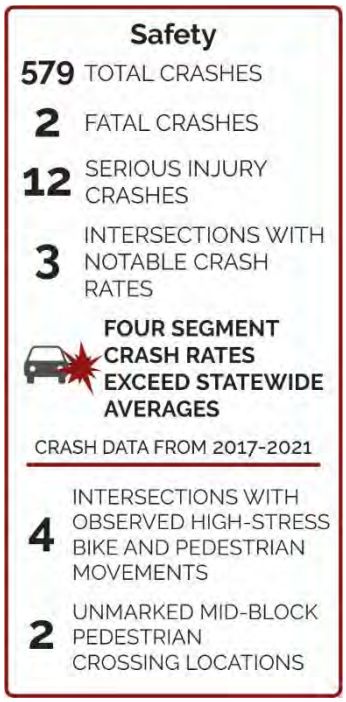
3.1. Safety

The safety of the traveling public is WisDOT's number one priority. In the period from 2017-2021, there were 579 crashes in the study area. Some of the crashes appear linked to operational congestion, geometric deficiencies, and a lack of complete and convenient pedestrian and bicycle facilities in the study area.

There are several primary safety needs for the study:

- Non-intersection segment crash patterns
- Intersection crashes
- Pedestrian and bicycle facilities and crashes

3.1.1. Corridor Crash Data



Frequent crashes in the corridor contribute to congestion and unexpected delays, leading to uncertainty of travel time. Increasing safety on US 51 would improve traffic flow, reducing the travel time for trips. It would also lower overall transportation costs for motorists by reducing auto repair costs, injury-recovery costs, and reducing idling times.

Safety was analyzed primarily based on crash frequency and crash severity. These metrics were considered in terms of

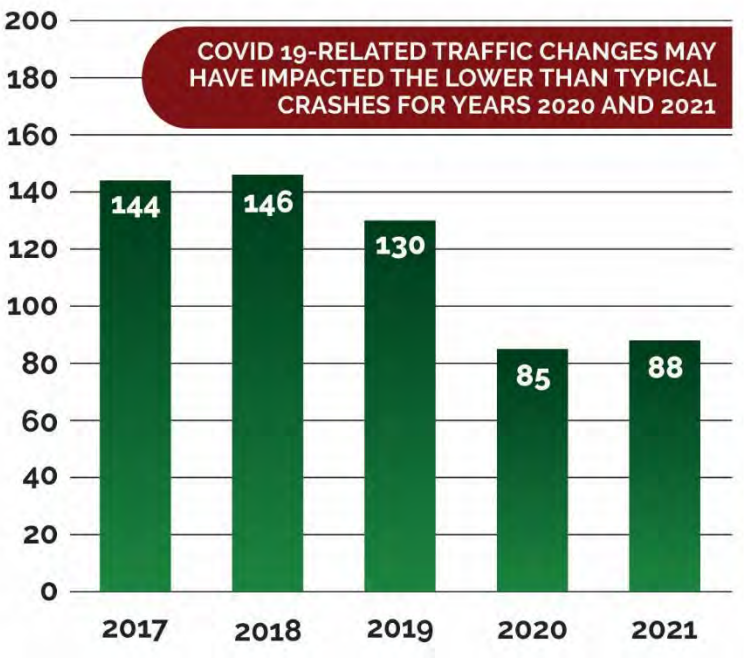
- Intersection crashes,
- Segment crashes and
- Bicycle and pedestrian crashes

Five years of crash data across the study area were analyzed (years 2017 through 2021) as obtained from the Traffic Operations and Safety (TOPS) Lab.[2] Crash data was reviewed for trends in accident type, severity, and other potential contributing factors. Notable crash trends and traffic safety considerations are described below:

Total Crashes

As stated previously, a total of 579 crashes occurred in the study area (as defined along US 51 from the WIS 30 ramp terminals to just south of I-39/90/94 at Daentl Road) between 2017 and 2021. On average, this equates to 2.2 crashes per week. Of the overall crashes, 532 of them were associated with intersections (about 90 percent). Annual crashes for the period from 2017 through 2021 for the corridor are shown in Figure 3-2. Statewide, the COVID-19 pandemic in 2020 to 2021 resulted in lower traffic volumes due to a variety of factors including work-from-home policies and distribution of peak volumes over longer time periods. This reduction in traffic volumes may be a factor in the lower number of total crashes in the analysis period. To illustrate this point, between 2012 and 2016, there were 805 crashes within the study area for that five-year segment. On average, that equates to 3.1 crashes per week.

Figure 3-2: Total Number of Crashes in Study Area by Year



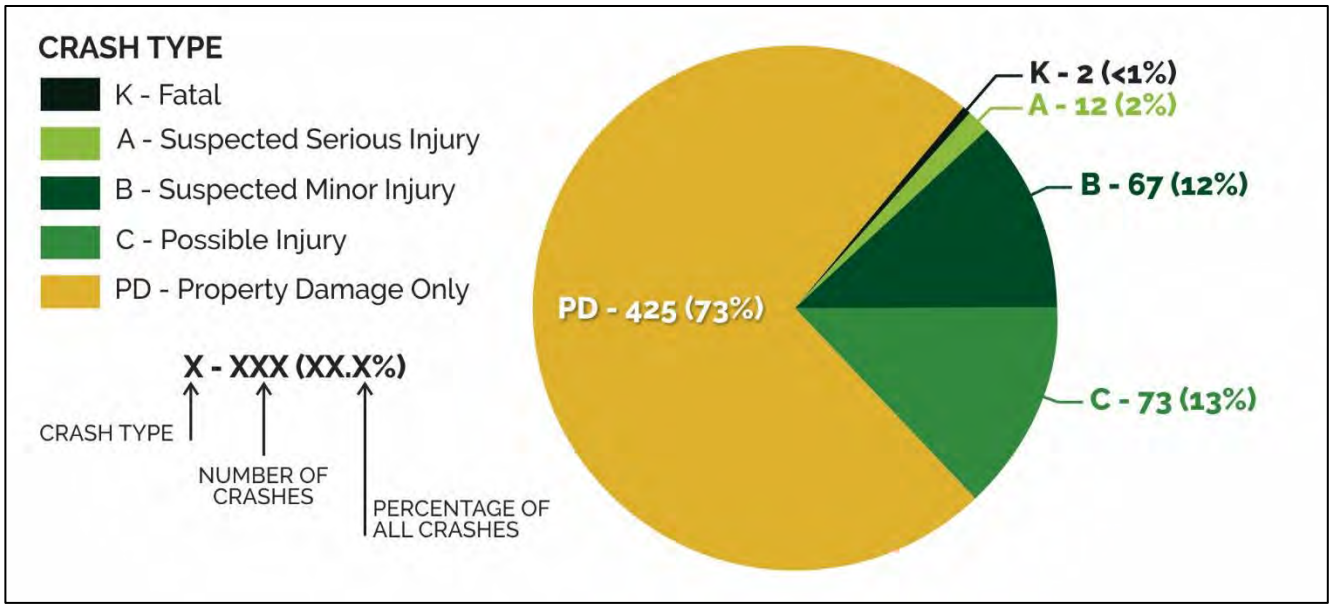
Crash severity is generally categorized into five areas:

- "K" – Fatal (indicates at least one fatality occurred because of a crash)
- "A" – Suspected Serious Injury
- "B" – Suspected Minor Injury
- "C" – Possible Injury
- "PD" – Property Damage (crashes that involved only damage to the vehicle or other property)

[2] *Wisconsin Traffic Operations and Safety Laboratory WisTransportal System Crash Data Retrieval Facility*

Figure 3-3 shows the crash severity distribution of the 579 crashes within the study area from 2017 to 2021.

Figure 3-3: Crash Severity Distribution in Study Area (2017-2021)



Top Madison Crash Locations

The city of Madison's annual Crash Facts Report lists the 30 highest crash locations within the City of Madison for nine different crash types, including intersection crashes. According to the reports, the US 51 and US 151/East Washington Avenue intersection had the second most crashes among all city intersections in 2019. In both 2020 and 2021, this intersection ranked third.

3.1.2. Segment Crashes

A historical crash analysis was conducted for the US 51 study area. The corridor was separated into six MetaManager[3] segments, each logically based on the nature of the facility in each segment. The US 51 segments used to define crash rates are shown in Table 3.1: Segment Crashes.

The crash rates along the corridor are greater than the statewide average crash rates for similar facilities in four of the six segments, as shown in Figure 3-4. Most of the crashes in the corridor were affiliated with intersections, but there was a cluster of 15 crashes at a pair of horizontal curves on the roadway segment between Pierstorff Street and Rieder Road.

[3] *MetaManager is a WisDOT data management system built upon the State Trunk Network (STN) GIS that integrates data across many functional areas.*

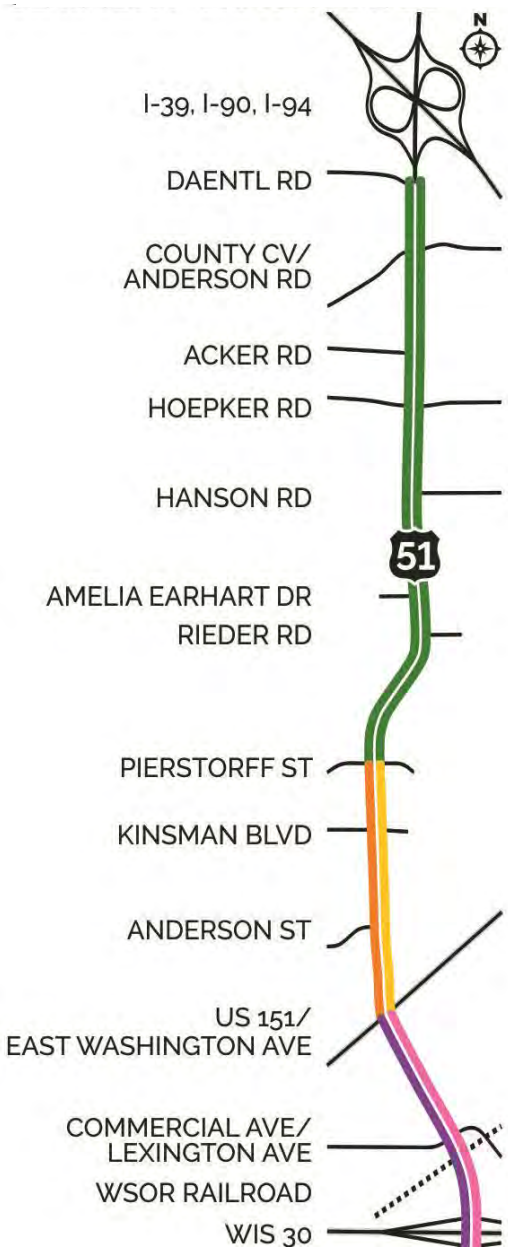
Table 3.1: Segment Crashes

Segment	Crash Rate*	WI Statewide Average**	Notes
US 51 NB (Pierstorff St to Daentl Rd)	123.22	204.68	Below Statewide Average
US 51 SB (Daentl Rd to Pierstorff St)	154.86	204.68	Below Statewide Average
US 51 NB (US 151 to Pierstorff St)	599.27	432.91	**1.4x greater** than statewide average.
US 51 SB (Pierstorff St to US 151)	641.48	432.91	**1.5x greater** than statewide average.
US 51 NB (WIS 30 EB Ramps to US 151)	835.04	204.68	**4.1x greater** than statewide average.
US 51 SB (US 151 to WIS 30 EB Ramps)	564.49	204.68	**2.8x greater** than statewide average.

**Rates for 2017-2021 not published yet, therefore, 2016-2020 rates used for comparison.*

***Statewide Average Crash Rates, October 2021. Crash rates are expressed in crashes per 100 million vehicle-miles traveled.*

Figure 3-4: Crash Rate Segments



3.1.3. Intersection Safety

Crashes and crash rates at intersections along the corridor, which account for about 90 percent of the total crashes in the study limits are summarized in Table 3.2. As is typical for a congested, higher speed roadway with numerous signalized intersections, rear-end crashes are the predominant intersection crash type, accounting for approximately 60 percent of multi-vehicle crashes at intersections. Through the evaluation of crash reports, many of the rear end crashes were a result of following too close, inattentive driving, or driving too fast for conditions as contributing circumstances.

Unlike segment crash rates, no statewide average intersection crash rate exists compared with study-specific intersection crash rates. Intersection crash rates are calculated based on the number of crashes per one million entering vehicles (MEV). The two highest crash rate intersections in the study area are the US 151/East Washington Avenue intersection and the US 51 intersection at the WIS 30 EB ramp terminal. Refer to Table 3.2 for a list of all intersection crash rates in the study area. Special attention will be given to the crash patterns and possible contributing geometric factors at these locations.

Table 3.2: Intersection Crash Metrics (2017-2021)

Intersection	Crash Severity					Total Crashes	Total Crash Rate	KAB[4] Crash Rate
	K	A	B	C	PD			
US 151/East Washington Ave	0	1	20	20	117	158	**1.42**	0.19
WIS 30 EB Ramp	0	2	14	11	77	104	**1.21**	0.19
Hoepker Rd	0	2	5	2	18	27	**0.85**	0.22
Kinsman Blvd	0	2	3	5	20	30	**0.79**	0.13
WIS 30 WB Ramp	0	0	11	10	49	70	**0.75**	0.12
County CV	1	0	5	1	27	34	**0.74**	0.13
Anderson St	0	1	0	5	32	38	**0.72**	0.02
Commercial Ave/Lexington Ave	0	2	1	9	20	32	**0.52**	0.05
Hanson Rd	0	1	1	0	11	13	**0.43**	0.07
Daentl Rd	0	0	0	1	12	13	**0.31**	0.00
Rieder Rd	0	0	2	1	5	8	**0.30**	0.08
Amelia Earhart Dr	0	0	1	0	1	2	**0.08**	0.04
Acker Rd	0	0	0	0	2	2	**0.08**	0.00
Pierstorff St	0	0	0	0	1	1	**0.04**	0.00

K – Fatal, A – Suspected Serious Injury, B – Suspected Minor Injury, C – Possible Injury, PD – Property Damage Only

Total entering volume is correlated with the total intersection crash frequency in the study area, meaning as traffic volume increases the crash frequency also increases. This typically results in more congested intersections having more frequent crashes and suggests that reducing congestion in the study area would likely improve safety metrics at these intersections. These findings are consistent with the Transportation Research Board (TRB) paper – Effect of Intersection Congestion on Accident Rates.

Fatal crashes are often a result of multiple failed conditions, but they are important to note and understand. Two fatal crashes occurred between 2017 through 2021:

- County CV and US 51: one fatal crash (at intersection caused by a driver that fell asleep while driving)
- North of Pierstorff Street: one fatal (segment) motorcycle crash caused by driver failing to negotiate the northbound roadway curve

3.1.4. Bicycle and Pedestrian Safety

This section addresses pedestrian and bicyclist safety issues in the study area. Consideration of the safety of bicyclists and pedestrians can be complex and relies on multiple data sources, including:

- Facilities: Understanding the existing pedestrian and bicyclist infrastructure in the study area and where there are gaps in the network
- Activity: Pedestrian and bicycle usage along the corridor
- Crash History: Pedestrian or bicyclist crash data

[4] *"KAB" is a severity measure that represents the sum of Fatal, A-Level, and B-Level injury crashes.*

Bicycle and Pedestrian Facilities

The US 51 study area lacks bicycle and pedestrian connections across and along the roadway.

The 2021 Dane County Bicycle Map identifies the southernmost section of the corridor from WIS 30 to US 151/East Washington Avenue as "bicycles prohibited or not recommended." Most of the study area (US 151/East Washington Avenue to I-39/90/94) is identified as "least suitable for bicycles."

Figure 3-5: Pedestrian Facilities in the Study Area

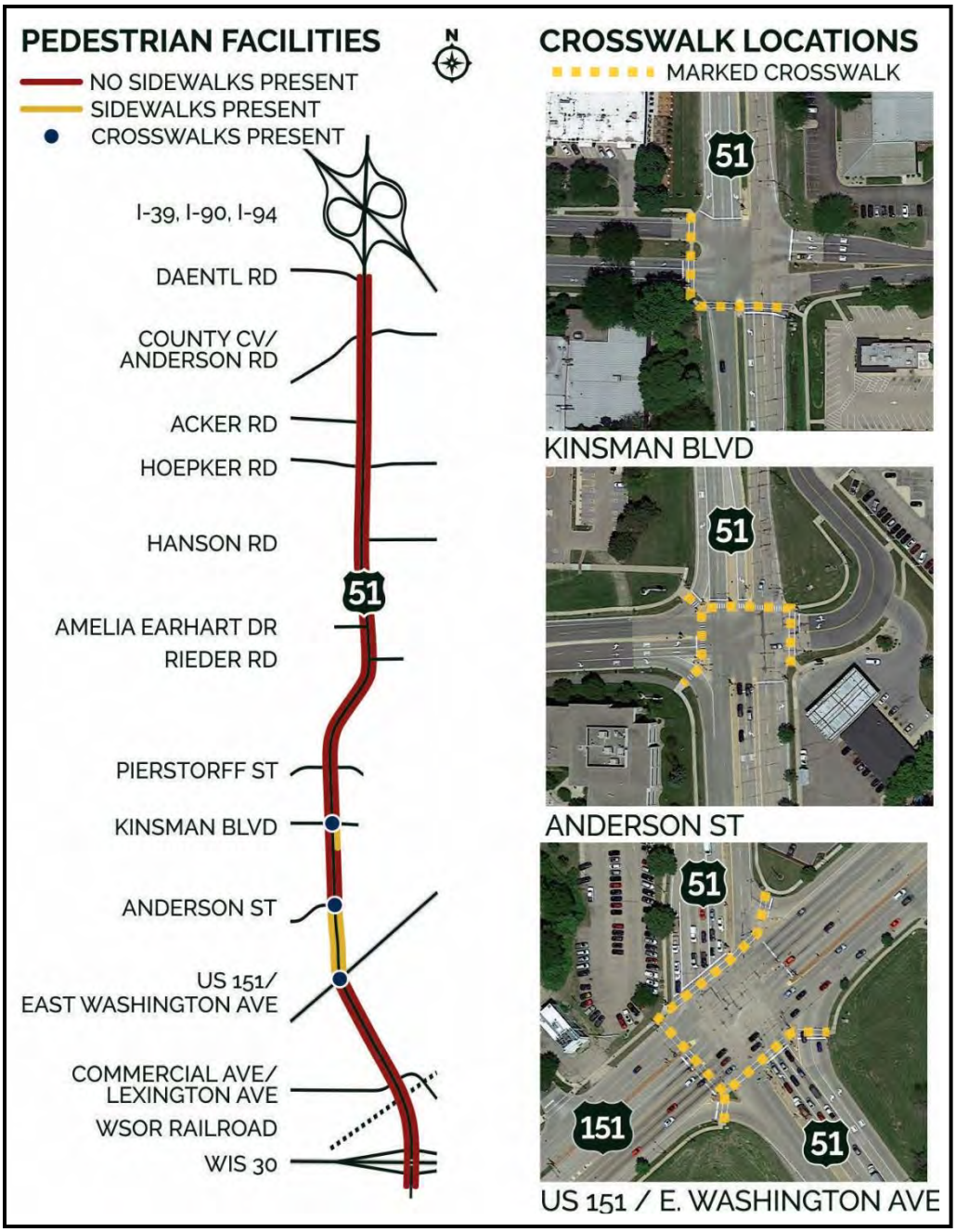


Figure 3-5 shows the pedestrian facilities along US 51. With the exception of a 350' gap on the east side of the roadway, sidewalks are present along US 51 between US 151/East Washington Avenue and Anderson Street. Sidewalks are otherwise absent along the remaining sections of US 51. The existing crosswalks along US 51 are located at Kinsman Boulevard, Anderson Street, and US 151/East Washington Avenue. There is a programmed pavement replacement project that includes installing a crosswalk on south leg of the Anderson Street intersection scheduled for construction in 2023.

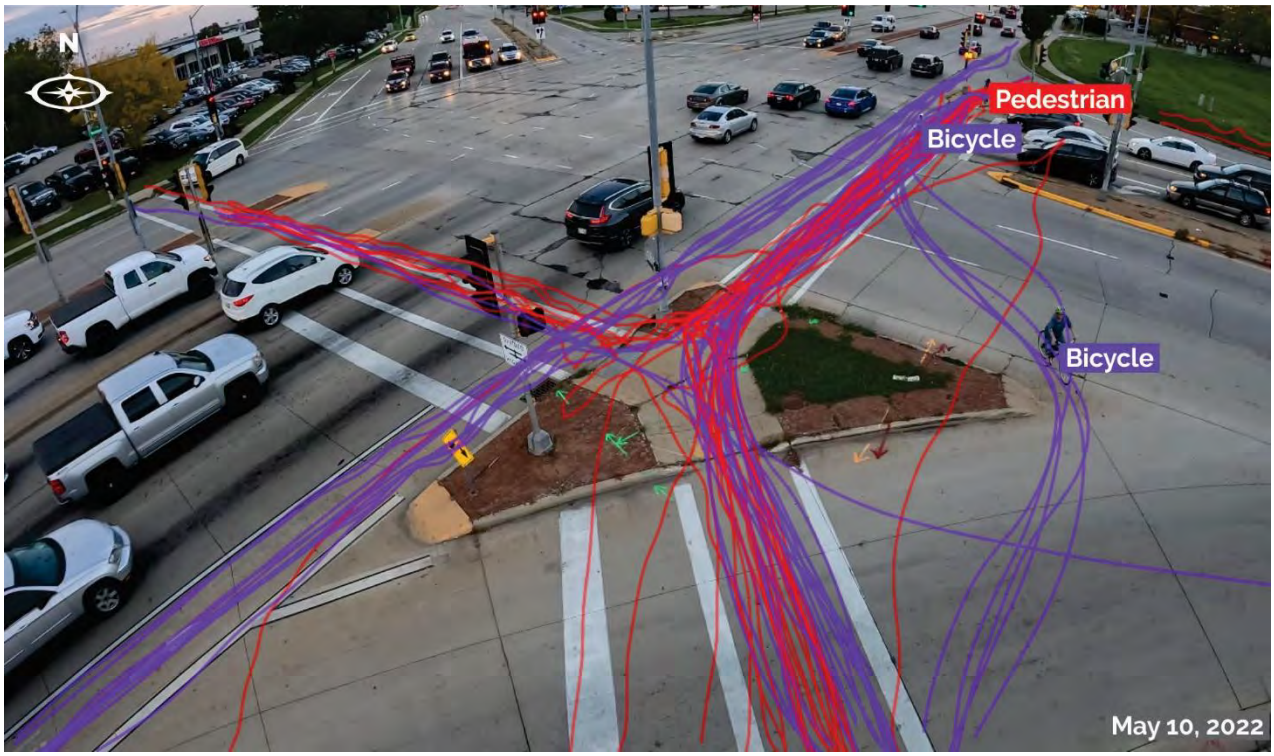
There are designated bicycle lanes and sidewalks on some intersecting roadways and include US 151/East Washington Avenue, Anderson Street, and Kinsman Boulevard. Lexington Avenue has designated bicycle lanes.

Bicycle and Pedestrian Activity

Although US 51 is not recommended for pedestrian and bicycle use, data collection and observed video indicate there are people walking and biking along the corridor. Existing pedestrian and bicyclist usage in the corridor includes crossings at both intersections and mid-block locations.

Specialized video tracking software was used to track the routes of pedestrians and bicycles. This software allows the study team to understand the use of the existing facilities. Figure 3-6 illustrates observed pedestrian and bicyclist activity at the intersection of US 51 and US 151/East Washington Avenue. The camera was on a pole in the southwest quadrant facing northeast.

Figure 3-6: Pedestrian and Bicycle Tracking Example



US 51 and US 151/East Washington Avenue intersection – Data collected Wednesday, October 5, 2022 from 6:00 a.m. to 12:00 p.m.

There are four primary intersections in the study area that have the highest pedestrian and bicycle usage. These include:

- Lexington Avenue/Commercial Avenue
- East Washington Avenue
- Anderson Street
- Kinsman Boulevard

As shown in Figure 3-5: Pedestrian Facilities in the Study Area, three of the intersections listed above have marked crosswalks. The Lexington/Commercial intersection does not have pedestrian or bicycle facilities.

US 51 and Lexington Avenue/Commercial Avenue Intersection

Figure 3-7: Pedestrian and Bicycle Counts at Lexington Avenue and Commercial Avenue

Figure 3-7 illustrates observed pedestrian and bicyclist counts at the intersection of US 51 and Lexington/Commercial Avenue. Bicycle lanes are present on the west leg of the intersection along Lexington Avenue but do not extend through the intersection. Although there are no dedicated bicycle or pedestrian facilities at this intersection, 31 bicyclists and 12 pedestrians crossed this intersection during the seven-hour count period.

Public comments received include increasing the safety and connectivity of bicycle and pedestrian movements at this intersection to neighborhoods, paths and area businesses.

Seven-hour bicycle and pedestrian counts were collected on Tuesday, October 4, 2022 from 12:00 p.m. to 7:00 p.m.

US 51 and US 151/East Washington Avenue Intersection

Figure 3-8: Pedestrian and Bicycle Counts at US 151/East Washington Avenue

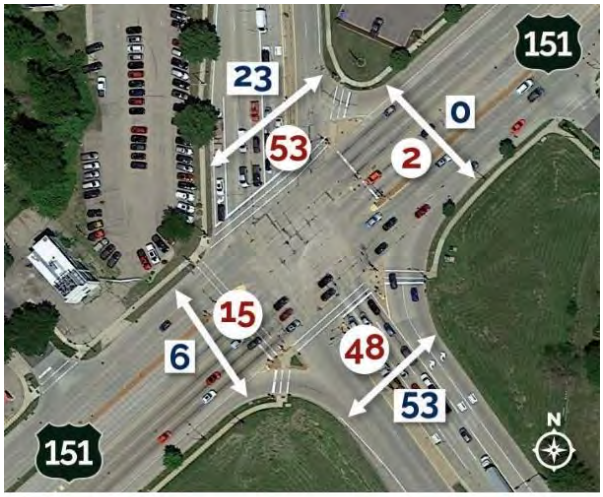


Figure 3-8 illustrates observed pedestrian and bicyclist counts at the intersection. The high volume of vehicle traffic along US 151/East Washington Avenue may discourage some bicyclists from using the roadway even with the dedicated bike lanes on the roadway. Due to the lack of bicycle accommodations on US 51, bicyclists that do travel on the US 151/East Washington Avenue bicycle lanes will then switch to riding on the sidewalks along US 51.

Observation of bicyclist activity at the intersection shows that bicyclists often use the crosswalks rather than the designated bicycle lanes. This can be seen in Figure 3-6 indicated by purple tracking lines on the sidewalk and crosswalks. Numerous studies show that fewer crashes occur when bicyclists ride on streets or marked bicycle lanes as opposed to riding on the sidewalks.

Public comments received include increasing the safety of pedestrian crossings on all four legs of this intersection.

Thirteen-hour bicycle and pedestrian counts were collected over two days from 6:00 a.m. to 7:00 p.m. The south and west legs of the intersection were tracked and counted on Wednesday, October 5, 2022. The north and east legs were tracked and counted on Thursday, October 20, 2022.

US 51 and Anderson Street Intersection

Figure 3-9: Pedestrian and Bicycle Counts at Anderson Street

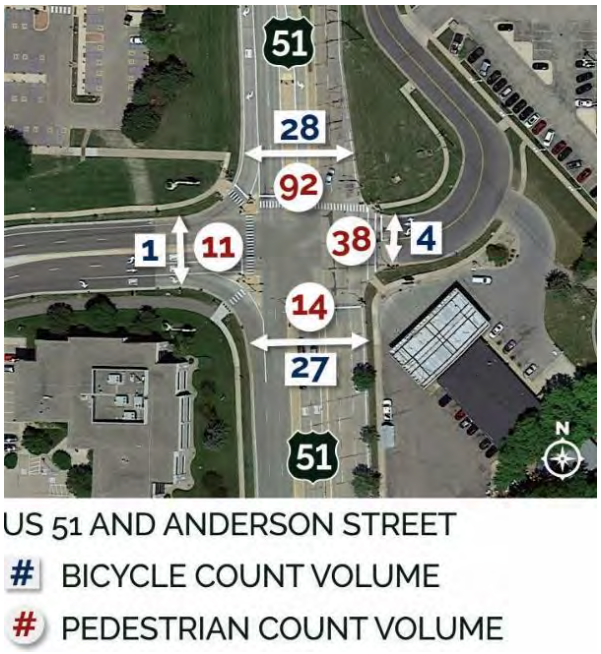


Figure 3-9 illustrates observed pedestrian and bicyclist counts at the Anderson Street intersection. Anderson Street had one pedestrian crash in the period from 2017-2021. Despite the lack of a south-leg pedestrian crosswalk, some pedestrians still use this crossing of the intersection. There is a shared-use path running along the south side of Anderson Street that terminates at this intersection. There is a programmed project that includes installing a crosswalk on south leg of the Anderson Street intersection that would extend this path to the east side of US 51. Due to the lack of bicycle lanes on US 51, bicyclists will ride on the sidewalks along US 51.

The City of Madison identified that with anticipated developments at Reindahl Park, Anderson Street is an important connection across US 51 with the Truax neighborhood.

Bicycle and pedestrian counts were collected at US 51 and Anderson Street over two separate days and added together to get the total pedestrian and bicycle count for the period from 6:00 a.m. to 7:00 p.m. These counts occurred on Thursday, October 20, 2022 and Wednesday, October 26, 2022.

Figure 3-10: Pedestrian and Bicycle Counts at Kinsman Boulevard

Figure 3-10 illustrates observed pedestrian and bicyclist counts at the intersection. At Kinsman Boulevard, pedestrian and bicycle activity was observed on the north and east legs of the intersection despite the lack of pedestrian facilities. Pedestrian and bicycle activity in the area is anticipated to increase due to the future construction of a permanent men's shelter in the southeast corner of this intersection.

Public comments received noted that there would be an increase in bicycle and pedestrian movements in this area due to the new permanent men's shelter in the southeast quadrant of the intersection.

A thirteen-hour bicycle and pedestrian count was performed at US 51 and Kinsman Boulevard on Thursday, October 6, 2022, from 6:00 a.m. to 7:00 p.m.

Non-Intersection (Mid-Block) Areas

Pedestrians and bicyclists have been known to cross US 51 mid-block between US 151/East Washington Avenue and Kinsman Boulevard, near the Truax neighborhood and Madison College. These types of pedestrian crossings are nationally correlated with higher levels of pedestrian collisions. Conflict points between pedestrians and vehicles at locations where pedestrians are unexpected are more likely to result in a crash. These mid-block crossings appear affiliated with pedestrians that want to cross US 51 but do not want to navigate to the nearest pedestrian facilities at an intersection.

The study team used bicycle and pedestrian tracking software to identify bicycle and pedestrian movements in the US 51 corridor between US 151/East Washington Avenue and Kinsman Boulevard, to better understand locations where pedestrians were crossing mid-block. Two areas with notable frequent mid-block pedestrian and bicycle crossings along US 51 are described below.

Between US 151/East Washington Avenue to Anderson Street

The section of US 51 between US 151/East Washington Avenue and Anderson Street is an area with commercial business development adjacent to US 51 and residential development further out. On the east side of US 51 the business are primarily retail and restaurants. On the west side the businesses are office and commercial. Pedestrians frequently cross US 51 at non-intersection areas within this section rather than navigating the marked crossings at the US 151/East Washington Avenue or Anderson Street intersections.

Based on the public comments received, the mid-block crossings of US 51 that occur between US 151/East Washington Avenue and Anderson Street are likely attributable to residents from the Truax neighborhood on the west side of US 51 crossing to access the Walgreens and/or Kwik Trip located on the east side of US 51. A sidewalk connection from the neighborhood connects with sidewalk along the west side of US 51 approximately 500 feet north of the US 151/East Washington Avenue intersection, see Figure 3-11. This is the same area where a vehicle/pedestrian crash occurred in 2018.

Figure 3-11: Map of Mid-Block Crossings Between US 151/East Washington Avenue and Anderson Street

Between Anderson Street and Kinsman Boulevard (Orin Road Crossing)

The section of US 51 between Anderson Street and Kinsman Boulevard is an area with educational development (Madison College) on the west side and commercial business (office and retail) development adjacent to US 51 with some residential development further out on the east side. Mid-block pedestrian crossings in this section primarily occur near Orin Road and are likely attributable to students that live east of US 51 in the area walking to Madison College. It is also possible that some students may park east of US 51. The curb cut for bus stop (ID# 9182) located on the east side of US 51 may draw attention to this area as a crossing location. Figure 3-12 shows the mid-block crossings at this location that were identified during the video tracking data collection effort.

Figure 3-12: Unmarked and Uncontrolled Mid-Block Crossing Near Orin Road

US 51 near Orin Road – Wednesday, October 5, 2022, from 12:00 p.m. to 7:00 p.m.

The mid-block pedestrian crossings occurring on US 51 near Orin Road are likely attributable to the combination of students that live in the area and people parking then potentially walking to Madison College. The curb cut for bus stop (ID# 9182) located on the east side of US 51 may draw attention to this area as a crossing location. This condition poses safety concerns because motorists do not expect pedestrians to cross at non-intersection locations.

Pedestrian and Bicyclist Crash History

From 2017-2021, there were three documented pedestrian or bicycle crashes within the study area. One of the crashes occurred between US 151/East Washington Avenue and Anderson Street, another occurred at the intersection of East Washington Avenue (bike crossing the westbound right-turn lane to get to the porkchop island) and one occurring at the north leg of the Anderson Street intersection.

Planned Bicycle and Pedestrian Improvements within the Corridor Area

Numerous planning documents and neighborhood plans have identified planned bicycle and pedestrian improvements.

Neighborhood Plans

The Hawthorne-Truax Neighborhood Plan (anticipated to be adopted in 2023), suggests the need for bicycle and pedestrian intersection improvements along US 51 at:

- Lexington Avenue/Commercial Avenue
- East Washington Avenue
- Anderson Street

Regional Transportation Plan 2050

The Metropolitan Planning Organization (MPO) Regional Transportation Plan 2050 defines high-conflict intersections at East Washington Avenue and Anderson Street. A map of the high-conflict intersections can be found at the link above. The Plan also identifies Tier 2 (second priority) sidewalk needs along US 51 between East Washington Avenue and Pierstorff Street and along Kinsman Boulevard (east of US 51) and Bartillon Drive. Tier 1, (first priority), sidewalk needs are identified along Lexington and Commercial Avenue.

A future planned north-south connection is identified north of Dane County Regional Airport. Tentative plans include a connection west of US 51 near County CV and crossing near the intersection of Hoepker Road with Token Creek Lane east of I-39/90/94 and Token Creek County Park before crossing back to the west side of US 51 at Williamsburg Way and Metro Drive.

3.1.5. Zero in Wisconsin and Vision Zero Madison

Wisconsin Department of Transportation, along with several traffic safety partners, is dedicated to saving lives and preventing injuries through high-visibility law enforcement efforts combined with public outreach. Six program areas, including occupant protection, impaired driving, distracted driving, pedestrian and bicycle safety, speeding and aggressive driving, and motorcycle safety, are all part of the campaign to achieve zero preventable deaths on Wisconsin roads.

The US 51 (Stoughton Road) North Study is located within the city of Madison. The Vision Zero Madison Action Plan 2020-2035 sets a goal of reducing all traffic deaths and severe injuries on city streets to zero by 2035. It represents a fundamental transformation in the city's approach to traffic safety in its prioritization of human life over the movement of motor vehicles. According to the Vision Zero Network, more than 45 cities in the United States have committed to the goal of zero traffic deaths and life-altering injuries by developing action plans and implementing community-specific strategies that address each transportation system's unique circumstances. In 2019 (17 years after adopting Vision Zero), the city of Oslo, Norway (population 681,067) demonstrated this goal is achievable as there were no pedestrian or bicyclist fatalities on city streets.

According to Wisconsin's Department of Transportation, Dane County had the state's second-highest number of traffic fatalities from 2015 to 2019. Forty-four people died from crashes on Madison streets between 2015 and 2019, and hundreds more were injured.

Vision Zero Madison aims to lay the groundwork for a new approach to traffic safety by designing streets within the city for people and cars. An emphasis will be placed on design decisions that focus on safe mobility for all roadway users, including pedestrians, bicyclists, and transit users.

3.2. Travel Demand (Traffic Volumes and Traffic Operations)

There are 14 intersections along US 51 in the study area (from WIS 30 to I-39/90/94). This count includes the WIS 30 ramp terminals but does not include the I-39/90/94 ramp terminals. Eight of the 14 intersections are signalized. Currently, six of those signalized intersections have poor operations (operational quality is defined in Section 3.2.2 Traffic Operations) during either the morning or evening peak hours. It's predicted that without improvements or changes in travel patterns, nine intersections will have poor operations in 2050. These existing and future

operational deficiencies cause long vehicle delays and traffic queues, which can result in safety concerns and a higher frequency of crashes.

Traffic volumes were obtained in the year 2022. Traffic forecasting methods, including regional growth rates were used to develop year 2050 traffic volumes. This section of the purpose and need describes:

1. Daily traffic volumes along the US 51 corridor
2. Peak hour traffic volumes at the intersections
3. Intersection Level of Service

3.2.1. Daily and Peak Hour Traffic Volumes

Daily volumes and peak hour turning movement counts were collected to identify operational concerns in the study area. This analysis relied on morning (7 a.m. to 8 a.m.) and afternoon (4 p.m. to 5 p.m.) peak hour turning movement counts to conduct morning and afternoon peak operations analysis as these peaks are known to have the heaviest traffic volumes throughout the day in the study area.

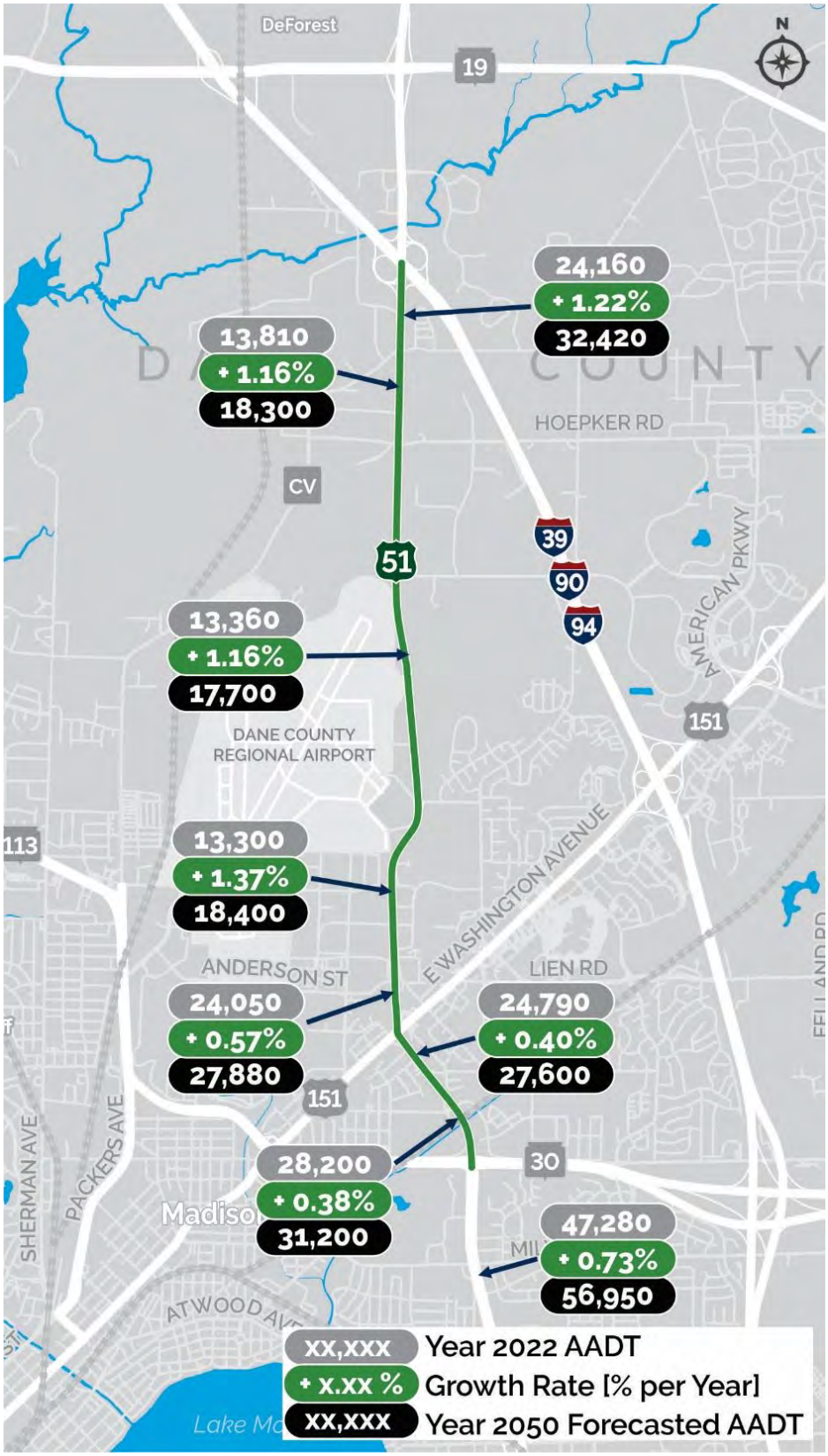
Daily Volumes (Year 2022 and Year 2050)

Figure 3-13 shows year 2022 daily and future Year 2050 no-build traffic volumes along US 51. The annual growth rate is also presented in this figure. Daily traffic volumes are anticipated to grow between 0.17 – 1.52 percent per year within the study area. This growth varies because some areas of the corridor have more potential to be influenced by land development such as those in the northern areas of the corridor where there is more adjacent developable land to generate higher amounts of traffic than those in the southern areas of the corridor that have less developable land.

Peak Hour Traffic Volumes (Year 2022 and Year 2050)

Intersection turning movement counts were collected in April of 2022 at all analyzed intersections in the study area. Additional supplemental turning data was also collected in September and October 2022. These peak hour volumes were used to analyze year 2022 traffic operations. Peak hour traffic volumes are anticipated to grow approximately 0.5 percent to two percent per year within the study area.

Figure 3-13: Annual Average Daily Traffic Volumes in Study Area (Year 2022 and Year 2050)

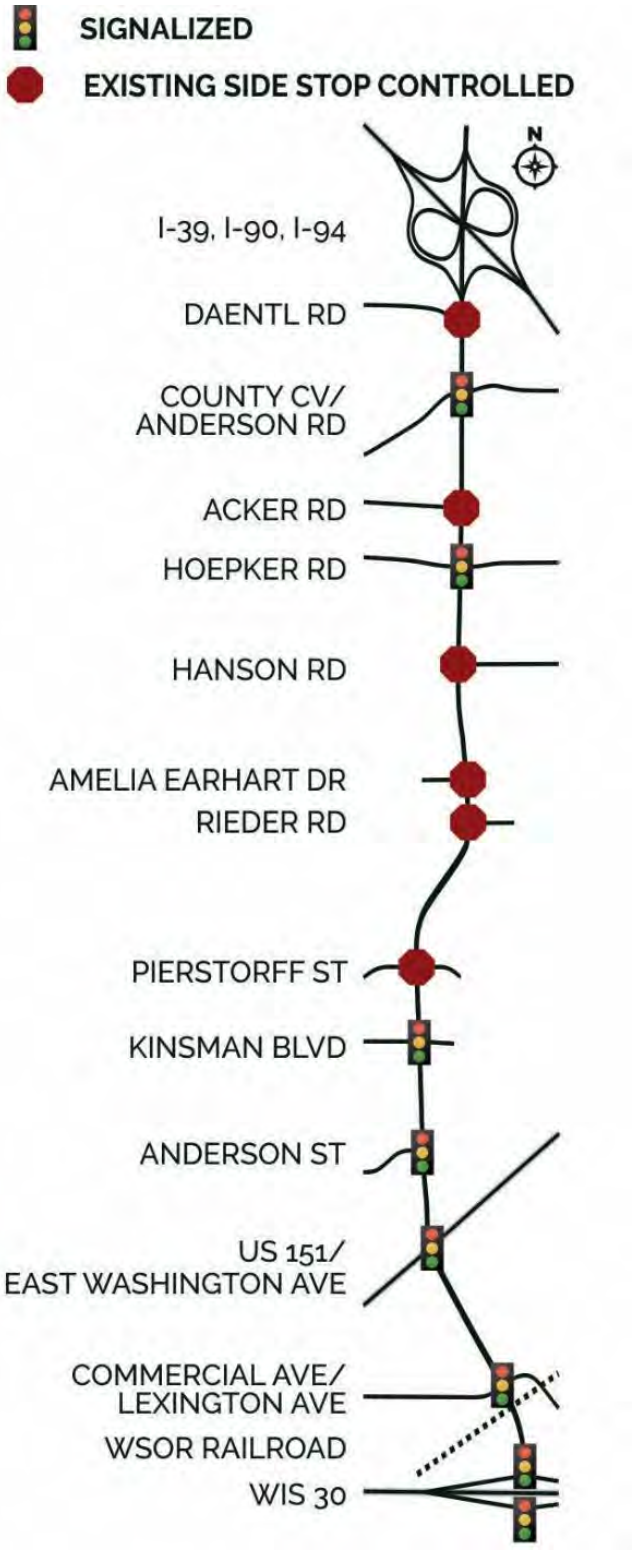


3.2.2. Traffic Operations

Synchro, a traffic analysis software package, was used to analyze intersection Level of Service (LOS), vehicle delay and queuing within the study area under morning and evening peak hour conditions. Operations analysis was focused on intersections because the delay, congestion and traffic queuing within this US 51 corridor is almost entirely associated with intersections. The current intersection control type that was analyzed is shown in Figure 3-14.

A traffic analysis was conducted for each of the intersections on the corridor to identify existing and future design year operating conditions and LOS at the intersections. Acceptable levels of service are defined for each of the different roadway classifications in WisDOT's Facility Development Manual (FDM) Chapter 11-5-3.2. LOS D or better is regarded as desirable for all the intersections in the study area because US 51 is classified as a principal arterial on the National Highway System within an urbanized area with a population of greater than 50,000[5]. Level of service criteria for signalized and unsignalized intersections is shown in Table 3.3.

Figure 3-14: Intersection Control Type



[5] *Arterial roadways are at the highest level of the highway functional classification system. They provide a high level of mobility, have generally higher speed limits, and carry the highest traffic volumes. Urban Arterials serve the major activity centers within the urban area and are its highest traffic volume corridors.*

Table 3.3: Level of Service Criteria for Signalized and Unsignalized Intersections

LOS Designation	Signalized Intersection	Unsignalized Intersection and Roundabout	Description of Operations
	Average Delay/Vehicle (seconds)		
A	≤ 10	≤ 10	No delays at intersections with continuous flow of traffic. Uncongested operations: high frequency of long gaps available for all left and right-turning traffic. No observable queues.
B	> 10 - 20	> 10 - 15	Nearly the same as LOS A but with slightly less favorable conditions.
C	> 20 - 35	> 15 - 25	Moderate delays at intersections with satisfactory to good traffic flow. Light congestion; infrequent backups on critical approaches.
D	> 35 - 55	> 25 - 35	Increased probability of delays along every approach. Substantial congestion on critical approaches, but intersection is functional. Limited stable traffic flow.
E	> 55 - 80	> 35 - 50	Heavy traffic flow condition. Heavy delays probable. No available gaps for cross-street traffic or main street turning traffic. Limited stable traffic flow.
F	> 80	> 50	Unstable traffic flow. Heavy congestion. Traffic moves in forced flow condition. Total breakdown.

Source: HCM 6th edition.

Summary of Intersection LOS (2022 and 2050)

There is one intersection operating with a deficient **overall** LOS under existing year 2022 conditions:

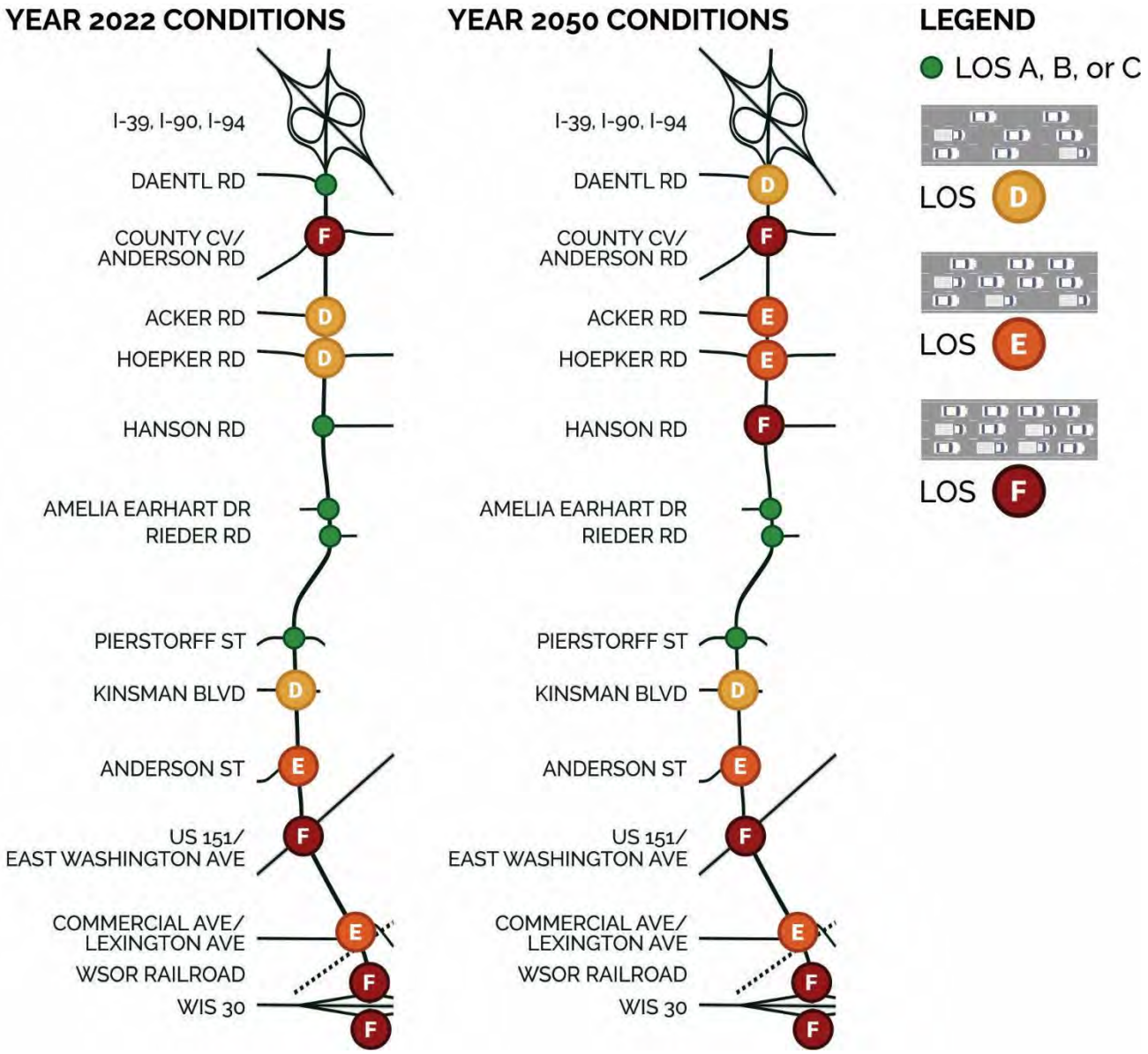
- US 151/East Washington Avenue in the PM Peak

There are two intersections operating with deficient **overall** LOS under future year 2050 no build conditions:

- US 151/East Washington Avenue in the PM Peak
- WIS 30 Westbound Terminal in the AM Peak

Figure 3-15 shows the results of traffic operations analysis for the existing conditions Year 2022 (left), and Year 2050 conditions (right) for the **worst peak hour intersection movement**. Intersections with movements at LOS C or above are not labeled. This figure and the narrative above indicate there are many intersections with poor operations anticipated in the future without improvements. The following sections provide additional details on specific intersections of concerns for both traffic operations in the existing Year 2022 and Year 2050. This section provides intersection delay, LOS, and queuing information. Full analysis can be found in the future traffic report.

Figure 3-15: Year 2022 and Year 2050 Worst Peak Hour Movement Level of Service



Existing Year 2022 Traffic Operations

Existing traffic operations metrics (Year 2022) are shown on the left side of Figure 3-15. Those intersections with LOS E or F conditions are described in more detail below.

WIS 30 Ramp Terminals (two intersections)

There are two primary delayed and queued movements at this interchange. The first is the westbound exit ramp in the morning. That often requires a motorist to wait through 2-3 traffic signal cycles to make their movement (westbound to southbound) and routinely queues up motorists onto the WIS 30 mainline auxiliary lane during the morning peak. This equates to 130 seconds of delay for an average motorist. This queue often blocks the ability of motorists to access the westbound right-turn lane and compounds the queue. Refer to Figure 3-16 for a still image from a traffic model microsimulation that shows the approximate backups on the westbound exit ramp in the morning.

The other primary delayed movement is the northbound right-turn movement onto the eastbound WIS 30 entrance ramp during the evening peak. That is a high-volume movement and can produce slow rolling queues of more than 30 vehicles. Often these peak hour queues are so long that it becomes challenging for US 51 northbound traffic to merge right into this queue so they can make a right turn at the interchange.

Figure 3-16: Year 2022 AM Peak Hour Vissim Model WIS 30 Exit Ramp Congestion

Commercial Avenue/Lexington Avenue

The primary delayed movement is the northbound left-turn movement. These motorists often need to wait through two traffic signal cycles to make it through this intersection, though this is a relatively low-volume movement.

US 151/East Washington Avenue

This intersection has heavy volumes on all approaches, but the largest overall volumes are during the evening peak hour. The combination of high through volumes on US 151/East Washington Avenue and the relatively high left-turn volumes, especially the southbound and westbound movements, produce notable delays for the southbound left-turn and eastbound through movements. These movements have between 79 and 100 seconds of delay per vehicle, respectively. This intersection has relatively large queues but currently these queues are able to clear through the traffic signal when given a green light. Some of the queues, especially eastbound and westbound on East Washington Avenue, extend across driveways to adjacent properties, leading to additional concern about these movements. Refer to Figure 3-17 for a microsimulation model screenshot showing evening commuter peak traffic backups at East Washington Avenue. Note that the eastbound backup blocks the access to South Frontage Road. It is undesirable to allow access points like roads or driveways to intersect a major arterial like East Washington Avenue this close to an adjacent intersection. Traffic backups at the adjacent intersection affect the driveway or roadway access and cause motorists to conduct unexpected turns. Motorists from the side road or driveway may try to cut into the congested adjacent intersection approach in a manner that may be unexpected by through-traveling motorists.

Figure 3-17: Year 2022 Vissim Model US 151/East Washington Avenue EB Congestion

Anderson Street

The primary delayed movement is the northbound left-turn movement, which exhibits about 60 seconds of delay during the evening peak, though queues are generally manageable in the existing storage bay.

County CV/Anderson Road

There are two primary delayed movements at this intersection. The first is the eastbound left turn from County CV onto US 51 northbound. This approach generates a relatively high delay (about 60 seconds) during the evening peak hour. This movement has frequent semi-trucks due to the adjacent truck stop, and those slow-moving semi-trucks often result in longer queues and longer delays. The other notable delayed movement is the westbound right turn from Anderson Road. This movement has as much as 130 seconds of delay during the evening peak.

Year 2050 (No-Build) Traffic Operations

Operational concerns identified in Year 2022 conditions are anticipated to further degrade by year 2050 as traffic volumes are anticipated to increase. All intersections in the corridor will operate with more vehicle delays and longer traffic queues without operation improvements or changes in travel patterns. Future year 2050 operational metrics are shown on the right side of Figure 3-15. These metrics help describe the quality of traffic movement at an intersection. In the following tables the vehicle delay, LOS, and queue are the reported metrics. Those intersection movements with LOS E or F conditions are described in more detail below. A “failed queue” occurs when a motorist is waiting in a traffic backup for a green traffic signal, but the green is not long enough for all stopped motorists to get through the signal before it turns red again.

The sections below describe intersections with LOS E and F movements anticipated in the future. Each table in these following sections shows current year 2022 LOS E and F movements and anticipated future 2050 LOS E and F movements in the same table. The movement columns are noted as the direction (WB=westbound) followed by the movement (L=left turn, T=through, R=right turn).

WIS 30 Ramp Terminals (two intersections)

The westbound exit ramp is anticipated to become substantially worse in the future, with exit ramp queues expected to back up all the way to the WIS 30 mainline lanes, degrading operations and safety on the WIS 30 mainline. The level of delay and queuing is likely to encourage motorists to avoid the exit ramp and choose an alternate route. The westbound left-turn motorists will routinely experience delays of over three and a half minutes. The northbound right-turn lane movement to access WIS 30 eastbound will regularly produce 50-vehicle rolling queues and backups into the Milwaukee Street entrance ramp. Refer to Table 3.4 for more detailed operational information related to the LOS E and F movements at the intersection in both year 2022 and year 2050.

Table 3.4: Year 2022 and Year 2050 LOS E and F Movements at WIS 30 Ramp Terminals

Intersection	Traffic Control	Time	Metric	Year 2022	Year 2050
US 51 & WIS 30 Westbound Ramp Terminal		AM	Movement	WBL	WBL
			Volume	915	1050
			Delay (sec)	130	215
			LOS	F	F
			Queue (ft)	650	775
		PM	Movement	WBL	WBL
			Volume		660
			Delay (sec)		64
			LOS		E
			Queue (ft)		430

Intersection	Traffic Control	Time	Metric	Year 2022		Year 2050		
US 51 & WIS 30 Eastbound Ramp Terminal		AM	Movement	NBT	NBR	EBL	NBT	NBR
			Volume	1435			1640	
			Delay (sec)	55			96	
			LOS	E			F	
			Queue (ft)	290			345	
		PM	Movement	NBT	NBR	EBL	NBT	NBR
			Volume		1015	80		1170
			Delay (sec)		175	58		256
			LOS		F	E		F
			Queue (ft)		615	130		740
Key:		= LOS D or better						

US 51 and Lexington Avenue/Commercial Avenue

The eastbound left-turn movement is anticipated to degrade further, with about 115 feet of queuing during the year 2050 evening peak hour. Refer to Table 3.5 for more detailed operational information related to the LOS E movements at the intersection in both year 2022 and year 2050.

Table 3.5: Year 2022 and Year 2050 LOS E and F Movements at Lexington Avenue/Commercial Avenue

Intersection	Traffic Control	Time	Metric	Year 2022	Year 2050
US 51 & Commercial Avenue		AM	Movement	EBL	EBL
			Volume		
			Delay (sec)		
			LOS		
			Queue (ft)		
		PM	Movement	EBL	EBL
			Volume	50	75
			Delay (sec)	56	59
			LOS	E	E
			Queue (ft)	75	115
Key:		= LOS D or better			

US 151/East Washington Avenue

The additional future traffic anticipated at this intersection is anticipated to create operational failures on the eastbound, southbound, and westbound approaches. Peak hour queues will often be too long for a single traffic signal cycle to process, and therefore there will be failing queues on many approaches. This will be a common occurrence on multiple approaches at this intersection in the future. Additionally, queues at this intersection will affect nearby intersections on the west, north, and east approaches, causing additional congestion at adjacent intersections. The most notable queue will be in the evening on the eastbound approach, where over 40 car backups in each lane will be likely. That is long enough to block the Schmedeman Avenue intersection, the south frontage road, and the eastbound left-turn lane storage bay. Refer to Table 3.6 for more detailed operational information related to the LOS E and F movements at the intersection in both year 2022 and year 2050.

Table 3.6: Year 2022 and Year 2050 LOS E and F Movements at US 151/East Washington Avenue

Intersection	Traffic Control	Time	Metric	Year 2022			Year 2050				
US 51 & US 151		AM	Movement	EBL	EBT	SBL	EBL	EBT	WBL	WBT	SBL
			Volume				160			1235	230
			Delay (sec)				57			71	59
			LOS				E			E	E
			Queue (ft)				115			550	165
		PM	Movement	EBL	EBT	SBL	EBL	EBT	WBL	WBT	SBL
			Volume	220	1295	340	265	1525	460		430
			Delay (sec)	64	100	79	102	182	57		158
			LOS	E	F	E	F	F	E		F
			Queue (ft)	165	640	250	240	1005	290		395
Key:		= LOS D or better									

Anderson Street

The primary delayed movements are the northbound left turn and southbound left turn from US 51 to Anderson Street. In the future, the southbound left movement will continue to have about 57 seconds of vehicle delay. Refer to Table 3.7 for more detailed operational information related to the LOS E movements at the intersection in both year 2022 and year 2050.

Table 3.7: Year 2022 and Year 2050 LOS E and F Movements at Anderson Street

Intersection	Traffic Control	Time	Metric	Year 2022		Year 2050	
US 51 & Anderson Street		AM	Movement	NBL	SBL	NBL	SBL
			Volume				
			Delay (sec)				
			LOS				
			Queue (ft)				
		PM	Movement	NBL	SBL	NBL	SBL
			Volume	290	30		35
			Delay (sec)	56	56		57
			LOS	E	E		E
			Queue (ft)	210	45		50
Key:		= LOS D or better					

Hanson Road

The primary delayed movement is the westbound left turn from Hanson Road to southbound US 51. This movement is anticipated to fail in the future and produce a nearly one minute vehicle delay in the AM peak for each motorist waiting for a gap in traffic. Since this is a stop-sign controlled movement, the level of service threshold is less than it is for a traffic signal. The reason for that is that motorists have less patience at a stop-controlled intersection because they aren't "guaranteed" a green light like they would at a traffic signal. That makes some motorists choose risky moves when they perceive they have waited longer than they should. Refer to Table 3.8 for more detailed operational information related to the LOS E and F movements at the intersection for year 2050.

Table 3.8: Year 2050 LOS E and F Movements at Hanson Road

Intersection	Traffic Control	Time	Metric	Year 2050	
US 51 & Hanson Road		AM	Movement	WBL	WBR
			Volume	55	110
			Delay (sec)	58	58
			LOS	F	F
			Queue (ft)	60	60
		PM	Movement	WBL	WBR
			Volume	100	205
			Delay (sec)	38	38
			LOS	E	E
			Queue (ft)	65	65
Key:		= LOS D or better			

Hoepker Road

In the future during the evening peak hour, the northbound left-turn movement has nearly one minute of delay, though queues are manageable. Refer to Table 3.9 for more detailed operational information related to the LOS E movement at the intersection for year 2050.

Table 3.9: Year 2050 LOS E and F Movements at Hoepker Road

Intersection	Traffic Control	Time	Metric	Year 2050
US 51 & Hoepker Road		AM	Movement	NBL
			Volume	
			Delay (sec)	
			LOS	
			Queue (ft)	
		PM	Movement	NBL
			Volume	70
			Delay (sec)	55
			LOS	E
			Queue (ft)	95
Key:		= LOS D or better		

Acker Road

In the future, the eastbound right turn and eastbound left turn are the most likely movements to be delayed, with future delays of more than 40 seconds per vehicle in the morning peak hour, though queues are manageable. The eastbound approach provides a single lane for vehicles, resulting in delays for both left-turning and right-turning vehicles. Refer to Table 3.10 for more detailed operational information related to the LOS E movement at the intersection in year 2050.

Table 3.10: Year 2050 LOS E and F Movements at Acker Road

Intersection	Traffic Control	Time	Metric	Year 2050	
US 51 & Acker Road		AM	Movement	EBL	EBR
			Volume	15	10
			Delay (sec)	42	42
			LOS	E	E
			Queue (ft)	15	15
		PM	Movement	EBL	EBR
			Volume		
			Delay (sec)		
			LOS		
			Queue (ft)		
Key:		= LOS D or better			

County CV/Anderson Road

In year 2050, the eastbound left turn in the evening peak from County CV onto US 51 northbound will have over one and a half minutes of delay per vehicle, the southbound left turn will have over one minute of delay in the morning peak, and the westbound right-turn movement will have nearly two and a half minutes of delay during the evening peak. These three movements all degrade in operations compared to year 2022 analysis due to an overall increase in traffic under year 2050 conditions. Refer to Table 3.11 for more detailed operational information related to the LOS E and F movements at the intersection in both year 2022 and year 2050.

Table 3.11: Year 2022 and Year 2050 LOS E and F Movements at County CV/Anderson Road

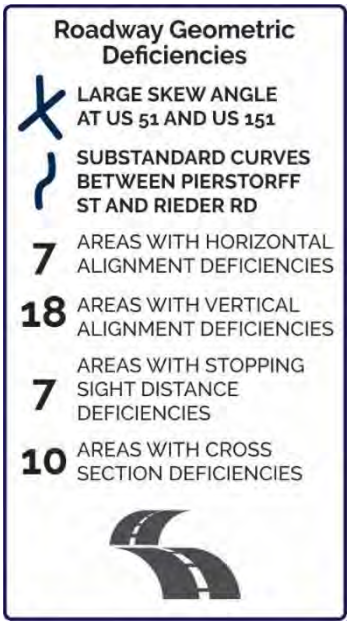
Intersection	Traffic Control	Time	Metric	Year 2022				Year 2050		
US 51 & County CV		AM	Movement	EBL	WBR	NBL	SBL	EBL	WBR	SBL
			Volume		40					140
			Delay (sec)		72					66
			LOS		E					E
			Queue (ft)		60					325
		PM	Movement	EBL	WBR	NBL	SBL	EBL	WBR	SBL
			Volume	520	105	20	40	640	110	
			Delay (sec)	60	131	56	57	99	146	
			LOS	E	F	E	E	F	F	
			Queue (ft)	290	200	40	65	445	300	
Key:		= LOS D or better								

3.3. Roadway and Geometric Deficiencies

Roadway and geometric deficiencies can lead to operational and safety concerns. Roadway standards are associated with systemic safety, meaning the standards applied to roadway features have been developed over time to create generally safe conditions under typical environmental conditions. Those elements of a roadway that do not meet minimum standards are not necessarily unsafe but may be more likely to be associated with operational or crash concerns.

Within the US 51 study area, there are:

1. Seven locations with horizontal alignment deficiencies. Among these:
    a. Two horizontal curves north of Pierstorff Street are associated with a historical crash trend.
    b. The intersection skew for the north leg of the intersection at US 51 and US 151/East Washington Avenue is also associated with a historical crash trend.
2. Eighteen locations with vertical alignment deficiencies
3. Seven areas with stopping sight distance deficiencies
4. Ten areas with cross section deficiencies



3.3.1. Horizontal Alignment

Horizontal alignment refers to the curvature of the roadway at a given design speed. A greater design speed requires a flatter curve – a curve with a larger radius. According to the American Association of State Highway Officials (AASHTO) "Design speed is a selected speed used to determine the various geometric design features of the roadway. The assumed design speed should consider topography, anticipated operating speed, the adjacent land use and the functional classification of the highway." AASHTO publishes specifications, test protocols and guidelines, which are used in highway design and is considered the official overseeing body for highway design standards. Regarding the selection of design speed, the WisDOT FDM states, "the type and functional classification of highway, the topography, the adjacent land use, driver expectations and economics are all factors influencing this selection." WisDOT typically uses a design speed that is 5 mph greater than the posted speed (FDM 11-10-1.5, December 21, 2012).

The alignment deflection, radii, and superelevation were evaluated, and deficiencies are present in each category. Points of intersection were evaluated by the maximum deflection angles allowed without horizontal curves and through lanes through urban intersections based on specific speeds as shown in the FDM. Five locations were identified to have substandard deflection angles including the deflection angle at US 51 and East Washington Avenue as mentioned previously. See Figure 3-18 and Figure 3-19.

Figure 3-18: Skew Angle at US 51 and US 151/East Washington Avenue

To maintain the desired design speed, highway and ramp curves are generally superelevated (banking of the roadway). Evaluation of horizontal curves is based on the radius of the curve in the roadway and the curve's superelevation, which determines the equivalent design speed. The US 51 Stoughton Road corridor was evaluated using WisDOT design criteria that call for a maximum superelevation of six percent for the rural sections of US 51. Four percent is the maximum for the urban sections of US 51.

While evaluating minimum and maximum superelevation values, it was determined that one section of roadway for both northbound and southbound US 51 exceeded maximum superelevation criteria for rural roadways. As noted in Figure 3-19 the section between Pierstorff Street and Rieder Road has two horizontal curves that utilize eight percent superelevation, which exceed the six percent maximum design criteria (see maroon lines in Figure 3-19).

At US 51 and US 151/East Washington Avenue over the past five years, an estimated 24 percent of crashes may be attributed to the intersection skew angle. This intersection angle is approximately 33 degrees which is over ten times the maximum allowable skew angle for the posted speeds at this location. Refer to Figure 3-18. It is anticipated that crashes could be reduced if the intersection skew angle is improved.

Figure 3-19: Horizontal Alignment Deficiencies

Vertical Alignment

Roadway vertical alignments consist of crest and sag curves with straight grades connecting them. Geometric design of a roadway profile is governed by safety, vehicle operations, drainage, and construction considerations. More details can be found in the geometric deficiencies technical memo.

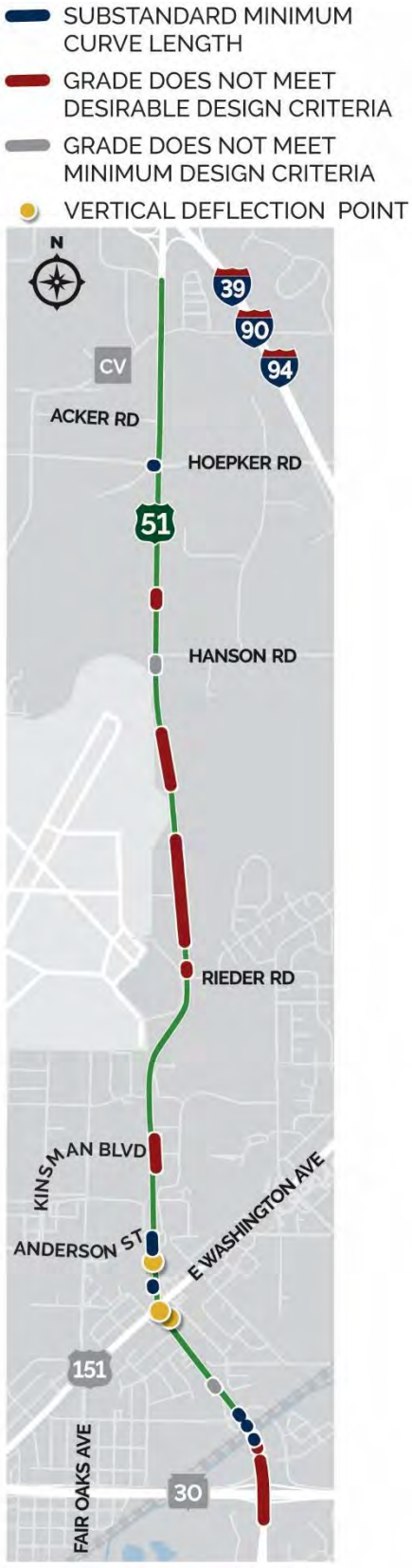
Vertical curves and grade changes without vertical curves were evaluated. Numerous grade changes without vertical curves are found throughout the study area with most located at intersections. When vertical curves are utilized, minimum curve lengths are required to be three-times the design speed of the road in feet. There are six locations where the minimum curve length was not met (see navy blue lines on Figure 3-20).

As-built construction plans were referenced in the evaluation of the vertical alignment. The minimum grade for rural (shoulders) and urban (curb and gutter) roadways is 0.0 percent and 0.3 percent respectively. A grade of 0.5 percent is minimum desirable for both environments. There are nine locations where the desirable or minimum grade was not met based on its rural or urban setting (see maroon and grey lines on Figure 3-20).

Vertical curves and grade changes without vertical curves were also evaluated. Three vertical deflection points (see yellow circles on Figure 3-20) do not meet standards.

The k-value of a curve correlates the algebraic grade difference and length of vertical curve. K-values are helpful when evaluating vertical curves because they indicate the sight distance for that curve. K-values for vertical curves were evaluated and a summary of deficiencies can be found in the following section.

Figure 3-20: Vertical Deficiencies



3.3.2. Sight Distance

Stopping sight distance (SSD) is the minimum distance required for a driver traveling at a given speed to stop a vehicle after seeing an object in their path. Stopping sight distance was evaluated with respect to the rate of vertical curvature or K-Value, for both crest and sag vertical curves. FDM values were used to determine the actual design speed of vertical curves. Seven locations were found to have below minimum stopping sight distance requirements (see Figure 3-21). Stopping sight distance is considered a controlling criteria for evaluation for this study.

Decision sight distance is the distance at which a driver can detect a decision point in an environment of visual clutter, recognize its potential threat, select an appropriate speed and path, and perform the required action safely and efficiently. This study evaluated the decision sight distance for situational locations along the corridor based on a 24-inch object height per the FDM. There are nine locations (see Figure 3-22) with decision sight distance deficiencies.

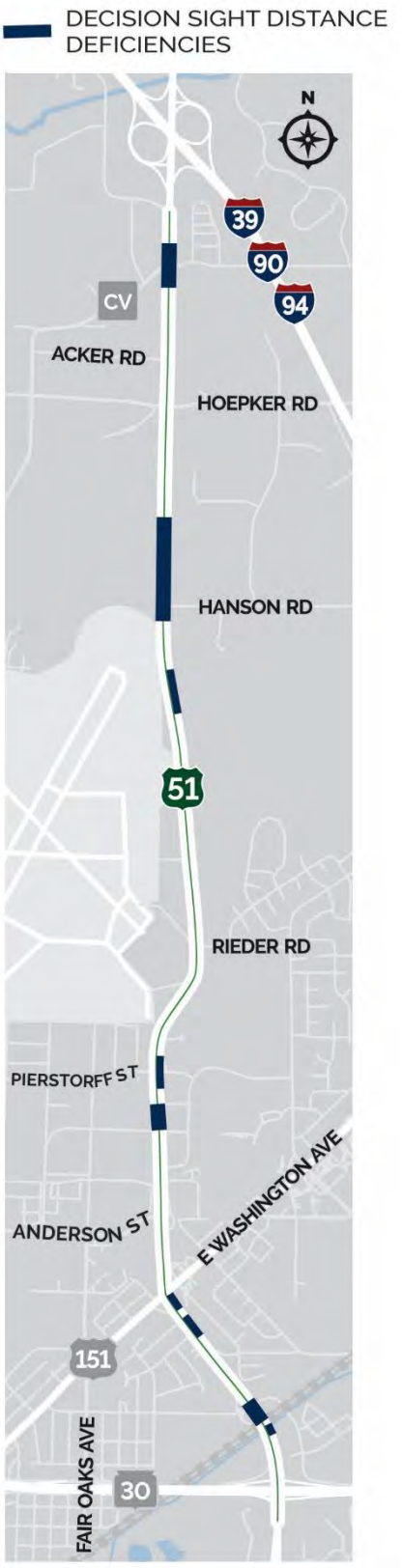
The application of design criteria for either SSD or DSD is different depending on the complexity of the driving conditions that can be expected at a particular location. Because of this, the locations of sight distance deficiencies for SSD or DSD do not overlap for this section of the US 51 corridor. More details can be found in FDM 11-10 Attachment 5.2 Sight Distance Category Applications.

3.3.3. Cross Section

Lane and shoulder widths, curb type, median widths, cross slopes, vertical and lateral clearances and clear zones were considered in examining the existing cross section of the roadway. See the geometric deficiencies technical memo for more details. Numerous locations were found to be deficient and details are listed in Table 3.12. They include:

Figure 3-21: Stopping Sight Distance Deficiencies

Figure 3-22: Decision Sight Distance Deficiencies



- The vertical curb face geometry does not meet standards due to the speed of the roadway.
- The existing beam guard does not meet current design standards.
- Three sign structure locations have below minimum vertical clearances within the study area. Two of these sign structures are exempt from sign specific clearance standards because they are mounted to the structures at US 51 and WIS 30. These structures meet minimum bridge vertical clearances for interchanges.
- The box culverts under Commercial Avenue and US 51 do not meet the required minimum roadway widths due to the presence of vertical curb.

Table 3.12: Cross Section Deficiencies

Location	Deficiency Type	Minimum Requirement	Actual Value
SB US 51 between WIS 30 and Commercial Avenue (Approx. 270' north of WIS 30 ramp termini)	Lateral Clearance	6' Lateral Clearance	2.5' Lateral Clearance
NB/SB US 51 between WIS 30 and East Washington Avenue	Curb Type/Height	4" Sloping Curb	6" Vertical Curb
NB/SB US 51 between Anderson Street and Pierstorff Avenue	Curb Type/Height	4" Sloping Curb	6" Vertical Curb
NB US 51 between Commercial Avenue and East Washington Avenue (Approx. 1400' north of Commercial Avenue)	Roadway Clear Zone	18' Clear Zone	10' Clear Zone
NB US 51 at Rieder Road	Roadway Clear Zone	30' Clear Zone	13' Clear Zone
NB/SB US 51 between Rieder Road and Hanson Road over Starkweather Creek (Approx. 4000' north of Rieder Road)	Roadway Clear Zone	30' Clear Zone	10' Clear Zone
NB/SB US 51 between Hanson Road and Hoepker Road (Approx. 700' north of Hanson Road)	Roadway Clear Zone	30' Clear Zone	6' Clear Zone
Between Commercial Avenue and East Washington Avenue - Ground mounted cantilever mast over NB US 51	Vertical Clearance	18'0"	16'11"
Commercial Avenue (East of US 51) at Starkweather Creek Box Culvert (B-13-390)	Horizontal Clearance	51' Roadway Clear Width	48' Roadway Clear Width
Commercial Avenue (West of US 51) at Starkweather Creek Box Culvert (B-13-389)	Vertical Clearance	51' Roadway Clear Width	32' Roadway Clear Width

3.3.4. Pavement Condition

Pavement

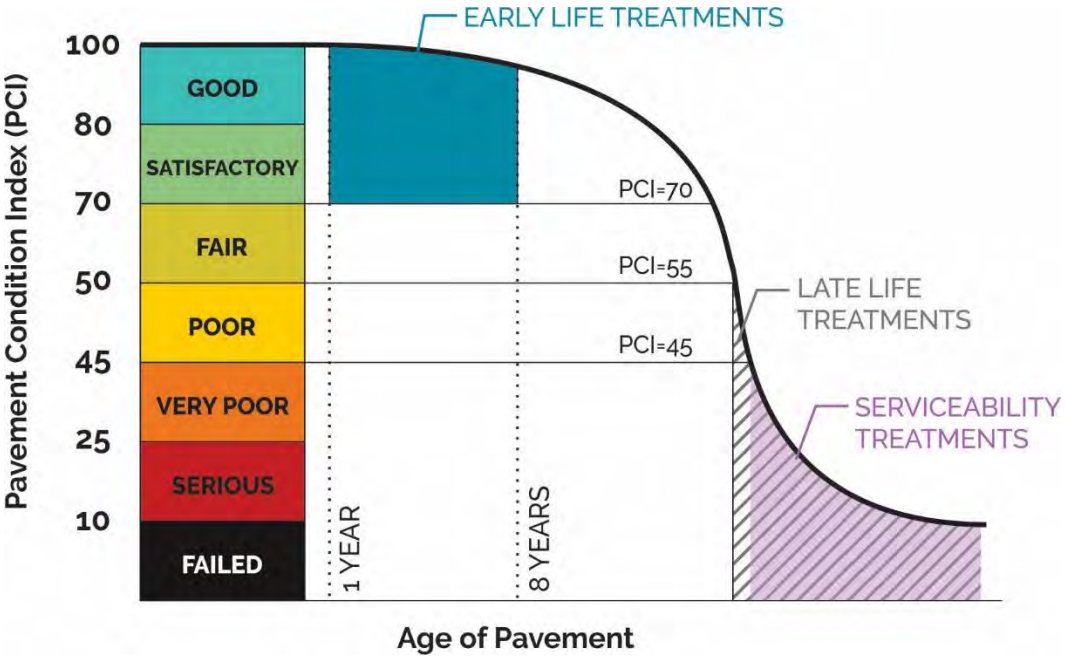
TWO LOCATIONS OF PAVEMENT CONDITIONS AT OR NEARING THE THRESHOLD FOR REPLACEMENT

There are two locations in the study limits that have current or anticipated poor pavement condition, one at the East Washington Avenue intersection and the other along US 51 between County CV and Hoepker Road.

To evaluate the condition of existing pavement, WisDOT uses the pavement condition index (PCI). This is a numerical index between 0 and 100 used to indicate the general condition of a pavement section. It is a statistical measure which requires manual survey standardized by the American Society for Testing Materials (ASTM). PCI is widely used in transportation civil engineering and asset management as the standard for cost-effective prediction of road conditions.

The ASTM divides the PCI into seven classes as Figure 3-23.

Figure 3-23: Pavement Life Cycle Schematic



Pavement distress types for asphalt pavements include:

- Alligator cracking
- Bleeding
- Block cracking
- Bumps and sags
- Corrugations
- Depressions
- Edge cracking
- Joint reflections
- Lane/shoulder drop-off
- Longitudinal and transverse cracking
- Low ride quality
- Patching and utility cut patching
- Polished aggregate
- Potholes
- Rutting
- Shoving
- Slippage cracking
- Swelling
- Weathering and raveling

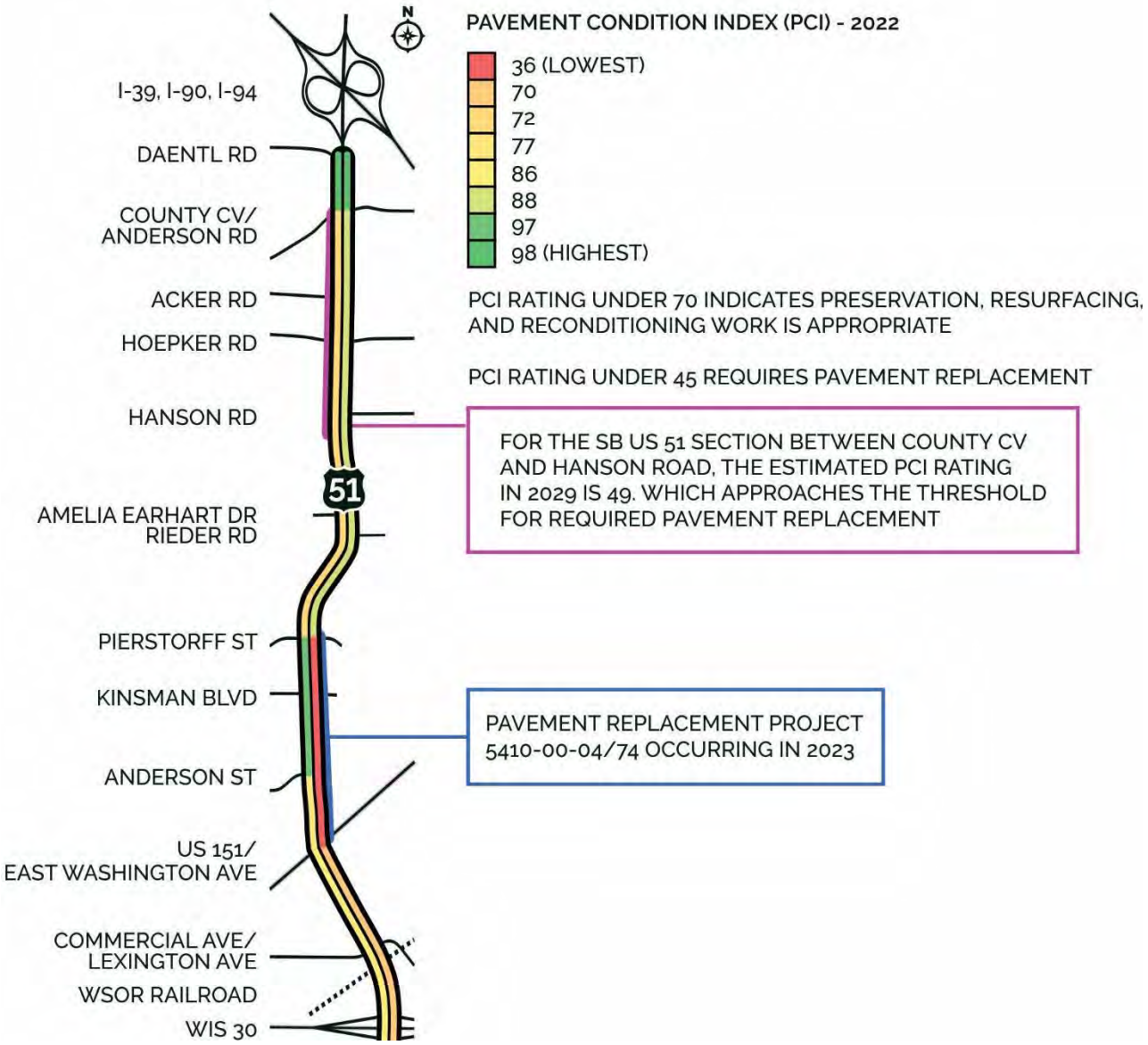
Existing pavement PCI data was provided by WisDOT Pavement Data Unit for the US 51 corridor (mainline) between WIS 30 and WIS 19 and can be found in Figure 3-24. The existing pavement condition along US 51 is currently rated “good” or “satisfactory” except at one location. The northbound travel lanes of US 51 between East Washington Avenue and Pierstorff Street (0.8 miles) have reached the Pavement Critical Index (PCI) threshold of 45 and needs serviceability treatments.

This section is programmed for improvement under the WisDOT Project ID: 5410-00-04/74 The US 51 Northbound Pavement Replacement (PVRPLA) Project. This project is scheduled for construction in 2023 and does not include pavement improvements through the entire East Washington Avenue intersection.

There are two areas of need related to the pavement conditions for the study. These areas are identified in Figure 3-24

- East Washington Avenue intersection outside of the limits of future Project ID:5410-00-04/74. This area has a current PCI rating of 36 (very poor) and an anticipated PCI rating of 20 (serious) in 2029.
- Southbound pavement between County CV and Hanson Road has an anticipated PCI rating of 49 (poor) in 2029. This rating is approaching the PCI threshold of 45 (very poor) pavement and the need for serviceability treatments. Depending on various factors, pavement in this section may deteriorate faster than anticipated due to increasing heavy truck use of the corridor. No maintenance projects have been identified along this segment.

Figure 3-24: Existing Roadway Pavement Conditions



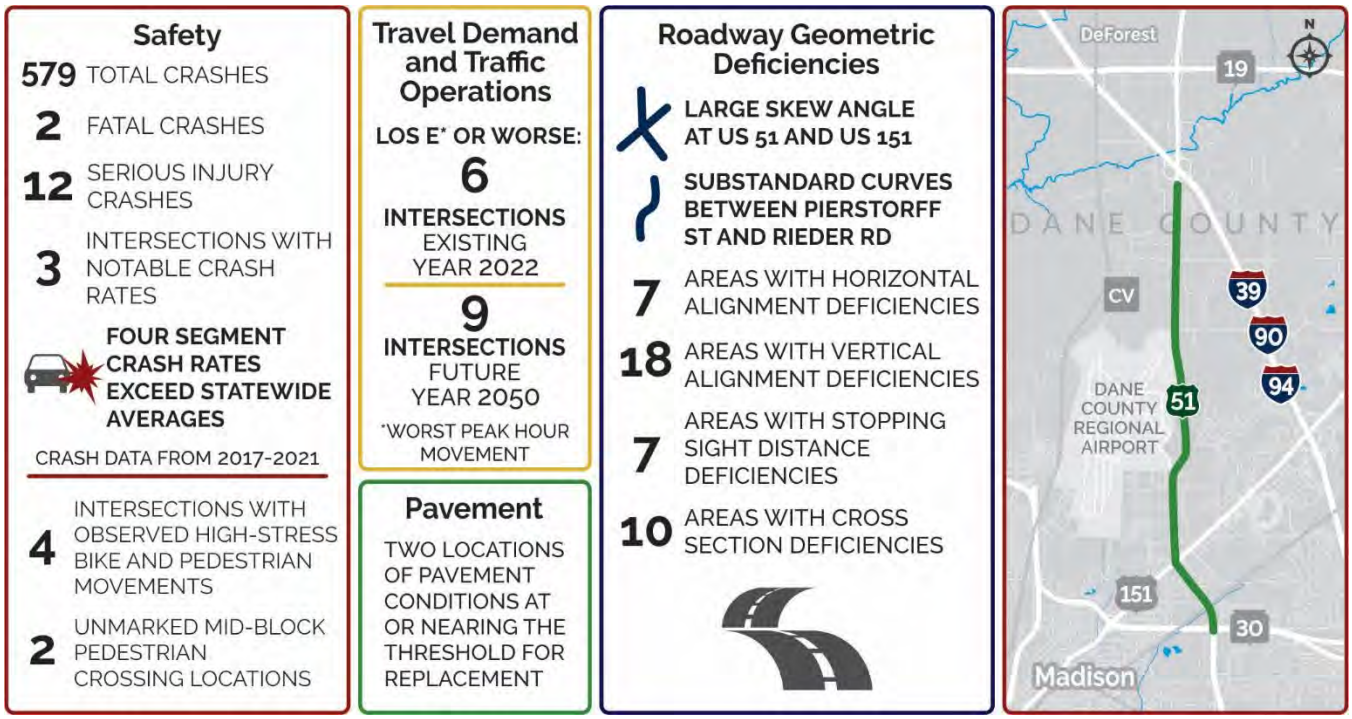
3.3.5. Additional Considerations

Dane County Regional Airport – Runway Protection Zones

US 51 traverses through the Dane County Regional Airport property and is located within runway protection zone (RPZ) boundaries. The Federal Aviation Administration (FAA) states that RPZs are trapezoidal areas beyond the runway end that serve to enhance the protection of people and property on the ground. This is preferably achieved through airport owner control over RPZs. While it is desirable to clear all incompatible land uses, objects, and non-aeronautical activities from the RPZ, some non-aviation uses are permitted where necessary. The study team will work with the Dane County Regional Airport to discuss improvement alternatives that do not further encroach on the RPZ areas and limit the public use of the areas. Additional information regarding the RPZ zone uses and limitations can be found in the alternative screening memo[7].

3.4. Summary of Needs

The need for transportation improvements throughout the US 51 (Stoughton Road) North Study corridor is demonstrated through the factors of safety, travel demand and traffic operations, and roadway and geometric deficiencies.



[7] *The alternative screening memo is in process and will be linked here when a draft version can be shared.*