Interstate Modification Justification Report

Interstate 229 - Exit 4 (Cliff Avenue)

Sioux Falls, SD

S.P. No. MINN05HN

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Executive Summary

This Interchange Modification Justification Report (IMJR) provides technical analysis related to the proposed changes to the existing Cliff Avenue interchange (Exit 4) on Interstate 229 (I-229) in Sioux Falls, SD.

The proposed action is a reconfiguration of the existing Cliff Avenue interchange on Interstate 229 in Sioux Falls, SD. The action is proposed to bring the existing interchange up to current design standards and provide improved safety and operational capacity for future traffic demand for all roadway users.

The existing Exit 4 interchange was first identified as having safety and capacity problems during the 2010 Decennial Interstate Corridor Study and more recently with the I-229 Major Investment Study (MIS), both included recommendations for interchange improvements at the Exit 4 interchange.

No adverse impacts to the Interstate highway system are forecast due to the proposed changes at the interchange. However, the design year 2050 traffic forecasts show impacts to the Interstate system due to regional growth in the metropolitan area.

Due to the impacts in the 2050 design year, an interim year of 2035 was evaluated to estimate the time-frame for the freeway mainline impacts in the study area. This evaluation resulted in no impacts along northbound I-229. Southbound I-229 would have capacity impacts along the 2-lane segments at each interchange in the study area in the No Build conditions. If these sections of I-229 are expanded they will operate within operational and safety goals with any build alternative; however at a minimum all bridge structures should be designed to accommodate the additional lanes.

The Federal policy considerations and requirements have been addressed in the Recommendations section of this report including the two technical requirements for approval.

The proposed change is a reconfiguration of an existing interchange and improvements to the existing arterial facility. These changes will correct existing deficiencies including:

- Safety
- Operations
- Intersection Spacing
- Non-motorized facilities

The proposed changes, as part of Alternative 6, do not result in any new access points on the Interstate Highway System.

The concept alternatives for the interchange and changes to the crossroad arterial street satisfy current design standards and meet the transportation needs within the study area.

Mass transit reaches a limited market in South Dakota and High Occupancy Vehicle (HOV) facilities are currently not in use because they have not been shown to be economically feasible at this time. Neither mass transit nor HOV facilities will correct design deficiencies or provide sufficient relief to future travel demands within the study planning horizon year.

The operational and safety analysis contained in this study show that the proposed build alternatives are not expected to adversely affect the safety or efficiency of the interstate system. The build

alternatives are also expected to improve access management and non-motorized facilities on the crossroad in the vicinity of the interchange area.

The proposal is the result of land use and transportation plans prepared within the Metropolitan Planning Organization (MPO) process, including the Sioux Falls MPO Long Range Transportation Plan. While the preliminary engineering for this project is included in the current Statewide Transportation Improvement Plan (STIP) for 2020-2023, the 2025-2028 Developmental STIP includes the funding and construction years.

Analysis techniques included evaluation of operational capacity using the Highway Capacity Manual (HCM), 6th Edition, techniques via the Highway Capacity Software (HCS) Version 7. Highway Safety Manual (HSM) techniques were used to the extent possible in this report; the Federal Highway Administration's (FHWA) Interactive Highway Safety Design Model (IHSDM) was utilized. Other techniques and reference materials are detailed in the Methods and Assumptions document prepared for this study and signed by the City of Sioux Falls, SDDOT, and FHWA participants on September 21, 2018 and modified as necessary throughout the study. The Methods and Assumptions document is included in **Appendix K**.

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Interstate Modification Justification Report

Interstate 229 - Exit 4 (Cliff Avenue)

Prepared for the South Dakota Department of Transportation in cooperation with the Federal Highway Administration and the City of Sioux Falls.

1 Introduction

The South Dakota Department of Transportation (SDDOT) has initiated an assessment of the existing interchange on Interstate 229 (I-229) at Cliff Avenue (Exit 4) in Sioux Falls, South Dakota.

This Interchange Modification Justification Report (IMJR) is the culmination of several steps that have been completed to document the benefits and impacts associated with a range of modification alternatives for the existing interchange. This document was completed following the outline provided in the Federal Highway Administration (FHWA) August 2010 Interstate System Access Informational Guide and meets the requirements of the Access to the Interstate System policy printed in the Federal Register on August 27, 2009 and updated on May 22, 2017.

The interchange study project evaluated both the Minnesota Avenue (Exit 3) and Cliff Avenue (Exit 4) interchanges with I-229; however, the delivery of the project was to separate the two interchange documents as two separate actions. Therefore, this IMJR will include a larger study area encompassing the entire interchange study, but contain information regarding the Cliff Avenue (Exit 4) interchange for approvals.

1.1 Background

SDDOT, the City of Sioux Falls, and FWHA have conducted an interchange study to evaluate the design, safety, and operations, as well as policy and funding implications, of modifying the Cliff Avenue (Exit 4) interchange along I-229.

The existing interchange serves as an urban arterial corridor that carries a significant amount of commuting traffic in southern Sioux Falls. The IMJR is being prepared in conjunction with applicable environmental reviews and analyses, and will provide the traffic analysis for the selection of the preferred alternative design.

1.2 Purpose

The purpose of the project is to improve travel mobility and safety at the I-229 interchange with Cliff Avenue (Exit 4) and along the Cliff Avenue corridor for all roadway users. The transportation planning process will be used to shape the project's objectives and purpose and need in the National Environmental Policy Act (NEPA) process.

The existing Exit 4 interchange was first identified as having safety and capacity problems during the 2010 Decennial Interstate Corridor Study, which identified the need for improvements at the

interchange. The 2010 study also recommended the widening of I-229 in the study area to add an additional lane in each direction by the forecast year 2020.

The more recent I-229 Major Investment Study (MIS) was completed and included recommendations for interchange improvements at the Exit 4 interchange. The MIS allowed the City of Sioux Falls, the Sioux Falls Metropolitan Planning Organization (MPO), the SDDOT, FHWA, and others to help determine the vision for the I-229 Corridor. The I-229 Exit 4 (Cliff Avenue) Corridor Study was a subarea study of the I-229 MIS.

Neither the MIS nor the subarea study recommended the need for I-229 capacity improvements through the forecast year 2035. This study continues the previous planning work and provides the necessary evaluations for consideration by SDDOT and FHWA.

1.3 Project Location

The subject interchange is at mileage reference marker 4 on I-229, in southern Sioux Falls, SD. The interchange is approximately four miles east/northeast of the I-29/I-229 system interchange and six miles south of the I-229/I-90 system interchange. The adjacent interchanges along I-229 are Minnesota Avenue (Exit 3) and 26th Street (Exit 5); the interchange spacing is approximately 1-mile to either side of the subject interchange.

This location is within the Sioux Falls MPO and within the developed urban area of the city. The Cliff Avenue corridor is a primary commuter route between downtown and the urban/suburban residential areas throughout the southern Sioux Falls metropolitan area.

Cliff Avenue is a five-lane principal arterial through the project area; there is a two way left turn lane (TWLTL) north and south of the interchange. Major intersections include 33rd Street, and 49th Street; however there are many local roadway intersections and driveway access locations, as well as access to Lincoln High School which is just north of the interchange.

1.4 Logical Termini

As the existing interchange is in the developed area of the city, the project termini extends away from the study interchange. The study area is shown in **Figure 1**; both Exits 3 and 4 are marked on the figure, as the interchanges were studied together. **Figure 2** shows an aerial view of the four study interchanges.

- Western Limits along I-229: the closest service interchange to the west is Minnesota Avenue (Exit 3), this interchange is approximately 1-mile west. As the Exit 3 and Exit 4 interchanges were studied together, the next interchange to the west is Western Avenue (Exit 2) and is approximately 1-mile west of the Minnesota Avenue interchange. Therefore, this interchange is a reasonable west terminus for this project.
- Eastern Limits along I-229: the closest service interchange to the east is 26th Street (Exit 5), this interchange is approximately 1-mile east. Therefore, this interchange is a reasonable east terminus for this project.
- Northern Limits along Cliff Avenue: the interchange project only intends to reconstruct Cliff Avenue at the interchange; therefore the next signalized intersection to the north is the intersection of Cliff Avenue at 33rd Street.

- Southern Limits along Cliff Avenue: the interchange project only intends to reconstruct Cliff Avenue at the interchange; therefore the next signalized intersection to the south is 49th Street.

Figure 1 – Project Study Area (Location Map)

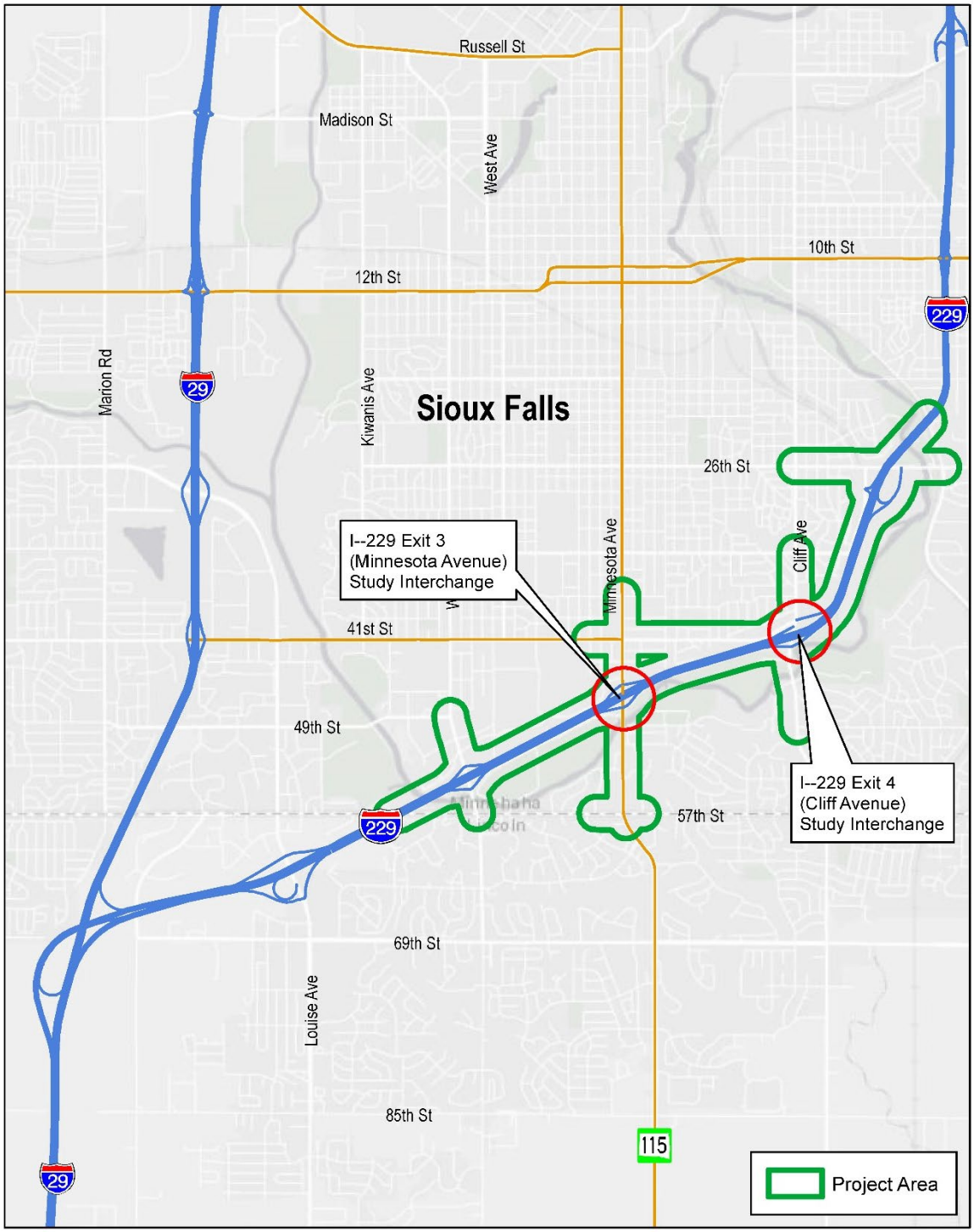
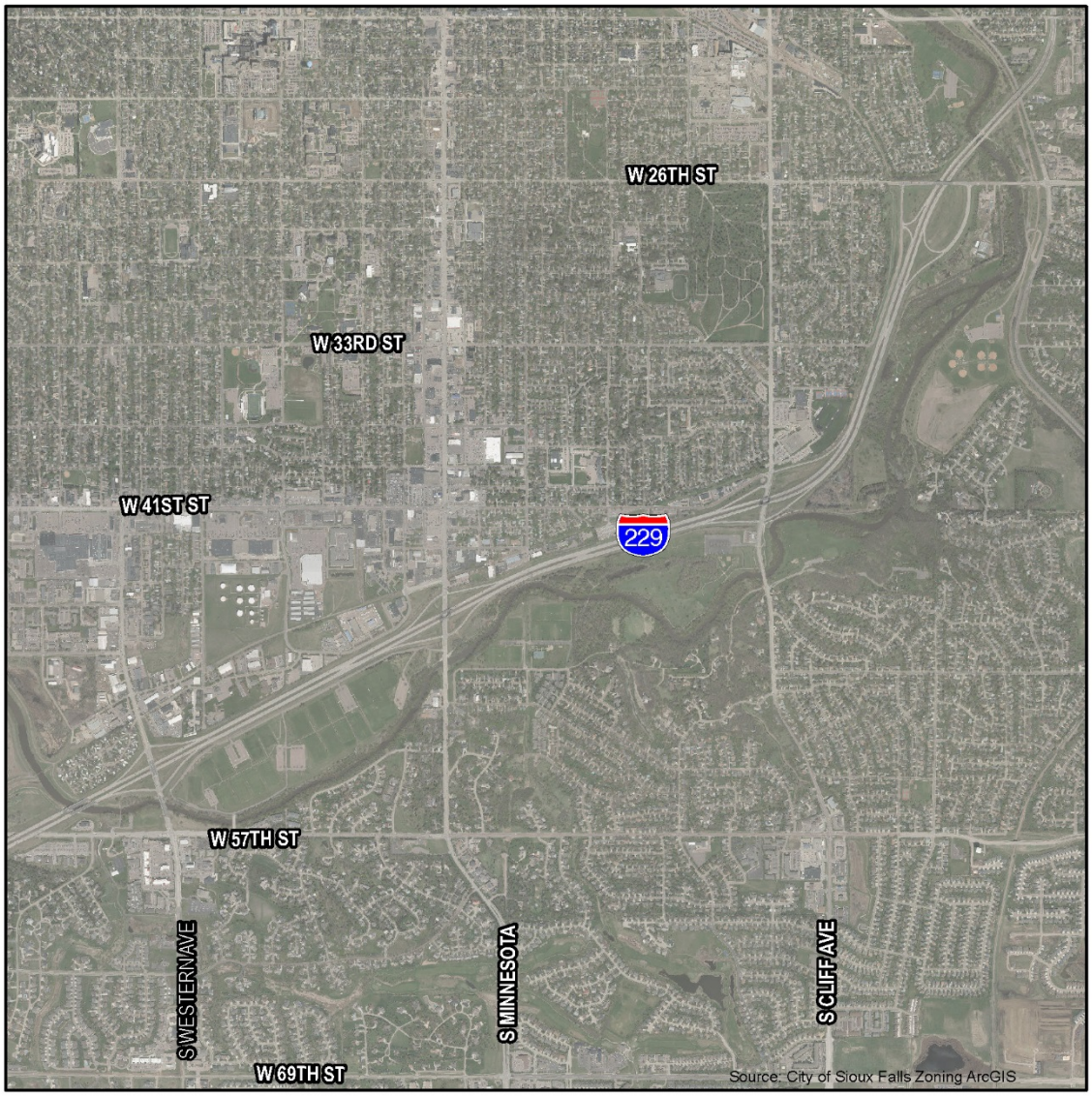


Figure 2 – Project Area Existing Configuration



2 Methodology

This Interchange Modification Justification Report (IMJR) demonstrates that the action associated with implementing the proposed project does not have any fatal flaws. Demonstrating that no fatal flaws exist does not endorse the action, but rather allows for the conclusion that the identified access alternatives are not flawed from the perspective of traffic operations and safety, as required by FHWA. Fatal flaws would include a proposed interchange justification that:

- Does not provide full access to public roadway.
- Would negatively impact interstate facility traffic operations and cannot be reasonably mitigated.
- Would negatively impact interstate facility/cross street safety and cannot be reasonably mitigated.
- Conflicts with, or is inconsistent with, local and regional plans.
- Would create the potential for environmental consequences which could not be mitigated.

This IMJR, including the analysis and documentation, was developed through the following steps:

- Establish an appropriate study area; determined in the Methods and Assumption document and represented in the previous **Figure 1**.
- Data gathering; review available traffic volume data, crash history, land use, and any other additional information.
- Review previous interstate and/or traffic studies, and coordinate with preparation of the environmental studies as part of the NEPA process, including the feasible alternatives and the best technical solution developed through the IMJR.
- Determine existing and future operational and safety characteristics of both the interstate and local cross street facilities to address FHWA requirements for interstate access modifications.
- Prepare and deliver the IMJR.

Traffic forecasts were prepared using output from the regional travel demand model maintained by the City of Sioux Falls. Analysis techniques included evaluation of operational capacity using the Highway Capacity Manual (HCM), 6th Edition, techniques via the Highway Capacity Software (HCS) Version 7. Highway Safety Manual (HSM) techniques were used to the extent possible in this report.

This IMJR document is organized in accordance with section 3.5.3 of FHWA's *Interstate Systems Access Information Guide*, August 2010.

This IMJR was developed with oversight from FHWA, SDDOT, City of Sioux Falls, and other project partners following the criteria outlined in the Methods and Assumptions (M&A) document for the study. The final M&A document is attached in **Appendix K**.

A Study Advisory Team (SAT) was set up and includes representatives of the SDDOT, FHWA, City of Sioux Falls, and the Sioux Falls Metropolitan Planning Organization (MPO). The SAT was formed to guide the study through completion.

3 Existing Conditions

The study area consists of four interchanges along I-229, including Western Avenue, Minnesota Avenue, Cliff Avenue, and 26th Street interchanges; this includes over 4-miles of I-229. Along the cross streets, a total of approximately 4-miles of arterial roadway, including I-229 study intersections, were evaluated.

Within the study area, the transportation system is comprised of the entire range of functional classification from local streets through interstate routes.

3.1 Demographics

The Sioux Falls metropolitan area enjoys a strong economy and sustained population growth. During the period 1980 – 2010 the population grew at a steady rate of between 2% and 2.5% per year. Even in the face of the recent recession, the population continued to grow with the 2010 Census showing the city with a population of 153,888; the 2018 Census Bureau estimated a current population of 181,883. The Metropolitan Statistical Area (MSA) had a population of 228,261. This area includes the four counties surrounding the City of Sioux Falls.

3.2 Existing Land Use

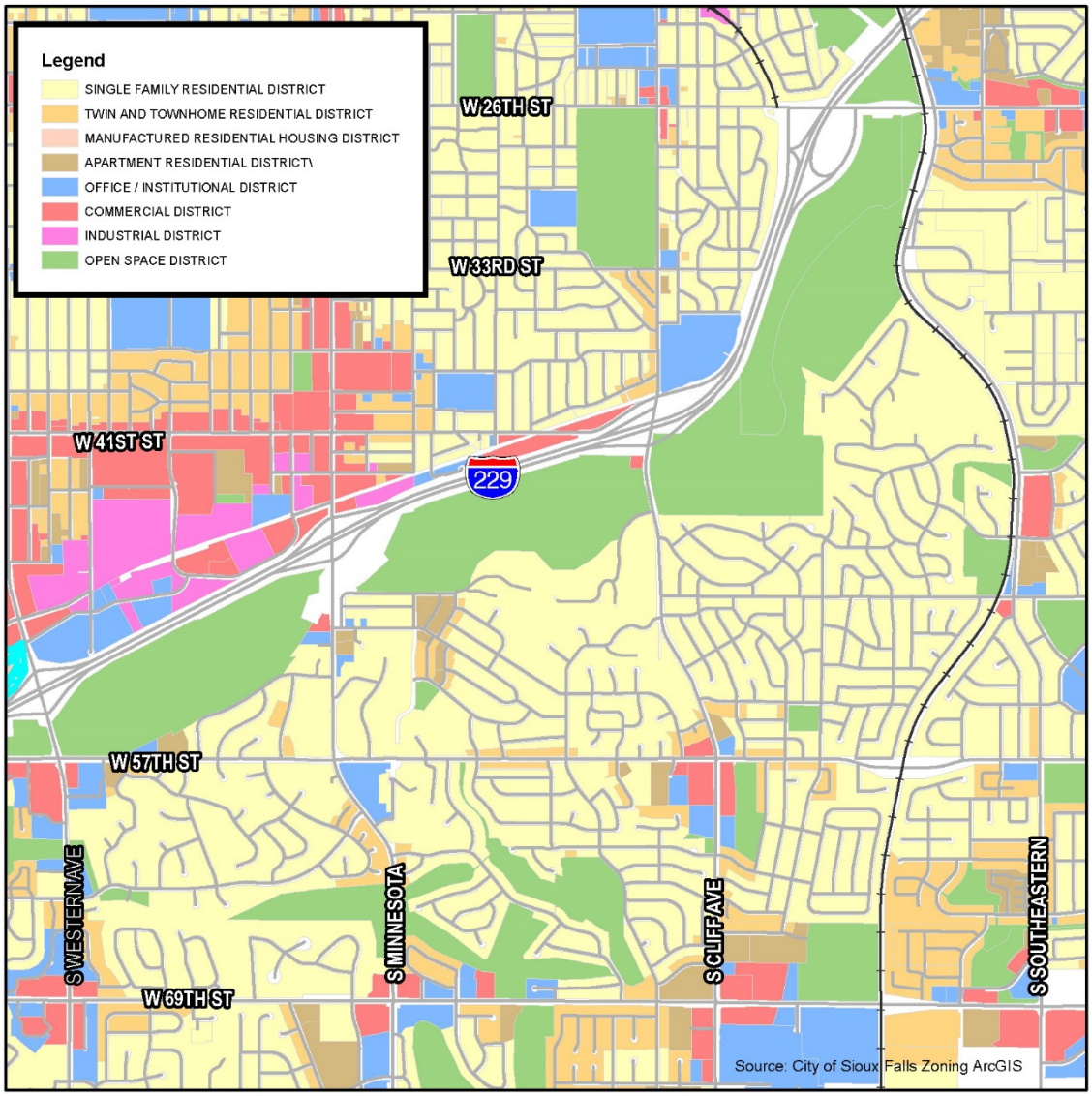
The entire study area is comprised of a mix of many different land uses including commercial, industrial, retail, and residential. The flood plain of the Big Sioux River and associated parks and open space are also present.

Directly north of I-229, along Cliff Avenue, there is a mix of residential uses as well as a high school directly in the northeast quadrant of the interchange. Directly south of I-229 is a significant amount of park land, which transitions to mostly residential uses.

The study area Traffic Analysis Zones (TAZ's) currently reflect the existing population and employment inputs. The future year TAZ's show limited increases in population and employment inputs in the established neighborhoods; however outside of the study area to the south and east, there are increases due to regional growth.

The current City of Sioux Falls zoning for the study area is represented in **Figure 3**.

Figure 3 – Existing Zoning Map



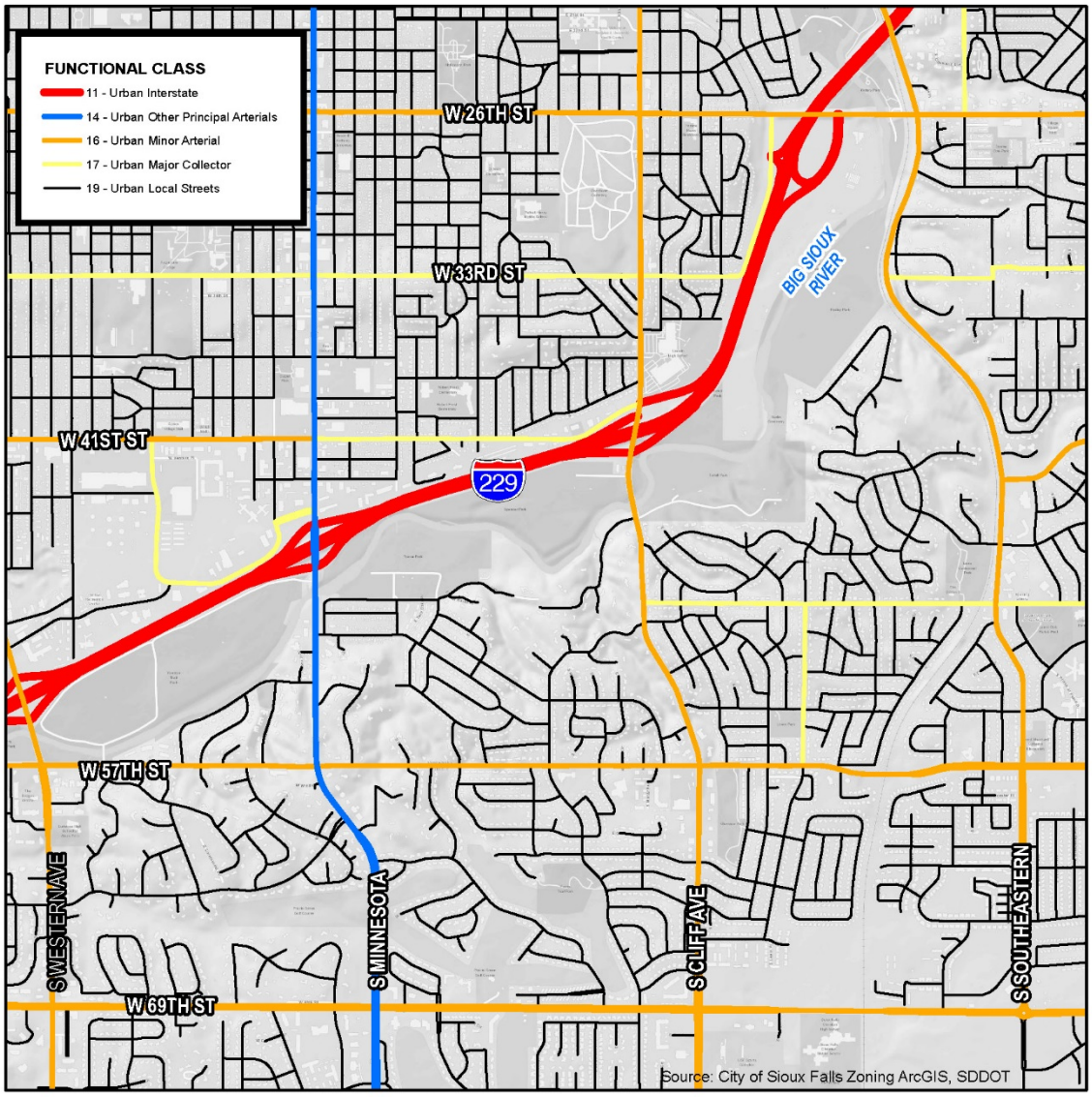
3.3 Existing Roadway Network

The existing roadway network, represented by their Federal functional classification, surrounding the project area is shown in **Figure 4**.

The existing major roadways within the study area include:

- **I-229** – urban interstate facility, currently two continuous lanes in each direction with auxiliary lanes provided between the four study area interchanges.
- **S. Western Avenue** – 4-lane divided urban minor arterial; transitions to a 5-lane section with a two way left turn lane (TWLTL) north of I-229.
- **S. Minnesota Avenue** – 5-lane urban principal arterial; two through lanes in each direction with a TWLTL.
- **S. Cliff Avenue** – 5-lane urban minor arterial; two through lanes in each direction with a TWLTL.
- **E. 26th Street** – urban minor arterial varying between 3- and 5-lane sections. 26th Street will be reconstructed to a 4-lane divided roadway through the I-229 interchange as part of an on-going interchange project (2019/2020 construction).
- **W. 57th Street** – urban minor arterial varying between a 4-lane undivided and 5-lane roadway.
- **W. 49th Street** – this roadway is currently discontinuous between Western Avenue and Minnesota Avenue; while not currently funded, the connection is anticipated to be completed before the 2050 horizon year. West of Western Avenue, 49th Street is a 4-lane undivided urban minor arterial. West of Minnesota Avenue, 49th is an urban major collector that extends for only approximately 700 feet before it terminates. It is anticipated that the functional classification between Western Avenue and Minnesota Avenue will change upon the connection's completion.
- **W. 41st Street** - 5-lane urban minor arterial west of Minnesota Avenue; to the east it transitions from a 5-lane urban major collector to a 3-lane urban major collector.
- **E. 41st Street** – 2-lane undivided urban collector west of Cliff Avenue.
- **E. 37th Street** – 2-lane urban local roadway.
- **E. 49th Street** – 2-lane undivided urban major collector roadway.
- **E. 33rd Street** – 2-lane undivided urban major collector roadway.
- **S. Yeager Road** – 2-lane undivided urban major collector roadway.
- **S. Southeastern Avenue** – urban minor arterial transitioning between a 3-lane and 4-lane roadway. Southeastern Avenue will be reconstructed to a 4-lane divided roadway through the 26th Street intersection as part of the 2019-2020 interchange project.

Figure 4 – Existing Federal Functional Classification



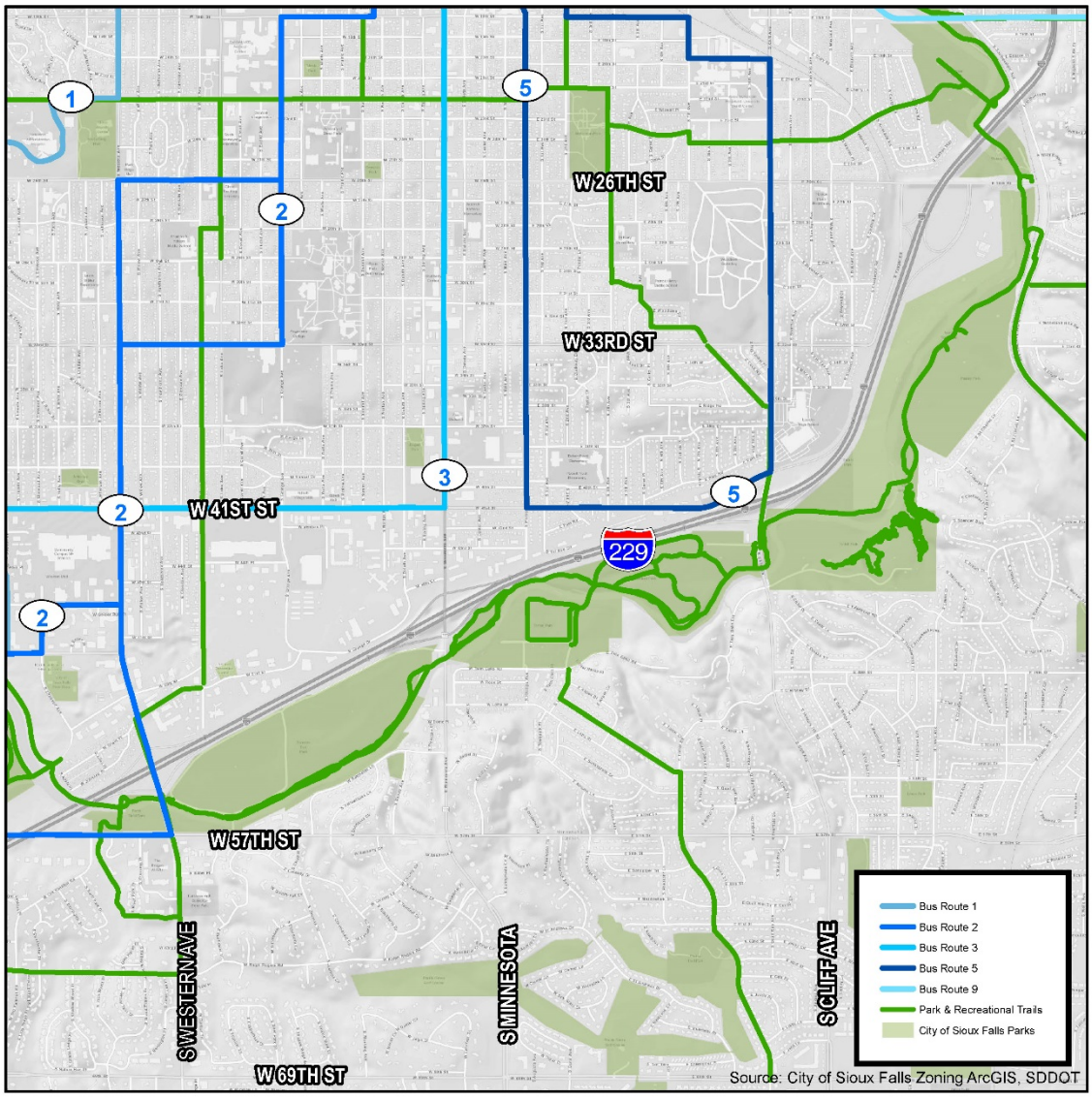
3.4 Alternative Travel Modes

Travel within the study area is primarily by automobile. Pedestrian and bicycle modes are used mainly for recreation, although bicycle commuters use the River Greenway bike trail system and street signed routes throughout the study area. Lincoln High School, located on Cliff Avenue, generates a significant amount of pedestrian volumes on the Cliff Avenue corridor.

The area is partially served by municipal transit routes 2, 3, and 5. These bus routes operate on portions of 57th Street, Western Avenue, Cliff Avenue, and 41st Street. Buses operate on headways that vary from about 30 to 60 minutes and routes wind through neighborhoods to serve passenger destinations.

The following **Figure 5** shows the existing bus routes and the existing bike trail system.

Figure 5 – Existing Bus Routes and Trail System



3.5 Interchanges

The following is a description and aerial photograph of the four existing interchanges within the entire project study area.

3.5.1 I-229 at Western Avenue (Exit 2)

This service interchange along I-229 is a standard diamond configuration as shown in **Figure 6**. All ramp connections are currently single lane ramps at the merge and diverge locations with I-229, with full auxiliary lanes provided between the adjacent interchanges on either side. At this interchange, Western Avenue travels over I-229 on a single bridge structure.

Both ramp terminal intersections are currently controlled by traffic signals with approximately 675 feet between the intersections. The nearest intersection north of the interchange is approximately 500 feet away at 51st Street (minor street stop control), the nearest intersection to the south is approximately 750 feet away at 57th Street (traffic signal control).

Directly south of the interchange, Western Avenue includes a bridge structure over the Big Sioux River; this structure currently limits the southbound approach capacity and storage to the 57th Street intersection.

Figure 6 – Existing I-229 at Western Avenue Interchange

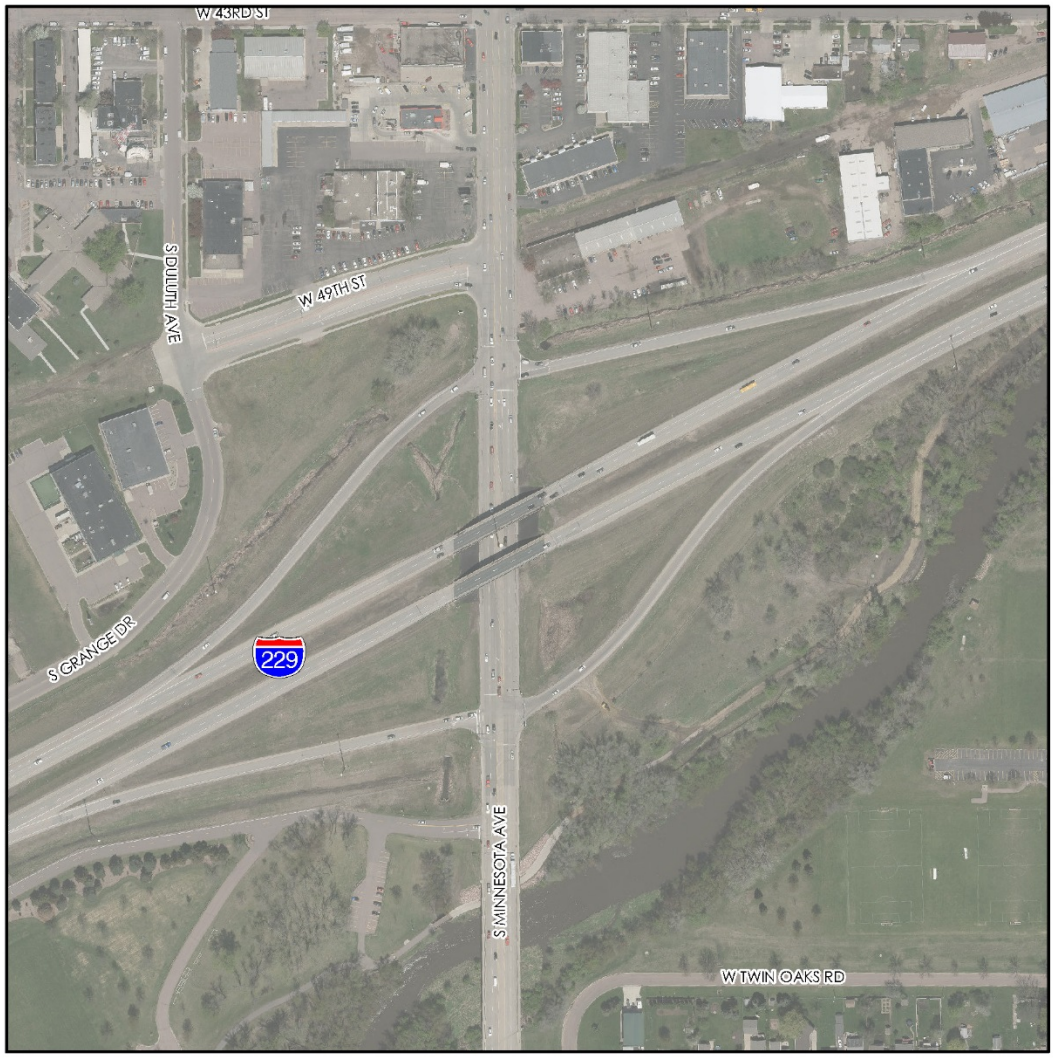
3.5.2 I-229 at Minnesota Avenue (Exit 3)

This service interchange along I-229 is a standard diamond configuration as shown in **Figure 7**. All ramp connections are currently single lane ramps at the merge and diverge locations with I-229, with full auxiliary lanes provided between the adjacent interchanges on either side. At this interchange, I-229 travels over Minnesota Avenue on two separate bridge structures.

Both ramp terminal intersections are currently controlled by traffic signals with approximately 675 feet between the intersections. The nearest intersection north of the interchange is approximately 200 feet away at 49th Street (minor street stop control), the nearest intersection to the south is approximately 200 feet away at Park Access Road (minor street stop control)).

Directly south of the interchange, Minnesota Avenue includes a bridge structure over the Big Sioux River.

Figure 7 – Existing I-229 at Minnesota Avenue Interchange



3.5.3 I-229 at Cliff Avenue (Exit 4)

This service interchange along I-229 is a modified diamond configuration as shown in **Figure 8**. The southbound I-229 off ramp is aligned with 41st Street and the southbound entrance ramp is a standalone T-intersection. All ramp connections are currently single lane ramps at the merge and diverge locations with I-229, with full auxiliary lanes provided between the adjacent interchanges on either side. At this interchange, I-229 travels over Cliff Avenue on two separate bridge structures.

The 41st Street/southbound I-229 exit ramp terminal intersection and the northbound I-229 ramp terminal intersection are currently controlled by traffic signals with approximately 800 feet between the intersections; the southbound entrance ramp intersection is uncontrolled and is less than 200 feet south of 41st Street. The nearest intersection north of the interchange is approximately 150 feet away at Lincoln High School (minor street stop control), the nearest intersection to the south is approximately 400 feet away at Park Access Road (minor street stop control); however there are two additional driveways between the intersections.

Figure 8 – Existing I-229 at Cliff Avenue Interchange

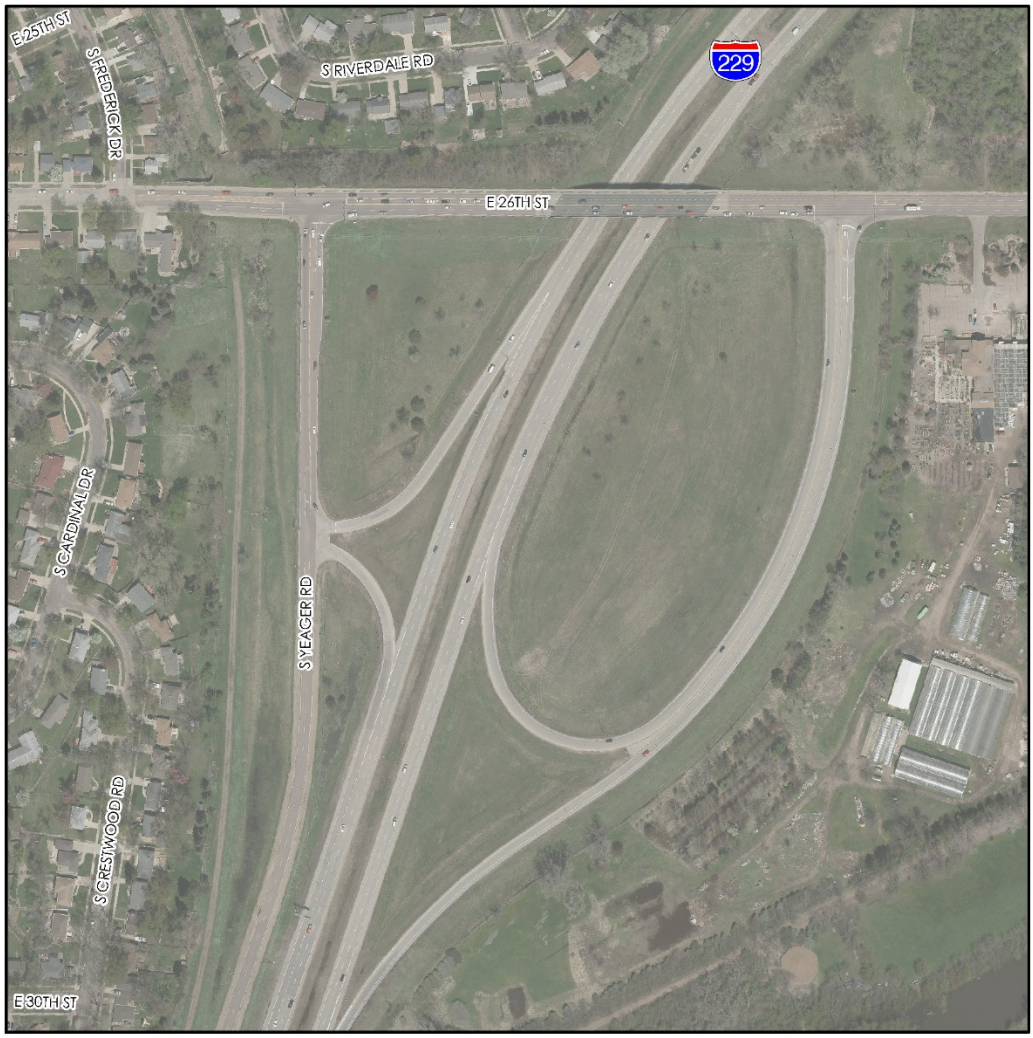
3.5.4 I-229 at 26th Street (Exit 5)

This service interchange is an unconventional interchange configuration as shown in **Figure 9**. The northbound I-229 ramps are a standard folded diamond configuration, while the southbound I-229 ramps are a buttonhook configuration connecting to Yeager Road. All ramp connections are currently single lane ramps at the merge and diverge locations with I-229; full auxiliary lanes are provided between the adjacent interchange to the south only. At this interchange, 26th Street travels over I-229 on a single bridge structure.

Currently, the 26th Street/Yeager Road intersection and the northbound ramp terminal intersection are controlled by traffic signals with approximately 1,100 feet between the intersections; the southbound ramp terminal intersection at Yeager Road includes stop control for the exit ramp.

A project is currently underway to reconstruct the interchange area and is slated to be complete after the 2020 construction season. Therefore, the existing conditions will use the current configuration, but all future analysis years will use the proposed reconfiguration.

Figure 9 – Existing I-229 at 26th Street Interchange

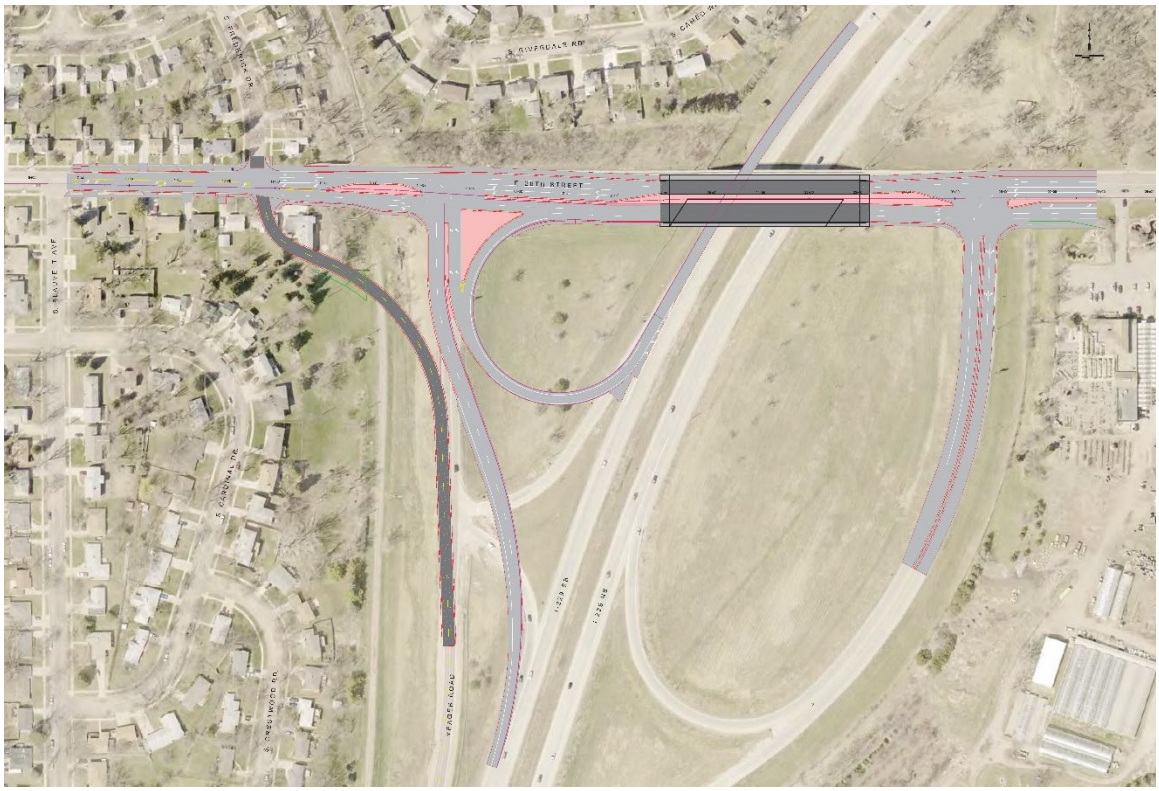


The proposed reconfiguration will reconstruct the interchange to a standard folded diamond configuration as shown in **Figure 10**. The northbound I-229 ramp connections will be widened near the ramp terminal intersection, but are unchanged near the ramp gores. The southbound ramp configuration will be entirely reconfigured.

Yeager Road will be realigned to connect to 26th Street west of its current location and will no longer be related to the interchange. A new southbound exit loop ramp will be constructed and directly tie into 26th Street; this new ramp terminal intersection is essentially in the same location as the existing 26th Street/Yeager Road intersection. The first intersection to the west will be approximately 400 feet away at the new Yeager Road intersection.

26th Street will be widened and additional turn lanes will be provided at the ramp terminal intersections; both will be controlled by traffic signals. The 26th Street at Yeager Road intersection will be under minor street stop control. The expansion of 26th Street will extend to the east and include significant reconfiguration of the intersection with Southeastern Avenue. The first intersection to the east will be approximately 300 feet away at a business driveway, with the first major intersection approximately 1,250 feet away at Southeastern Avenue.

Figure 10 – Proposed I-229 at 26th Street Interchange (2020)



3.6 Existing Data

The data used to create this document came from the participating agencies including the SDDOT and the City of Sioux Falls. The most recent data available was used in the analysis including traffic counts, crash data, signal timing data, and the travel demand forecast model.

The existing freeway traffic counts and intersection turning movements at all study intersections can be found in **Appendix I**, *I-229 Exit 3 and Exit 4 Interchange Study – Traffic Forecasts* memorandum.

3.6.1 Origin Destination Study

An origin-destination (OD) study was developed for I-229 based on data from a 3rd party vendor platform, StreetLight Data Incorporated. The platform uses global positioning system (GPS) information and location based service (LBS) information from both connected vehicles (cars and trucks) and cell phones.

A full OD study was conducted along I-229 between I-29 and I-90, including all nine service interchanges between the two system interchanges. The full results can be found in the *I-229 Exits 3 & 4 Interchange Study: Origin-Destination Study* memorandum, which can be found attached in **Appendix J**.

The platform allowed for 1-year worth of data to be pulled for the entire I-229 corridor; a total of 375,000 personal LBS trips and 265,000 commercial GPS trips were captured along the corridor. Personal vehicle GPS data did not provide sufficient trip counts. The data only produced approximately 40,000 trips, therefore, it was not used in the evaluation.

The data is sorted out by day of the week and grouped by hours throughout the day. For this OD analysis, the weekday trips during the AM and PM peak periods, 6am to 9am and 3pm to 6pm, were tabulated for use in this study evaluation.

For this report, the information regarding the weaving percentages between the study interchanges was utilized in the operational weaving analysis. **Table 1** shows the results of the six weaving segments within this interchange project area.

Table 1 – Origin-Destination Weaving Results

Ramp Weaving Segment		Avg Weekday 24-hr Data	Avg Weekday AM Peak	Avg Weekday PM Peak
NB I-229	Exit 2 to Exit 3	20%	20%	18%
NB I-229	Exit 3 to Exit 4	17%	20%	18%
NB I-229	Exit 4 to Exit 5	24%	11%	27%
SB I-229	Exit 5 to Exit 4	18%	15%	19%
SB I-229	Exit 4 to Exit 3	23%	20%	24%
SB I-229	Exit 3 to Exit 2	32%	32%	30%

3.7 Operational Performance

A traffic operations study was conducted for the project area using 2018 traffic volumes. A total of twenty-nine existing intersections and sixteen ramp junctions were analyzed within the interchange study area.

Analysis techniques included evaluation of operational capacity using the Highway Capacity Manual (HCM), 6th Edition, techniques via the Highway Capacity Software (HCS) Version 7.

It should be noted that the HCM does not recommend using the merge and diverge analysis procedures when a full length auxiliary lane is provided; the methodologies were derived from acceleration and deceleration lengths of 1,500 feet or less. Page 14-30 of the HCM 6th Edition says:

- The freeway segment downstream of the on-ramp or upstream of the off-ramp is simply considered to be a basic freeway segment with an additional lane.
- The case of an on-ramp followed by an off-ramp lane drop may be a weaving segment and should be evaluated with the procedures of Chapter 13, Freeway Weaving Segments.

Therefore, for this analysis both the basic lane and weaving segment analysis were conducted on all freeway mainline segments that include full auxiliary lanes between ramp connections.

3.7.1 Level of Service Criteria

The freeway and arterial Level of Service (LOS) criteria presented in the following tables were used to evaluate the traffic operations in the study area; the information is from the SDDOT Road Design Manual (Chapter 15) and based on the Highway Capacity Manual (HCM).

Table 2 – Freeway – LOS Criteria

Level of Service (LOS)	Description	Density (pc/mi/ln)
A	Free-flow operation	≤ 11.0
B	Reasonably free-flow operation; minimal restriction on lane changes & maneuvers	> 11.0 to 18.0
C	Near free-flow operation; noticeable restriction on lane changes & other maneuvers	> 18.0 to 26.0
D	Speed decline with increasing flows; significant restriction on lane changes & other maneuvers	> 26.0 to 35.0
E	Facility operates at capacity; very few gaps for lane changes & other maneuvers; frequent disruptions & queues	> 35.0 to 45.0
F	Unstable flow; operational breakdown	> 45.0

Source: SDDOT Road Design Manual (Table 15-1)

Table 3 – Signalized Intersection Control – LOS Criteria

Level of Service (LOS)	Description	Signalized Delay (sec/veh)
A	Very minimal queueing; excellent corridor progression	≤ 10.00
B	Some queuing; good corridor progression	> 10.0 to 20.0
C	Regular queueing; not all demand may be serviced on some cycles (cycle failure)	> 20.0 to 35.0
D	Queue lengths increased; routine cycle failures	> 35.0 to 55.0
E	Majority of cycles fail	> 55.0 to 80.0
F	Volume to capacity ratio approaches 1.0; very long queues, almost all cycles fail	> 80.0

Source: SDDOT Road Design Manual (Table 15-5)

Table 4 – All-Way Stop & Two Way Stop Intersection Control – LOS Criteria

Level of Service (LOS)	Description	Un-signalized Delay (sec/veh)
A	Queuing is rare	≤ 10.00
B	Occasional queueing	> 10.0 to 15.0
C	Regular queueing	> 15.0 to 25.0
D	Queue lengths increase	> 25.0 to 35.0
E	Significant queueing	> 35.0 to 50.0
F	Volume to capacity ratio approaches 1.0; very long queues	> 50.0

Source: SDDOT Road Design Manual (Table 15-6 and 15-7)

The SDDOT has established a minimum of LOS C on urban interstate highway corridors, including ramp terminal intersections.

The City of Sioux Falls has established a minimum of LOS D on arterial signalized intersections and any intersection movement at LOS E or better.

3.7.2 Existing Operations

The summation of the existing traffic operations analysis show that mainline I-229 operates acceptably. All existing ramp junctions and weaving segments operate at a LOS C or better during the AM and PM peak hours.

Results for the individual segments and ramp junctions of I-229 are shown in **Figure 11** as well as **Table 5**.

Figure 11 – Existing 2018 Freeway Configuration and LOS

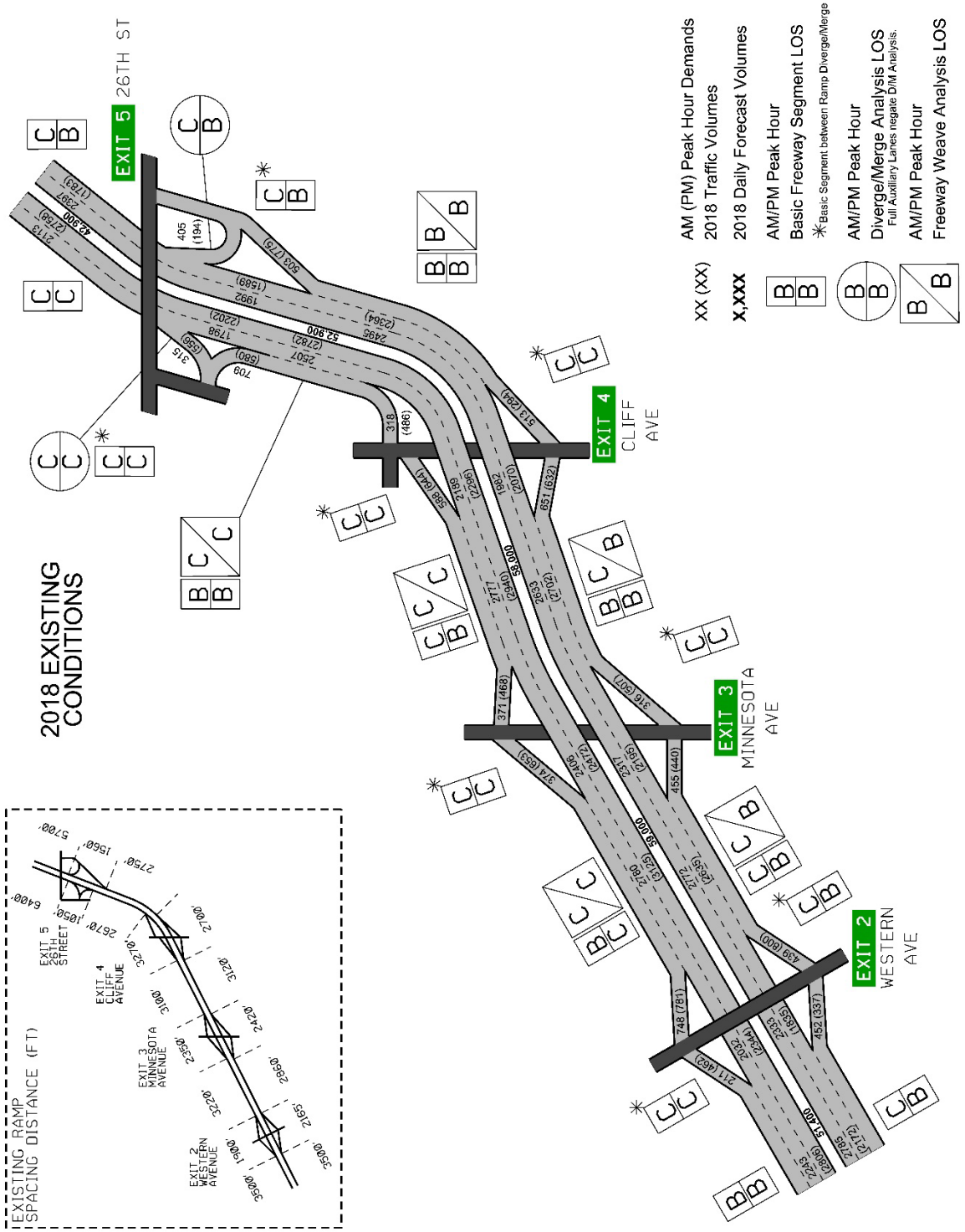


Table 5 – Existing 2018 I-229 Freeway Operations Summary

Road	Description	Analysis Type	AM Peak LOS	PM Peak LOS
NB I-229	NB I-229: southwest of Exit 2	Basic	C	B
	NB I-229: between Exit 2 Exit and Entrance Ramps	Basic	C	B
	NB I-229: between Exit 2 and Exit 3	Basic	C	B
		Weave	C	B
	NB I-229: between Exit 3 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 3 and Exit 4	Basic	B	B
		Weave	C	B
	NB I-229: between Exit 4 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 4 and Exit 5	Basic	B	B
		Weave	B	B
	NB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	B
	NB I-229: Exit 5 Entrance Ramp	Merge	C	B
	NB I-229: northeast of Exit 5	Basic	C	B
SB I-229	SB I-229: northeast of Exit 5	Basic	C	C
	SB I-229: Exit 5 Exit Ramp	Diverge	C	C
	SB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	C
	SB I-229: between Exit 5 and Exit 4	Basic	B	B
		Weave	C	C
	SB I-229: between Exit 4 Exit and Entrance Ramps	Basic	C	C
	SB I-229: between Exit 4 and Exit 3	Basic	C	B
		Weave	C	C
	SB I-229: between Exit 3 Exit and Entrance Ramps	Basic	C	C
	SB I-229: between Exit 3 and Exit 2	Basic	B	C
		Weave	C	C
	SB I-229: between Exit 2 Exit and Entrance Ramps	Basic	C	C
	SB I-229: southwest of Exit 2	Basic	B	B

The project study area also includes twenty-nine arterial intersections identified for operational analysis. **Table 6** summarizes the results of the existing traffic analysis for the ramp terminal intersections as well as adjacent major intersections within the study area. The existing lane configurations of each study intersection, with turn lane storage and the intersection LOS results, can be found in **Appendix A**.

Available storage for turning vehicles plays an important role in the operations of an intersection. The HCM software does not properly handle lane blockage conditions, providing LOS results that are not reflective of actual operations. The HCM methodologies provide a “Queue Storage Ratio” (RQ) which is the maximum stacking of queued vehicles (SDDOT recommends the 95th percentile queue) divided by the available storage length provided for the movement. If the RQ is above 1.0, it represents a queue that is spilling outside of the available storage and blocking other movements at the intersection. At any intersection where the RQ is above 1.0 for a

movement, it is SDDOT preference to state the intersection has failing operations, regardless of the overall delay at the intersection.

Throughout all four interchange areas many intersections, including ramp termini, operate at unacceptable LOS during the peak hours. A total of 22 of the study intersections have at least one peak hour operating under failing conditions.

Table 6 – Existing 2018 Arterial Intersection Control – LOS Criteria

Major Roadway	Intersecting Roadway	Control Type	AM Peak	PM Peak
Western Avenue	W 49th Street	Signal	B	C
Western Avenue	I-229 SB Ramp Terminal	Signal	C	**C***
Western Avenue	I-229 NB Ramp Terminal	Signal	C	**C***
Western Avenue	W 57th Street	Signal	D	**D***
Minnesota Avenue	W 37th Street	Signal	C	**C-**
Minnesota Avenue	W 41st Street	Signal	**C***	**E-**
Minnesota Avenue	W 49th Street	Minor Stop	**C-**	**F**
Minnesota Avenue	I-229 SB Ramp Terminal	Signal	B	**B-**
Minnesota Avenue	I-229 NB Ramp Terminal	Signal	**C-**	**B***
Minnesota Avenue	Yankton Park Entrance	Minor Stop	B	**F**
Minnesota Avenue	W Lotta Street	Minor Stop	**E-**	**E-**
Minnesota Avenue	W 57th Street	Signal	**C***	**D***
Cliff Avenue	E 33rd Street	Signal	B	C
Cliff Avenue	36th St/LHS Entrance #4	Minor Stop	C	C
Cliff Avenue	38th St/LHS Entrance #3	Minor Stop	**F**	D
Cliff Avenue	LHS Entrance #2	Minor Stop	C	A
Cliff Avenue	LHS Entrance #1	Minor Stop	**F**	**E**
Cliff Avenue	41st St/I-229 SB Exit Ramp	Signal	**B***	**C***
Cliff Avenue	I-229 SB Entrance Ramp	No Control	C	D
Cliff Avenue	I-229 NB Ramp Terminal	Signal	**C***	B
Cliff Avenue	Spencer Park Entrance	Minor Stop	C	C
Cliff Avenue	E 49th Street	Signal	**B***	B
26th Street	S Cliff Avenue	Signal	**C***	**D***
26th Street	S Yeager Road	Signal	B	**C***
26th Street	I-229 NB Ramp Terminal	Signal	**B***	**F**
26th Street	Southeastern Avenue	Signal	**C***	D
Yeager Road	I-229 SB Ramp Terminal	Minor Stop	**F**	**F**
41st Street	S Norton Avenue	Signal	**A-**	B
41st Street	S Phillips Avenue	Signal	C	C

Notes: *Intersection considered failing due to LOS and/or Queue Storage Ratio.*

- Average Intersection LOS shown, individual movements and/or approaches may be different. Minor Street Stop Control intersections LOS represents the worst minor approach LOS; major roadway would operate at LOS A.

*- " * " Queue Storage Ratio greater than 1.0 for at least 1 movement, results in failing intersection.*

- " – " At least one movement operates at a LOS F (not noted if intersection is at LOS F)

3.8 Existing Safety Issues

A comprehensive safety analysis was conducted for the entire project area for this study. The analysis included the most recent 5-years of crash history available from the SDDOT. This included the five calendar years of 2013 through 2017.

The crash records were segregated into crashes for each of the study intersections and the arterial and freeway segments. The type and severity of the crashes were reviewed and crash rates and critical rates were calculated for each.

Crash severity is comprised of 5 separate types including fatal, an incapacitating injury (Severity A), a non-incapacitating injury (Severity B), a possible injury (Severity C), or a property damage only (PD) crash; wild animal hits are coded in a separate category.

Crash rates are expressed as the number of crashes per million entering vehicles (MEV) at an intersection or along a segment. The critical crash rate is a statistical value that is unique to each intersection. It is based on vehicular exposure and the average crash rate for similar intersection or segment; a crash rate higher than the critical rates indicates a sustained crash problem. A critical crash rate index is calculated by dividing the crash rate by the critical rate. Any index value above 1.0 indicates a crash rate at or exceeding the critical rate.

The average crash rate for an urban freeway system, provided by SDDOT, was 1.09 crashes per MEV. The City of Sioux Falls provided the most recent average crash data, from 2015, for the varying arterial roadway and intersection control types.

A total of 1,939 crashes occurred within the entire project area during the 5-year analysis period. A total of 1,209 occurred at the study intersections, 443 crashes occurred along the study area roadway segments, and 287 crashes occurred along the freeway mainline or ramp connections.

The following tables show the severity breakdown of the study area intersections, roadway segments, and freeway segments.

All freeway mainline segments are well below the calculated critical rates, see **Table 7**. Approximately 53%, 137 crashes of the 259 total, were single vehicles departing the roadway or an animal hit. Approximately 25% of the crashes were rear end collisions and 14% were side swipe. Poor weather conditions were only observed in approximately 28% of the mainline crashes.

Along the I-229 ramp connections, only one of the study area ramps is above the critical rate, see **Table 8**. The 26th Street entrance loop ramp had a total of 10 crashes; all were single vehicles departing the roadway with 3 caused by too high of speeds and 5 had poor road surface conditions.

Table 7 – Crash History – I-229 Mainline

	Description	Crash Severity							Rate Information		
	Segment	Fatal	A	B	C	PD	Wild Animal	Total	Crash Rate	Critical Rate	Critical Index
Northbound I-229	Exit 2 Diverge	0	0	1	1	9	1	12	0.92	1.87	0.49
	Exit 2 between Ramps	0	0	0	0	5	0	5	0.31	1.80	0.17
	Exit 2 Merge	0	0	0	3	3	0	6	0.41	1.82	0.22
	Between Exits 2 & 3	0	0	1	0	1	0	2	0.07	1.61	0.04
	Exit 3 Diverge	0	0	2	1	10	2	15	1.01	1.82	0.55
	Exit 3 between Ramps	1	0	3	1	7	2	14	0.72	1.72	0.42
	Exit 3 Merge	0	0	0	0	5	0	5	0.34	1.82	0.19
	Between Exits 3 & 4	0	0	0	0	2	1	3	0.10	1.59	0.06
	Exit 4 Diverge	0	0	1	2	3	1	7	0.47	1.82	0.26
	Exit 4 between Ramps	0	0	0	4	4	2	10	0.46	1.69	0.27
	Exit 4 Merge	0	0	1	0	9	2	12	0.86	1.85	0.47
	Between Exits 4 & 5	0	0	0	0	2	1	3	0.12	1.64	0.07
	Exit 5 Diverge	0	0	0	4	10	2	16	1.15	1.85	0.62
	Exit 5 between Ramps	0	0	0	0	1	1	2	0.22	2.03	0.11
	Exit 5 Merge	0	0	1	1	4	3	9	0.85	1.97	0.43
Southbound I-229	Exit 5 Diverge	0	0	0	2	4	1	7	0.63	1.94	0.32
	Exit 5 between Ramps	0	0	0	0	0	0	0	0.00	2.27	0.00
	Exit 5 Merge	0	0	0	1	4	5	10	0.72	1.85	0.39
	Between Exits 5 & 4	0	0	0	1	2	3	6	0.24	1.65	0.15
	Exit 4 Diverge	1	1	3	1	8	2	16	1.16	1.85	0.63
	Exit 4 between Ramps	0	0	1	4	14	2	21	0.81	1.64	0.49
	Exit 4 Merge	0	0	0	0	13	0	13	0.85	1.81	0.47
	Between Exits 4 & 3	0	0	0	0	2	1	3	0.10	1.59	0.06
	Exit 3 Diverge	0	0	0	0	4	0	4	0.26	1.81	0.14
	Exit 3 between Ramps	0	0	0	2	17	0	19	0.67	1.61	0.42
	Exit 3 Merge	0	0	0	0	9	0	9	0.56	1.80	0.31
	Between Exits 3 & 2	0	0	0	1	4	0	5	0.15	1.56	0.10
	Exit 2 Diverge	0	1	0	2	6	0	9	0.56	1.80	0.31
	Exit 2 between Ramps	0	1	0	0	7	0	8	0.53	1.82	0.29
	Exit 2 Merge	0	0	0	3	5	0	8	0.58	1.85	0.31
	TOTAL	**2**	**3**	**14**	**34**	**174**	**32**	**259**	n/a	n/a	n/a

- All mainline segments are Urban Interstate with a Statewide Average Crash Rate of 1.09.

Table 8 – Crash History – I-229 Ramp Connections

	Description	Crash Severity							Rate Information		
	Segment	Fatal	A	B	C	PD	Wild Animal	Total	Crash Rate	Critical Rate	Critical Index
NB I-229 Ramps	Exit 2 Off Ramp	0	0	0	0	1	0	1	0.74	3.78	0.20
	Exit 2 On Ramp	0	0	0	0	1	0	1	0.33	2.81	0.12
	Exit 3 Off Ramp	0	0	0	0	1	0	1	0.48	3.20	0.15
	Exit 3 On Ramp	0	0	0	0	2	0	2	0.94	3.17	0.30
	Exit 4 Off Ramp	0	0	0	0	0	0	0	0.00	3.00	0.00
	Exit 4 On Ramp	0	0	0	0	1	0	1	0.50	3.25	0.15
	Exit 5 Off Ramp	0	0	0	0	3	0	3	0.45	2.21	0.20
	Exit 5 On Ramp	0	0	1	1	8	0	10	**4.60**	**3.14**	**1.46**
SB I-229 Ramps	Exit 5 Off Ramp	0	0	0	0	0	0	0	0.00	4.16	0.00
	Exit 5 On Ramp	0	0	0	0	0	0	0	0.00	3.41	0.00
	Exit 4 Off Ramp	0	0	0	0	1	0	1	0.45	3.12	0.14
	Exit 4 On Ramp	0	0	0	0	0	0	0	0.00	2.93	0.00
	Exit 3 Off Ramp	0	0	0	0	3	0	3	1.52	3.26	0.47
	Exit 3 On Ramp	0	0	0	0	2	0	2	0.80	2.99	0.27
	Exit 2 Off Ramp	0	0	0	0	1	0	1	0.35	2.86	0.12
	Exit 2 On Ramp	0	0	0	1	1	0	2	1.85	4.14	0.45
	TOTAL	**0**	**0**	**1**	**2**	**25**	**0**	**28**			

- All mainline segments are Urban Interstate with a Statewide Average Crash Rate of 1.09.
- **Bold/Shaded** indicates a calculated crash rate that is at or exceeding than the critical rate.

There are 12 existing intersections that exceed the calculated critical rate and 5 additional intersections approaching (within 15%) the critical rates. **Table 9** shows the intersection crashes throughout the project area and **Table 10** shows the arterial roadway segment crashes.

Approximately 67% of all intersection and arterial segment crashes occurred during the afternoon hours, with approximately 25% occurring between 12pm and 3pm and approximately 42% between 3pm and 6pm. This timeframe is typically when traffic is increased to the highest levels with commuters and retail trips. Weather does not seem to be a factor with the arterial crashes; less than 15% of all crashes occurred on a roadway due to poor weather conditions.

Along Cliff Avenue, only the intersection at 41st Street/I-229 SB Exit Ramp is above the critical rate, with almost 70% of the crashes being rear end collisions. The majority of crashes involve southbound and eastbound vehicles which could be related to lack of right turn lanes and congestion at the intersection. At Otonka Trail, the majority of the crashes involved Cliff Avenue traffic rear ending each other due to following too close or failing to yield. All roadway segments along Cliff Avenue are below the critical rates.

Table 9 – Crash History – Arterial Intersections

	Description	Crash Severity							Rate Information		
	Intersection	Fatal	A	B	C	PD	Wild Animal	Total	Crash Rate	Critical Rate	Critical Index
Minnesota Avenue	at 37th St *	0	1	6	10	46	0	63	**1.07**	**0.86**	**1.25**
	at 41st St *	1	0	7	12	80	0	100	**1.33**	**1.24**	**1.08**
	at 49th St	0	1	1	9	31	0	42	**0.81**	**0.48**	**1.69**
	at I-229 SB Ramp *	0	0	1	13	44	0	58	**0.99**	**0.86**	**1.15**
	at I-229 NB Ramp *	0	0	4	4	34	0	42	0.77	0.87	0.89
	at Yankton Trail Park	0	0	1	1	2	0	4	0.10	0.49	0.20
	at Lotta St	0	0	1	5	14	0	20	0.48	0.49	0.98
	at 57th St *	0	1	2	14	50	0	67	0.93	1.24	0.75
Cliff Avenue	at 33rd St *	0	0	2	4	21	0	27	0.64	0.91	0.71
	at 36th St/LHS Ent #4	0	0	2	2	5	0	9	0.25	0.50	0.50
	at 38th St/LHS Ent #3	0	0	1	3	9	0	13	0.33	0.50	0.66
	at Lincoln HS Ent #2	0	0	0	0	1	0	1	0.03	0.50	0.06
	at Pam Road	0	0	1	4	1	0	6	0.15	0.49	0.30
	at Lincoln HS Ent #1	0	0	0	0	0	0	0	0.00	0.50	0.00
	at 41st St/I-229 SB *	0	1	2	8	54	0	65	**1.31**	**0.88**	**1.49**
	at I-229 SB Ent Ramp	0	0	0	2	11	0	13	0.35	0.50	0.70
	at I-229 NB Ramp *	0	2	0	6	18	0	26	0.53	0.88	0.60
	at Spencer Park Ent	0	0	1	0	4	0	5	0.13	0.49	0.26
	at Twin Oaks Estates	0	0	0	2	8	0	10	0.23	0.48	0.48
	at Otonka Trail	0	0	0	5	13	0	18	0.41	0.48	0.85
	at 49th St *	0	0	1	3	20	0	24	0.64	0.93	0.69
Western	at 49th St*	0	1	7	16	47	0	71	**1.49**	**1.31**	**1.13**
	at I-229 SB Ramp *	0	0	4	10	33	0	47	0.79	0.85	0.92
	at I-229 NB Ramp *	0	0	1	11	31	0	43	**0.88**	**0.88**	**1.00**
	at 57th St *	1	1	5	10	45	0	62	0.94	1.26	0.75
26th St	at Cliff Ave *	0	1	11	23	58	0	93	**1.99**	**1.32**	**1.51**
	at Yeager Road *	0	0	1	10	30	0	41	**1.21**	**0.95**	**1.28**
	at I-229 NB Ramp *	0	0	5	16	70	0	91	**1.54**	**0.86**	**1.80**
	at Southeastern Ave *	0	0	5	17	55	0	77	1.17	1.26	0.93
Yeager Rd at I-229 SB Ramp		0	1	0	6	9	0	16	**1.21**	**0.68**	**1.79**
41st St at Norton Ave *		0	1	5	5	30	0	41	**0.94**	**0.90**	**1.04**
41st St at Phillips Ave *		0	0	1	2	11	0	14	0.76	1.06	0.71
TOTAL		**2**	**11**	**78**	**233**	**885**	**0**	**1209**	n/a	n/a	n/a

- *Signalized Intersection
- **Bold/Shaded** indicates a calculated crash rate that is at or exceeding than the critical rate.
- **Shaded** crash rates indicated approaching the critical crash rate with an index of 0.85 or greater.

Table 10 – Crash History – Arterial Segments

Roadway Description		Crash Severity							Rate Information		
	From / To	Fatal	A	B	C	PD	Wild Animal	Total	Crash Rate	Critical Rate	Critical Index
Minnesota Ave	37th St / 41st St	0	0	5	3	46	0	54	4.56	4.66	0.98
	41st St / 49th St	0	0	2	2	30	0	34	3.52	4.77	0.74
	I-229 SB Ramp / I-229 NB Ramp	0	0	0	0	3	0	3	0.49	3.85	0.13
	Yankton Trail Park / Lotta St	0	0	0	0	1	1	2	0.32	5.33	0.06
	Lotta St / 57th St	0	0	0	2	12	5	19	1.22	4.52	0.27
Cliff Avenue	26th St / 33rd St	0	0	2	1	8	0	11	0.89	4.58	0.19
	33rd St / 36th St / LHS Ent #4	0	1	0	0	1	0	2	0.36	5.31	0.07
	36th St / / 38th St	0	0	2	1	4	0	7	2.49	6.25	0.40
	I-229 SB Entrance Ramp / I-229 NB Ramp	0	0	0	1	1	0	2	0.51	5.94	0.09
	I-229 NB Ramp / Spencer Park	0	0	0	0	0	1	1	0.37	6.36	0.06
	Spencer Park / Twin Oaks Estates	0	0	2	0	4	0	6	1.22	5.64	0.22
	Twin Oaks Estates / Otonka Trail	0	0	0	0	4	0	4	1.41	6.11	0.23
	Otonka Trail / 49th St	0	0	0	0	4	1	5	0.79	5.02	0.16
Western	49th St / I-229 SB Ramp	0	2	6	11	51	0	70	**5.23**	**4.52**	**1.16**
	I-229 SB Ramp / I-229 NB Ramp	0	0	0	1	1	0	2	0.42	4.08	0.10
	I-229 NB Ramp / 57th St	0	0	0	0	4	0	4	0.86	4.10	0.21
26th St	Cliff Ave / Yeager St	0	0	2	7	41	0	50	5.43	6.41	0.85
	Yeager St / I-229 NB Ramp	0	1	1	2	5	0	9	1.30	5.18	0.25
	I-229 NB Ramp / Southeastern Ave	0	0	1	2	12	1	16	1.44	4.74	0.30
41st St	Norton Ave / Minnesota Ave	0	0	4	12	53	0	69	**10.74**	**5.14**	**2.09**
	Minnesota Ave / Phillips Ave	0	0	0	0	4	0	4	1.13	7.36	0.15
	Phillips Ave / Carter Pl	0	1	0	4	13	0	18	**1.84**	**1.82**	**1.01**
	Carter Pl / Cliff Ave	0	0	0	0	5	0	5	0.51	1.80	0.28
57th -Western Ave/Minnesota Ave		1	1	3	8	27	6	46	1.66	4.17	0.40
TOTAL		**1**	**6**	**30**	**57**	**334**	**15**	**443**	n/a	n/a	n/a

- Segments not listed did not contain crashes, see intersection specific crashes.
- **Bold/Shaded** indicates a calculated crash rate that is at or exceeding than the critical rate.

Along Minnesota Avenue, the major intersections between 37th Street and the I-229 ramp terminal intersection are all at or above the critical rate; over half of the crashes are rear end collisions which is expected with a signalized intersection. However, at the 41st Street signal, over 40% of the crashes are right angle crashes which could be caused by congestion and the existing phasing scheme at the intersection (split phase). At Lotta Street, the majority of the crashes involved Minnesota Avenue traffic rear ending each other due to following too close or

failing to yield. All roadway segments are below the critical rates; however, between 37th and 41st Streets there is a high number of crashes due to turning traffic at all the access locations.

Along Western Avenue, the 49th Street intersection and both ramp terminal intersections are above the critical rates. As typical with signalized intersections, the majority (65%) of crashes are rear end collisions at all three intersections. However, at the 49th Street signal, over 30% of the crashes are right angle crashes. Many were caused by left turning vehicles not yielding to through traffic. The roadway segment between 49th and the southbound I-229 ramp terminal intersection is above the critical rate with a high number of rear end and angle crashes likely due to the number of driveway access locations along the roadway.

Along 26th Street, all four signalized intersections are at or exceeding the critical rates. As typical with signalized intersections, the majority (56%) of crashes are rear end collisions. However, at both Cliff Avenue and Southeastern Avenue, between 40% and 50% of the crashes are right angle crashes. All roadway segments are below the critical crash rates.

The intersection of Yeager Road and the I-229 southbound ramp terminal is also above the critical rate; almost 70% of the crashes at this minor street stop control are angle crashes due to the high amount of turning traffic, limited gaps, and vehicles failing to yield.

With the impending 26th Street interchange project, three of these intersections, as well as the Yeager Road and southbound ramp terminal, will be reconstructed and should see significantly improved safety and operations.

The 26th Street and Cliff Avenue intersection, as previously mentioned, has a high angle crash occurrence (53%). It should also be noted that just over 51% of the crashes have occurred in the last two years of the analysis period. There does not appear to be a clear cause of the crashes as they include all directions of traffic, with an even distribution of failure to yield, following too closely, and disregard of traffic control. There have also been 3 pedestrian crashes at this intersection in the last 5-year period.

Along 41st Street, the intersection with Norton Avenue is above the critical rate as well as the segments between Norton Avenue-Minnesota Avenue and Phillips Avenue-Carter Place. At the Norton Avenue intersection, approximately 80% of the crashes involved eastbound traffic, with the majority (66%) being rear end collisions; the majority of crashes cited failure to yield or following too closely. The roadway segment between Norton Avenue and Minnesota Avenue has a high number of rear end and angle crashes likely due to the many driveway and access locations along the roadway. The roadway segment between Phillips Avenue and Carter Place had 67% of the crashes occurring in the eastbound direction with many following too closely; there was also five crashes that involved parked vehicles.

3.8.1 Cliff Avenue Interchange Area Crashes

At the Cliff Avenue interchange, a total of 96 crashes occurred along the freeway mainline or ramp connections, 217 crashes occurred at intersections along Cliff Avenue and 29 crashes occurred on the roadway between the study intersections along Cliff Avenue.

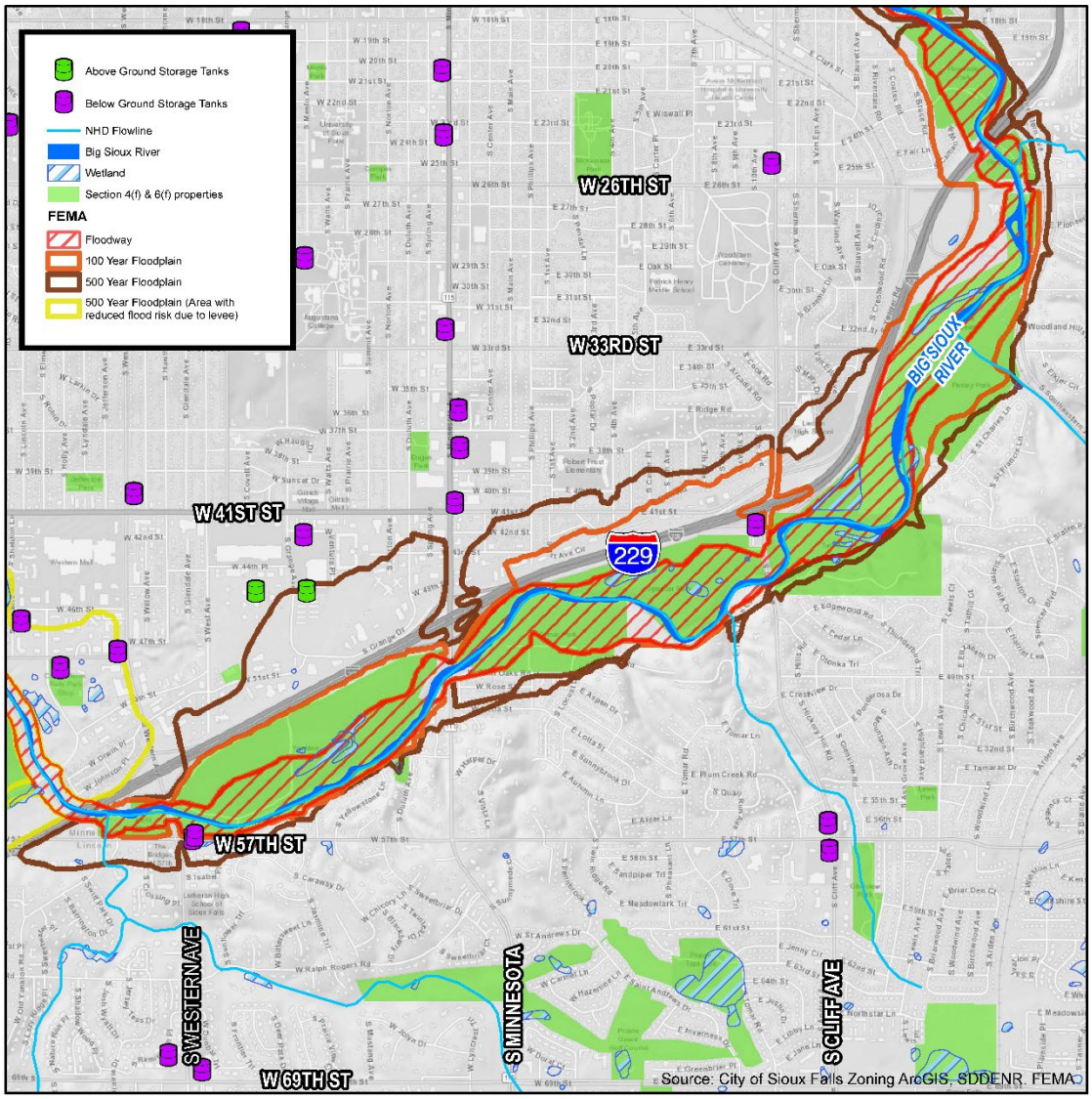
As mentioned previously, the interstate mainline, freeway ramp connections, and Cliff Avenue roadway segments are all below the critical rates. Approximately 65% of the intersection crashes along Cliff Avenue occurred at the four signalized intersections. These intersections all have high traffic volumes, intersection capacity constraints, and poor access management.

3.9 Existing Environmental Constraints

Environmental constraints are being evaluated through the Environmental Screening Report (ESR) that is being prepared concurrently with this IMJR. The study area includes portions of the Big Sioux River floodplain and associated parks, riparian and wooded areas. An overview of the study area surrounding the existing interchanges shows the most potential environmental constraints could be the wetlands, Section 4(f)/6(f) properties, and floodplains surrounding the interchanges. The interchange is surrounded by parks, trails, and pockets of residential properties that may have noise impacts and will be evaluated as part of the environmental documentation.

An ESR is being developed in conjunction with the IMJR as part of the NEPA process. The NEPA document will compare each alternative and their environmental impacts compared to the No Build alternative. **Figure 12** shows the locations of the known environmental constraints within the project area.

Figure 12 – Known Potential Environmental Constraints



4 Project Need

Previous studies including the 2010 Decennial Interstate Corridor Study and the I-229 Major Investment Study (MIS) have identified the need to improve the I-229 Exit 4 interchange to address safety concerns, correct geometric deficiencies, and improve operations during the peak periods.

The timing of interchange reconfiguration projects in South Dakota typically is controlled by the need to replace the existing pavement and/or structures. A combination of all the various needs at an interchange defines the overall need for an interchange to be reconfigured.

Geometric Deficiencies

Since the interchange was constructed in the early 1960's, geometric design standards have changed. As a result some of the existing geometric characteristics no longer meet current design standards. Some of the deficiencies include:

- Substandard shoulder widths on the ramp connections; left and right shoulders.
- Control of access of adjacent intersections to the ramp terminal intersections are less than desirable. There are currently full access intersections on either side within 250 feet of the ramp terminal intersections.

Pavement

The need to replace or rehabilitate the pavement is often the driving force behind the timing of when the majority of construction projects on the state highway system occur.

The pavement on the existing I-229 mainline through the project area is Continuously Reinforced Concrete (CRCP) and was resurfaced in 2001; many of the ramp connections were also resurfaced at this time. The I-229 pavement is in good condition.

The pavement along Cliff Avenue, according to the 2020 Pavement Management Analysis website for the City of Sioux Falls, currently has a Pavement Condition Index (PCI) that varies between 39 and 54; this ranges from "Poor" to "Fair" pavement conditions. The relative remaining life for these ranges is between 5 and 12 years.

As the remaining life of the pavement is relatively short, it is appropriate to evaluate existing and future traffic operations of the existing interchange configuration before replacing the existing pavement.

Structural

The need to replace or rehabilitate a structure is another critical consideration for timing of construction projects on the state highway system.

I-229 has two separate bridges over Cliff Avenue, both structures are currently in fair condition. The concrete bridges were constructed in 1959 and have exceeded their 50 year design life.

It is appropriate to evaluate the existing and future traffic operations before replacing or rehabilitating a structure with the expectations for continued service life.

Transportation Demand

The existing intersection traffic operations showed that all the study intersections along Cliff Avenue, including the I-229 ramp terminal intersections, have failing congestion issues during the PM peak hour; the AM peak operates at mostly acceptable delays but with many queue storage issues. The existing I-229 freeway mainline, ramp connections, and weaving segments all operate acceptably under current volumes. Details pertaining to the existing traffic operations can be found in the previous **Section 3.7**.

The lack of continuous multi-modal facilities along Cliff Avenue causes significant concerns for non-motorized users traveling along the corridor.

With the increased local and regional growth surrounding the interchange and the Sioux Falls metropolitan area, traffic operations will degrade significantly by the design year 2050. The I-229 freeway will begin to have unacceptable LOS and almost all Cliff Avenue intersections will see increased delays, longer queues, and failing operations. Details pertaining to the future No Build operations can be found in **Section 6**.

Safety

The Cliff Avenue (Exit 4) interchange was ranked 14th out of the 126 interchanges included in Phase 1 of the 2010 Decennial Interstate Corridor Study.

A review of the reported crashes between 2013 and 2017 shows that the 41st Street/I-229 Southbound ramp terminal intersection is significantly above the calculated critical rates and should be addressed.

5 Alternatives

The purpose of this chapter is to discuss the I-229 freeway facility and proposed access modifications at the Cliff Avenue (Exit 4) interchange.

The I-229 Major Investment Study (MIS) was completed and included recommendations for the Exit 4 interchange. The MIS allowed the City of Sioux Falls, the Sioux Falls Metropolitan Planning Organization (MPO), the SDDOT, FHWA, and others to help determine the vision for the I-229 corridor.

The I-229 Exit 4 (Cliff Avenue) Corridor Study was a subarea study of the I-229 MIS. The study included 8 interchange alternatives, including an added loop ramp and variations of a single point urban interchange (SPUI). The results of the alternative screening reduced the recommended alternatives to three for further evaluation, these include:

- **Cliff-1**: NB Cliff to SB I-229 Loop Ramp.
- **Cliff-6**: SPUI, 41st Realigned to the north.
- **Cliff-7**: SPUI, SB I-229 Off-Ramp Thru & Rights at 41st Street

More information regarding the I-229 MIS and the various alternatives in the Exit 4 subarea study can be found at the following website: http://www.i229study.com/

5.1 Design Criteria

The primary design principles and criteria that were used to guide the design process include:

- Basic Lane Capacity
- Route Continuity
- Lane Balance
- Interchange Spacing
- Ramp Spacing

These criteria are described in the American Association of State Highway and Transportation Official's (AASHTO) Policy on Geometric Design of Highways and Streets 2011 edition.

The existing design speed for I-229 is 70 mph, with a posted speed limit of 65 mph. The design speed of this project will follow the existing design speed.

5.1.1 Basic Lane Capacity

The basic number of lanes is defined as a minimum number of lanes designated and maintained over a significant length of a corridor, regardless of changes in traffic volumes and lane-balance. An assessment of basic lane needs is an indicator of minimum capacity requirements; it is not an indicator of the actual capacity. **Table 11**, below, summarizes the basic lane volumes for LOS C, LOS D and LOS E from the Highway Capacity Manual (HCM).

Table 11 – Basic Lane Capacity

Free Flow Speed (mph)	Per-Lane Volume Threshold (pcphpl) / (Vehicle Density (pc/mi/ln))		
	LOS C	LOS D	LOS E
75 mph	1,750 / (26.0)	2,110 / (35.0)	2,400 / (45.0)
70 mph	1,690 / (26.0)	2,080 / (35.0)	2,400 / (45.0)
65 mph	**1,630 / (26.0)**	**2,030 / (35.0)**	**2,350 / (45.0)**
60 mph	1,560 / (26.0)	2,010 / (35.0)	2,300 / (45.0)
55 mph	1,430 / (26.0)	1,900 / (35.0)	2,250 / (45.0)

Source: Highway Capacity Manual 6th Edition, Exhibit 12-4; HCM 2010, Exhibit 11-17

Table 12 represents the maximum peak hour traffic volumes along I-229 compared to the basic roadway capacity; typically the maximum peak hour volumes for northbound I-229 is during the AM peak and for southbound I-229 is during the PM peak. If the basic lane need exceeds the number of lanes provided it would represent a capacity constraint on the roadway indicated by a LOS D or LOS E. As recommended in the Methods and Assumptions document, all future year evaluations assumed a peak hour factor of 0.9 in this evaluation.

Under the existing 2018 conditions, all traffic demands are below the basic capacity thresholds for LOS C throughout the project area. Under the year of opening 2024 conditions, all traffic demands would still be below the basic capacity thresholds for LOS C throughout the project area.

By 2050, many of the southbound I-229 segments will be at LOS D/E and require additional lanes due to the increased regional traffic demands. Along northbound I-229 there are two segments that will be at LOS D and require additional lanes.

To mitigate the basic lane capacity needs along southbound I-229, three continuous travel lanes would be required from the 10th Street entrance ramp through the Louise Avenue exit ramp. Northbound I-229 would require three continuous travel lanes between the Louise Avenue entrance ramp and the Cliff Avenue exit ramp.

Regional growth in the surrounding metro area is the main culprit for the capacity constraints, not the interchange reconfiguration, therefore a mid-term analysis year of 2035 was evaluated. In this interim year, all northbound I-229 segments operate at a LOS C or better. The existing two lane segments between the exit and entrance ramps along southbound I-229 are at LOS D at the interchanges of 26th Street, Minnesota Avenue, and Western Avenue; the segment at the Cliff Avenue interchange is within 4% of capacity threshold in 2035.

Table 12 – Basic Lane Assessment - I-229 No Build

Description			Basic # Lanes	2018 Existing		2024 No Build		2035 No Build		2050 No Build	
	From	To		Peak Traffic	LOS	Peak Traffic	LOS	Peak Traffic	LOS	Peak Traffic	LOS
NB I-229	NB Louise Ave Entrance	Western Ave Exit	3	2785	B	2950	B	3230	C	3595	C
	Western Ave Exit	Western Ave Entrance	2	2333	C	2480	C	2725	C	3045	**D**
	Western Ave Entrance	Minnesota Ave Exit	3	2772	B	2930	B	3185	C	3520	C
	Minnesota Ave Exit	Minnesota Ave Entrance	2	2317	C	2460	C	2715	C	3040	**D**
	Minnesota Ave Entrance	Cliff Ave Exit	3	2702	B	2920	B	3260	C	3720	C
	Cliff Ave Exit	Cliff Ave Entrance	2	2070	B	2225	C	2470	C	2800	C
	Cliff Ave Entrance	26th St Exit	3	2495	B	2620	B	2835	B	3215	C
	26th St Exit	26th St Entrance	2	1992	B	2075	B	2225	C	2420	C
	26th St Entrance	10th St Exit	2 / 3*	2397	C	2505	B	2690	B	2930	B
SB I-229	10th St Entrance	26th St Exit	2 / 3*	2758	C	3140	B	3710	C	4520	**D**
	26th St Exit	26th St Entrance	2	2202	C	2495	C	2940	**D**	3575	**D**
	26th St Entrance	Cliff Ave Exit	3	2782	B	3085	B	3545	C	4190	C
	Cliff Ave Exit	Cliff Ave Entrance	2	2296	C	2500	C	2825	C	3290	**D**
	Cliff Ave Entrance	Minnesota Ave Exit	3	2940	B	3190	C	3580	C	4120	C
	Minnesota Ave Exit	Minnesota Ave Entrance	2	2472	C	2715	C	3090	**D**	3655	**E**
	Minnesota Ave Entrance	Western Ave Exit	3	3125	B	3375	C	3765	C	4315	C
	Western Ave Exit	Western Ave Entrance	2	2344	C	2580	C	2955	**D**	3485	**D**
	Western Ave Entrance	Louise Ave Exit	3	2806	B	3100	B	3555	C	4195	C

- Traffic is the highest/maximum peak hour volume in either of the AM or PM peak hours.
- **Bold/Shaded** indicates a LOS D or worse
- Underlined LOS criteria indicates the volume is within 10% of next LOS threshold.
- " * " Additional lane added between 10th Street and 26th Street by 2020.

5.1.2 Route Continuity

A route continuity evaluation is used to determine if any forced lane changes are required to continue along a specific highway. A forced lane change occurs when either an established through lane is dropped at a major fork diverge or when an auxiliary lane is added to the left side

of the roadway to accommodate the design of a major fork diverge and the through traffic must change lanes in order to continue.

Route continuity is currently satisfied for I-229 in the project area; I-229 has two continuous travel lanes in both directions which connect to both the I-29 and I-90 system interchanges. The proposed interchange design modifications would not alter the current route continuity of I-229.

5.1.3 Lane Balance

The concept of lane balance is intended to smooth traffic flow through and beyond an interchange. The AASHTO definition of lane balance is as follows:

1. At entrances, the number of lanes beyond the merging of two traffic streams should not be less than the sum of all traffic lanes on the merging roadways minus one.
2. At exits, the number of approach lanes on the highway must be equal to the number of lanes on the highway beyond the exit, plus the number of lanes on the exit, minus one. Exceptions to this principle occur at cloverleaf loop-ramp exits that follow a loop-ramp entrance and at exits between closely spaced interchanges (i.e. interchanges where the distance between the end of the taper of the entrance terminal and the beginning of the taper of the exit terminal is less than 1,500 ft). In these cases, the auxiliary lane may be dropped in a single-lane exit with the number of lanes on the approach roadway being equal to the number of through lanes beyond the exit plus the lane on the exit.
3. The traveled way of the highway should be reduced by not more than one traffic lane at a time.

Lane balance is satisfied at all entrances in the project area. Lane balance is not satisfied at the exit ramp locations that are fed by a full auxiliary; to fully satisfy the criteria, escape lanes would need to be provided after the exit ramp to ensure vehicles would not become trapped in the auxiliary lane.

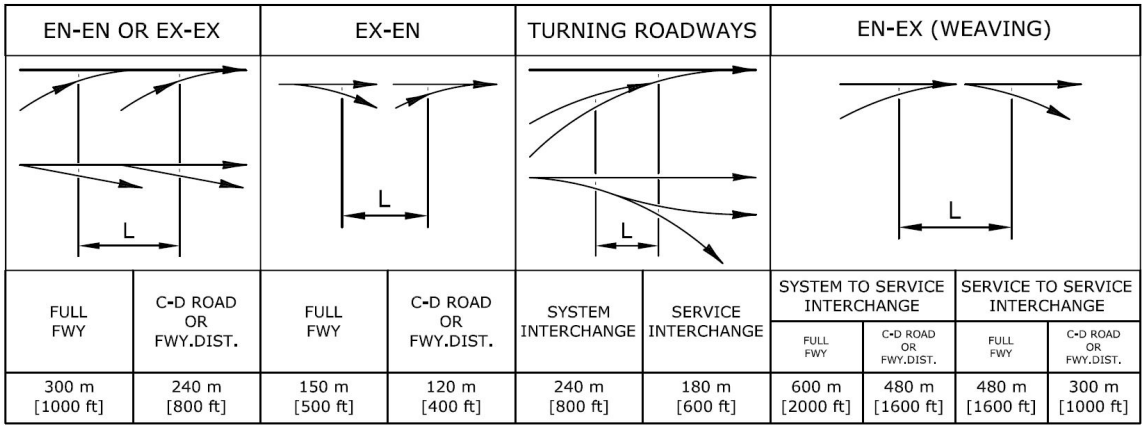
5.1.4 Interchange Spacing

In urban or urbanizing areas, the minimum recommended interchange spacing is 1-mile. The four existing I-229 interchanges all currently meet the 1-mile spacing.

5.1.5 Ramp Spacing

The distance between freeway ramps can be one of the most important features to impact freeway operations. SDDOT has established guidelines for desired interchange ramp spacing based on AASHTO criteria and these guidelines are documented in the SDDOT Road Design Manual, Chapter 13, and are shown in **Figure 13.**

Figure 13 – AASHTO/SDDOT Ramp Spacing Criteria



The primary goal for ramp spacing is “desirable” spacing; the shortest acceptable spacing is “minimum” spacing. **Table 13** summarizes the existing and No Build ramp spacing for I-229; all ramp spacing is greater than the “desirable” ramp spacing for I-229. The proposed ramp configurations will be discussed in **Table 14** as each alternative has differing spacing conditions.

Table 13 – I-229 Ramp Spacing – Existing/No Build

	Description		Ramp Type	Desirable Space (ft)	Minimum Space (ft)	Existing (ft)	No Build (ft)
	From	To					
NB I-229	NB Louise Ave Entrance	Western Ave Exit	EN-EX	2000	1500	3500	3500
	Western Ave Exit	Western Ave Entrance	EX-EN	750	500	2165	2165
	Western Ave Entrance	Minnesota Ave Exit	EN-EX	2000	1500	2860	2860
	Minnesota Ave Exit	Minnesota Ave Entrance	EX-EN	750	500	2420	2420
	Minnesota Ave Entrance	Cliff Ave Exit	EN-EX	2000	1500	3120	3120
	Cliff Ave Exit	Cliff Ave Entrance	EX-EN	750	500	2700	2700
	Cliff Ave Entrance	26th St Exit	EN-EX	2000	1500	2750	2750
	26th St Exit	26th St Entrance	EX-EN	750	500	1560	1560
	26th St Entrance	10th St Exit	EN-EX	2000	1500	5700	5700
SB I-229	10th St Entrance	26th St Exit	EN-EX	2000	1500	6400	6400
	26th St Exit	26th St Entrance	EX-EN	750	500	1050	**1200**
	26th St Entrance	Cliff Ave Exit	EN-EX	2000	1500	2670	**2520**
	Cliff Ave Exit	Cliff Ave Entrance	EX-EN	750	500	3270	3270
	Cliff Ave Entrance	Minnesota Ave Exit	EN-EX	2000	1500	3100	3100
	Minnesota Ave Exit	Minnesota Ave Entrance	EX-EN	750	500	3350	3350
	Minnesota Ave Entrance	Western Ave Exit	EN-EX	2000	1500	3220	3220
	Western Ave Exit	Western Ave Entrance	EX-EN	750	500	1900	1900
	Western Ave Entrance	Louise Ave Exit	EN-EX	2000	1500	3500	3500

- All ramp spacing distances are approximate.
- No Build includes reconfiguration of 26th Street Interchange.
- **Bolded** indicates a change from the Existing conditions.

In all three proposed alternatives, the northbound I-229 Cliff Avenue ramp exit and entrance gores are located in essentially the same location as the existing/No Build conditions, therefore there are no spacing issues along northbound I-229. **Table 14** only represents the changes that occur on southbound I-229 for the proposed Build alternatives.

Table 14 – Southbound I-229 Ramp Spacing – Proposed Build Conditions

Description			Ramp Type	Desirable Space (ft)	No Build (ft)	Build 1 (ft)	Build 6 (ft)	Build 7 (ft)
	From	To						
SB I-229	10th St Entrance	26th St Exit	EN-EX	2000	6400	6400	6400	6400
	26th St Exit	26th St Entrance	EX-EN	750	1200	1200	1200	1200
	26th St Entrance	Cliff Ave Exit	EN-EX	2000	2520	2520	2520	2520
	Cliff Ave Exit	Cliff Ave Entrance	EX-EN	750	3270	n/a	3270	3270
	Cliff Ave Entrance	NB Cliff Ave Entrance	EX-EN	750	**n/a**	**1850**	**n/a**	**n/a**
	NB Cliff Ave Entrance	SB Cliff Ave Entrance	EN-EN	1500	**n/a**	**1950**	**n/a**	**n/a**
	Cliff Ave Entrance	Minnesota Ave Exit	EN-EX	2000	3100	**2570**	3100	3100
	Minnesota Ave Exit	Minnesota Ave Entrance	EX-EN	750	2350	2350	2350	2350
	Minnesota Ave Entrance	Western Ave Exit	EN-EX	2000	3220	3220	3220	3220
	Western Ave Exit	Western Ave Entrance	EX-EN	750	1900	1900	1900	1900
	Western Ave Entrance	Louise Ave Exit	EN-EX	2000	3500	3500	3500	3500

- All ramp spacing distances are approximate.
- "**n/a**" indicates that spacing does not exist in that alternative.
- **Bolded** indicates a change from the No Build conditions.
- Northbound I-229 spacing will remain as the No Build conditions and is therefore not represented in this table. .

In all proposed alternatives, the desirable ramp spacing is either met or exceeded along the southbound I-229 corridor.

5.2 I-229 at Cliff Avenue Interchange Alternatives

Constructed in the early 1960's, the Cliff Avenue (Exit 4) interchange consists of a modified diamond configuration. Northbound I-229 has a standard diamond configuration with the ramp terminal intersection controlled by a traffic signal, the southbound exit ramp aligns with 41st Street and is controlled by a traffic signal. The southbound entrance ramp is an uncontrolled intersection less than 200 feet south of the 41st Street signal.

The MIS recommended three proposed build alternatives during the screening process; this study evaluated the three alternatives in addition to the No Build conditions.

5.2.1 Alternative 0 – No Build

This alternative does not alter the current configuration of the existing Cliff Avenue interchange or apply any improvements along Cliff Avenue or mainline I-229.

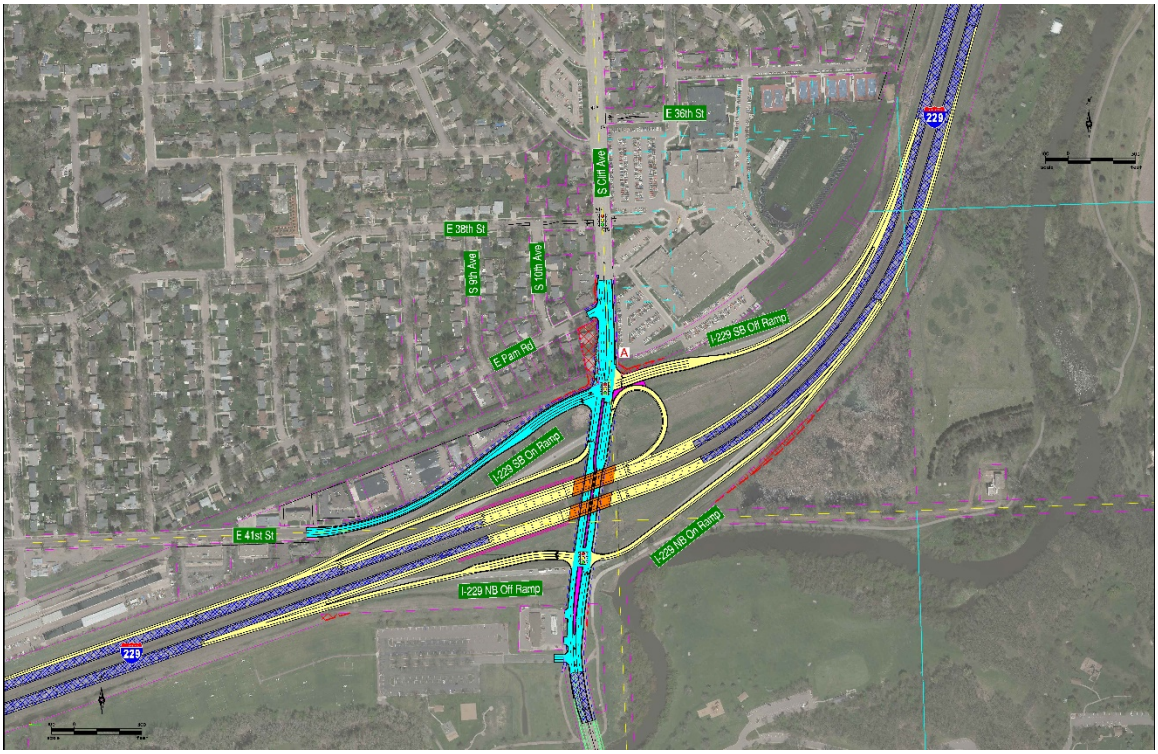
5.2.2 Alternative Cliff-1

This alternative is carried forward from the I-229 MIS recommendations. The northbound I-229 ramp terminal would remain a standard diamond configuration with additional turn lanes to improve capacity.

The southbound I-229 ramps would be significantly reconfigured. The I-229 entrance ramp would be split into two ramps with a new entrance ramp access on southbound I-229. The southbound Cliff Avenue ramp would be a free right turn movement and the northbound Cliff Avenue traffic would have a free right turn onto a new loop ramp connection. The southbound I-229 exit ramp would connect to the 41st Street intersection; this connection helps relieve the closely spaced intersection issues.

Along Cliff Avenue, a 4-lane divided roadway would be provided directly to the north with the south Lincoln High School driveway access being reduced to a right-in/right-out (RI/RO) access. To the south, a median would be constructed to just north of the Spencer Park intersection resulting in RI/RO access for the existing business driveways.

Figure 14 – Alternative Cliff-1



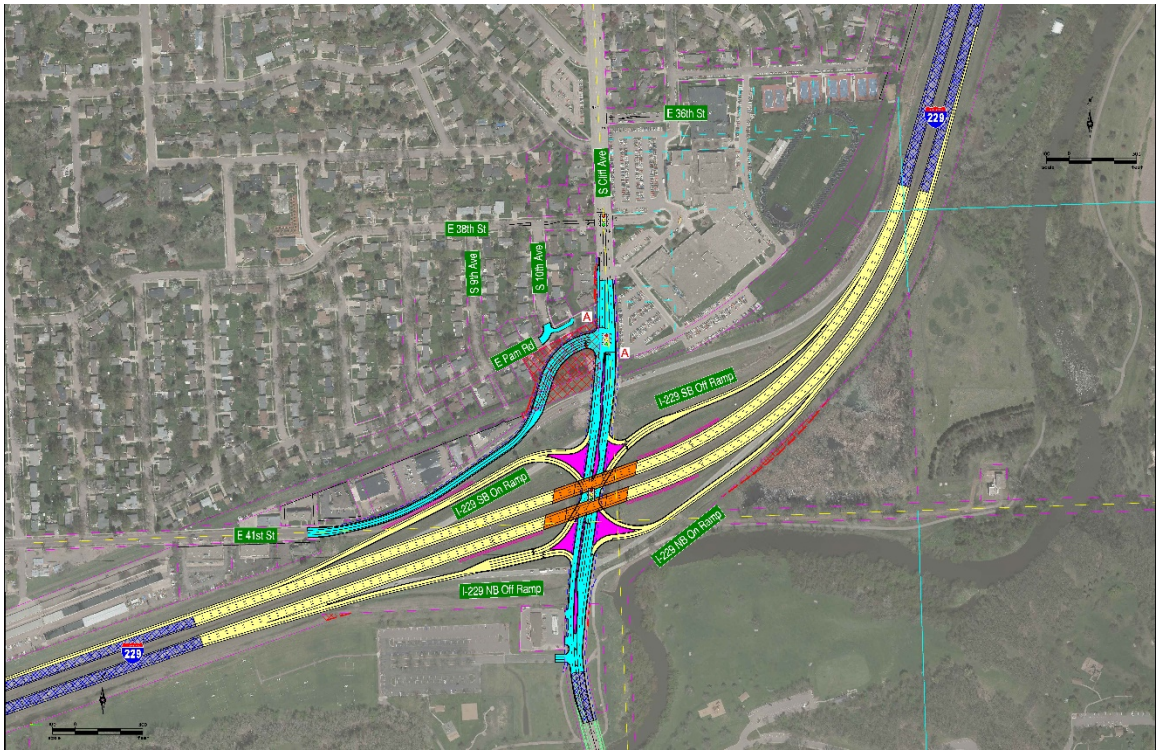
5.2.3 Alternative Cliff-6

This alternative is carried forward from the I-229 MIS recommendations; the existing diamond interchange would be reconfigured to a Single Point Urban Interchange (SPUI). W 41st Street would be realigned to the north to provide better intersection spacing with the proposed interchange design.

The 41st Street realignment creates a significant amount of right-of-way impacts and would require Pam Road to be closed to Cliff Avenue. The configuration creates a weaving condition along northbound Cliff Avenue between the southbound I-229 right turning vehicles wanting to use 41st Street to the west.

Along Cliff Avenue, a 4-lane divided roadway would be provided directly to the north with the south Lincoln High School driveway access being reduced to a RI/RO. To the south, a median would be constructed to just north of the Spencer Park intersection resulting in RI/RO access for the existing business driveways.

Figure 15 – Alternative Cliff-6



5.2.4 Alternative Cliff-7

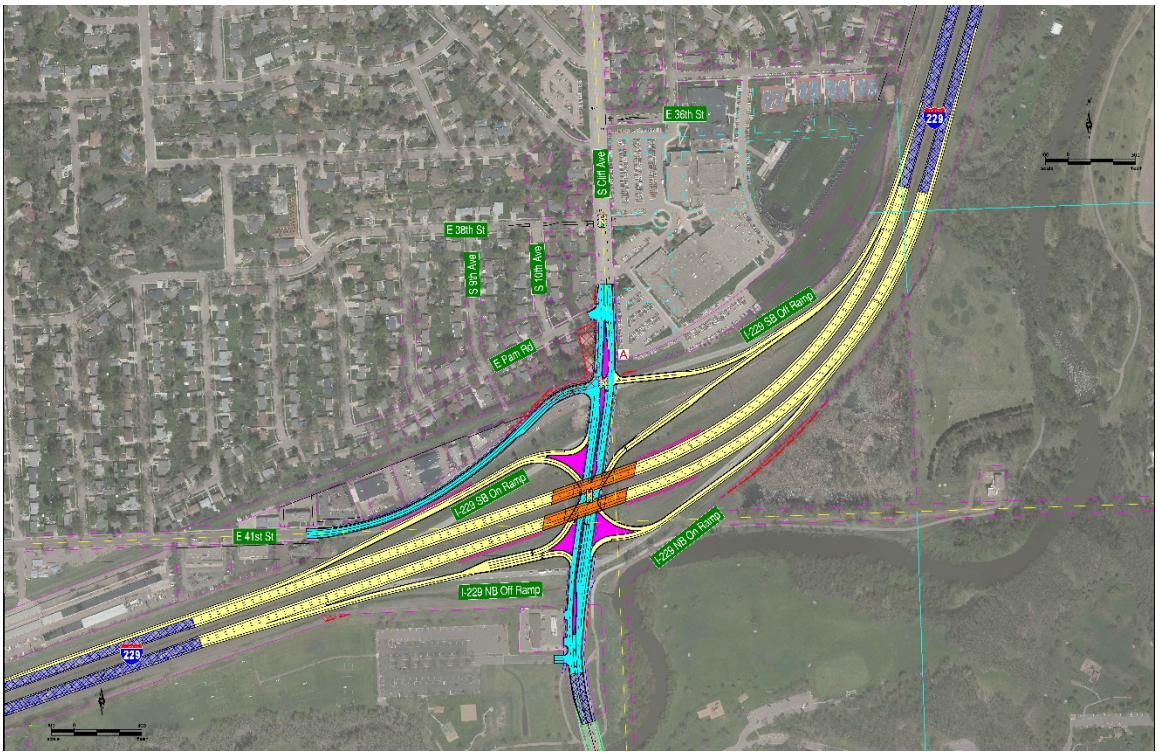
This alternative is carried forward from the I-229 MIS recommendations; the existing diamond interchange would be reconfigured to a SPUI with a modified southbound ramp connection.

The northbound I-229 ramps are of typical SPUI design and the southbound I-229 entrance ramp is also typical of a SPUI design.

The southbound I-229 exit ramp would be significantly reconfigured from a standard SPUI design. The I-229 exit ramp would be split into directional ramps for Cliff Avenue. The southbound Cliff Avenue traffic would tie into the traditional SPUI intersection. The northbound Cliff Avenue traffic would connect to the 41st Street intersection; this connection helps relieve the closely spaced intersection and weaving issues.

Along Cliff Avenue, a 4-lane divided roadway would be provided directly to the north with the south Lincoln High School driveway access being reduced to a RI/RO. To the south, a median would be constructed to just north of the Spencer Park intersection resulting in RI/RO access for the existing business driveways.

Figure 16 – Alternative Cliff-7



5.3 Dismissed Alternatives

The I-229 Major Investment Study initially included 8 interchange alternatives for the Cliff Avenue interchange with I-229. The project process narrowed the number down and ultimately recommended the three alternatives carried forward in this evaluation.

For more information on the previously dismissed alternatives from the MIS, see the I-229 Exit 4 (Cliff Avenue) Crossroad Corridor Study. The evaluation and elimination of these alternatives will be incorporated by reference into the NEPA process and provide a basis for screening out the alternatives.

In addition to the MIS dismissed alternatives, a modification to Alternative 6 was explored as part of this analysis. An offset SPUI design was explored with the SPUI intersection located near the existing southern ramp terminal intersection which became known as Alternative 6B. This design provides better intersection spacing and would require 41st Street to not be realigned; however, the design requires 6 separate bridge structures along I-229 to relocate the southbound I-229 ramps to the south side. Due to the increased number of structures, this alternative was removed from consideration.

5.4 Surrounding Project Interchanges

Congestion and safety issues occur on the surrounding project area interchanges; while not explicitly requiring FHWA approval as part of this document, mitigations to the project interchanges were explored as part of the overall study (see **Section 6** for more discussion).

5.4.1 Western Avenue Interchange

The diamond interchange has both operational and safety issues under existing conditions. These issues will be exacerbated as traffic demands increase to the 2050 design year. While there are currently no plans to reconstruct the interchange, capacity improvements within the next 5 to 10 years are currently being explored by SDDOT and would be included in all future No Build conditions.

To mitigate poor operations, additional turning lanes were explored to provide acceptable traffic operations through the design year.

At the south I-229 ramp terminal intersection, the addition of southbound dual left turn lanes to enter northbound I-229 are needed to reach acceptable operations through 2050. The movement is projected to have over 500 vehicles making the movement during the PM peak hours and the SDDOT is currently planning this modification.

Additional improvements may be required to keep acceptable operations through the 2050 design year, including that the eastbound approach may need separate dual left turn lanes and a separate right turn lane in order to serve the long term future demands. At the southbound I-229 ramp terminal intersection, the addition of a separate southbound right turn lane was explored. The separation of the southbound approach traffic allows the northbound left turn to operate acceptably under protected/permissive conditions.

5.4.2 Minnesota Avenue Interchange

This interchange was studied as part of the overall project; however a separate Interstate Modification Justification Report (IMJR) was prepared to discuss the alternatives that were evaluated.

This document will assume a standard diamond configuration for the freeway analysis and that the arterial intersections along Minnesota Avenue will be addressed in that IMJR document.

5.4.3 26th Street Interchange

This interchange is currently being reconstructed and is slated to be completed by the year 2020; the proposed design is discussed in **Section 3.5.4** of this document. The proposed interchange design will provide acceptable traffic safety and operations at the ramp terminal intersections through the design year.

5.5 Surrounding Arterial Improvements

The City of Sioux Falls and SDDOT have planned intersection improvements throughout the project area. The following is a brief list of planned intersection improvements included in all future No Build conditions:

- 26th Street at Southeastern Avenue:
  - Reconstructed as part of the 26th Street Interchange project.
  - Additional turn lanes and turn lane storage on 26th Street.
  - Northbound and southbound dual left turn lanes and separated right turn lanes on Southeastern Avenue approaches.
- Western Avenue at 49th Street:
  - The east leg will be constructed to include a left turn lane, two through lanes and a right turn lane.
  - A northbound separate right turn lane will also be constructed.
- Minnesota Avenue at 41st Street:
  - Eastbound and westbound approaches reconfigured with dual left turn lanes to remove existing split phase signal operations.
  - Eastbound right turn lane will be added.
- Minnesota Avenue at 37th Street:
  - Separated right turn lanes added for both eastbound and westbound approaches.
- Cliff Avenue between Tomar Road and 56th Street:
  - Expand existing 3-lane roadway to 4-lane roadway.

6 Future Year Traffic

The design year for this project is 2050 with an anticipated year of opening of 2024. With the year of opening so close to the existing conditions and the design year over 25 years out, a mid-term forecast year of 2035 was also developed to aid in development of roadway network planning for additional capacity along the interstate system.

As previously noted, the HCM does not recommend using the merge and diverge analysis procedures when a full length auxiliary lane is provided; see Page 14-30 of the HCM 6th Edition. Therefore, any analysis which includes a full auxiliary lane to a ramp connection would not include merge/diverge analysis. It would only include the basic lane and weaving analysis on all freeway mainline segments that include full auxiliary lanes between ramp connections.

6.1 Future Year Traffic Forecasts

Traffic forecasts were prepared using the latest version of the Regional Travel Demand Model (RTDM) for the Metropolitan Planning Organization (MPO) area; this model is maintained by the City of Sioux Falls and the Sioux Falls MPO. As part of the interchange project, traffic forecasts were developed for all intersections and roadway segments within the project area.

The latest version of the RTDM is an activity based model that provides more realistic trip routing than the previous version of the demand model. It should be noted that all previous studies in the project area, including the MIS, utilized the previous trip based RTDM models and therefore the traffic forecasts may have significant variations between the previous and current forecast demands.

The full traffic forecast memorandum, *I-229 Exits 3 & 4 Interchange Study – Traffic Forecasts* memorandum is provided in **Appendix I**.

6.2 Design Year Analysis

The 2050 design year traffic forecasts resulted in significant growth throughout the southern Sioux Falls metropolitan area, including the immediate project area.

The projected traffic forecast volumes resulted in the same volumes between the No Build and Build scenarios. The proposed build alternatives add capacity to the interchange area, but do not add significant capacity that would alter regional route choices.

Poor operational performance outside the immediate project construction area would not be impacted by proposed build conditions and therefore the project is not required to mitigate these areas. This includes operational problems that may exist along Western Avenue and 26th Street, as well as I-229 outside the immediate interchange area.

Appendix C includes all HCS summary sheets for the 2050 No Build conditions analysis, **Appendix D** includes all HCS summary sheets for the 2050 Build conditions.

6.2.1 2050 No Build Conditions

The summation of the 2050 No Build traffic operations analysis show that mainline I-229 operates with poor LOS along both northbound and southbound I-229. Northbound I-229 has LOS D operations on the 2-lane segments underneath Western Avenue and over both Minnesota Avenue and Cliff Avenue. Southbound I-229 has LOS D operations through much of the project

area with LOS E on the 2-lane segments at the interchanges of 26th Street and Minnesota Avenue. Results for the individual segments and ramp junctions of I-229 are shown in **Figure 17** as well as **Table 15**.

Figure 17 – 2050 No Build Freeway Configuration and LOS

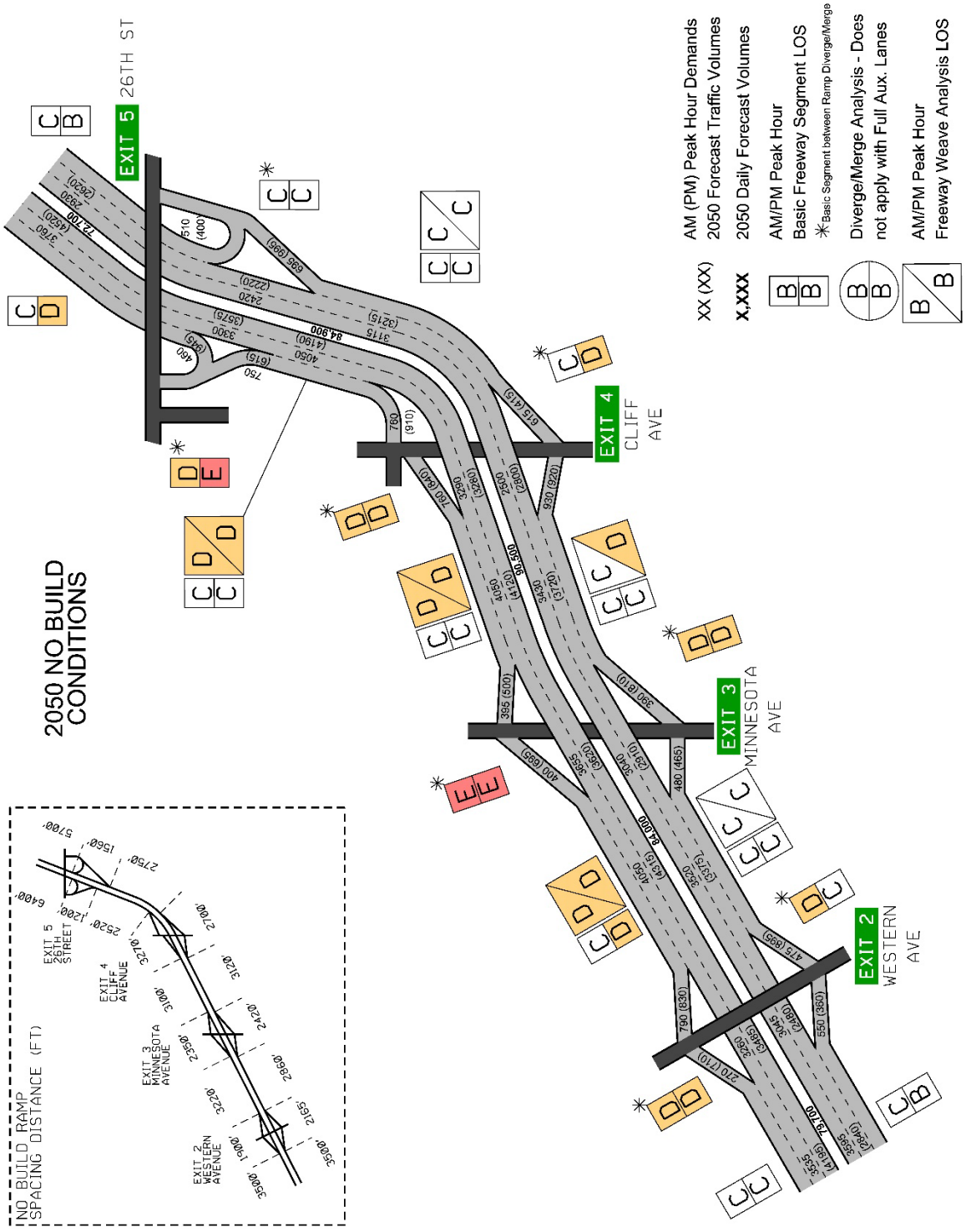


Table 15 – 2050 No Build I-229 Freeway Operations Summary

Road	Description	Analysis Type	AM Peak LOS	PM Peak LOS
NB I-229	NB I-229: southwest of Exit 2	Basic	C	B
	NB I-229: between Exit 2 Exit and Entrance Ramps	Basic	**D**	C
	NB I-229: between Exit 2 and Exit 3	Basic	C	C
		Weave	C	C
	NB I-229: between Exit 3 Exit and Entrance Ramps	Basic	**D**	**D**
	NB I-229: between Exit 3 and Exit 4	Basic	C	C
		Weave	C	**D**
	NB I-229: between Exit 4 Exit and Entrance Ramps	Basic	C	**D**
	NB I-229: between Exit 4 and Exit 5	Basic	C	C
		Weave	C	C
	NB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	C
	NB I-229: northeast of Exit 5	Basic	C	B
SB I-229	SB I-229: northeast of Exit 5	Basic	C	**D**
	SB I-229: between Exit 5 Exit and Entrance Ramps	Basic	**D**	**E**
	SB I-229: between Exit 5 and Exit 4	Basic	C	C
		Weave	**D**	**D**
	SB I-229: between Exit 4 Exit and Entrance Ramps	Basic	**D**	**D**
	SB I-229: between Exit 4 and Exit 3	Basic	C	C
		Weave	**D**	**D**
	SB I-229: between Exit 3 Exit and Entrance Ramps	Basic	**E**	**E**
	SB I-229: between Exit 3 and Exit 2	Basic	C	**D**
		Weave	**D**	**D**
	SB I-229: between Exit 2 Exit and Entrance Ramps	Basic	**D**	**D**
	SB I-229: southwest of Exit 2	Basic	C	C

- **Bold/Shaded** indicates a LOS D or worse

The project study area also includes twenty-nine arterial intersections identified for operational analysis. **Table 16** summarizes the results of the 2050 No Build traffic analysis for the ramp terminal intersections as well as adjacent major intersections within the study area. The 2050 No Build lane configurations of each study intersection, with turn lane storage and the intersection LOS results, can be found in **Appendix A**.

Throughout all four interchange areas many intersections, including ramp termini, operate at unacceptable LOS during the peak hours. Through planned capacity improvements and signal timing/phasing changes, some intersections are actually improved over the existing conditions; for instance the 26th Street ramp terminal intersections will both operate at a LOS C or better. However the total number of failing intersections is the same as the existing conditions, with 22 study intersections having at least one peak hour operate under failing conditions.

Table 16 – 2050 No Build Arterial Intersection Control – LOS Criteria

Major Roadway	Intersecting Roadway	Control Type	AM Peak	PM Peak
Western Avenue	W 49th Street	Signal	C	**E-**
Western Avenue	I-229 SB Ramp Terminal	Signal	C	**C***
Western Avenue	I-229 NB Ramp Terminal	Signal	C	B
Western Avenue	W 57th Street	Signal	**D***	**D-**
Minnesota Avenue	W 37th Street	Signal	C	C
Minnesota Avenue	W 41st Street	Signal	C	**E-**
Minnesota Avenue	W 49th Street	Minor Stop	**F**	**F**
Minnesota Avenue	I-229 SB Ramp Terminal	Signal	B	**C-**
Minnesota Avenue	I-229 NB Ramp Terminal	Signal	C	**E-**
Minnesota Avenue	Yankton Park Entrance	Minor Stop	**B-**	**F**
Minnesota Avenue	W Lotta Street	Minor Stop	**F**	**F**
Minnesota Avenue	W 57th Street	Signal	**C***	**E-**
Cliff Avenue	E 33rd Street	Signal	C	C
Cliff Avenue	36th St/LHS Entrance #4	Minor Stop	**F**	D
Cliff Avenue	38th St/LHS Entrance #3	Minor Stop	**F**	**F**
Cliff Avenue	LHS Entrance #2	Minor Stop	D	B
Cliff Avenue	LHS Entrance #1	Minor Stop	**F**	**F**
Cliff Avenue	41st St/I-229 SB Exit Ramp	Signal	**D-**	**E-**
Cliff Avenue	I-229 SB Entrance Ramp	No Control	**F**	**F**
Cliff Avenue	I-229 NB Ramp Terminal	Signal	**D-**	C
Cliff Avenue	Spencer Park Entrance	Minor Stop	D	**E-**
Cliff Avenue	E 49th Street	Signal	**E-**	**C***
26th Street	S Cliff Avenue	Signal	**C***	**D***
26th Street	S Yeager Road	Minor Stop	**E**	**F**
26th Street	I-229 SB Ramp Terminal	Signal	B	C
26th Street	I-229 NB Ramp Terminal	Signal	B	C
26th Street	Southeastern Avenue	Signal	**E-**	**E-**
41st Street	S Norton Avenue	Signal	B	B
41st Street	S Phillips Avenue	Signal	**B***	**C***

Notes: *Intersection considered failing due to LOS and/or Queue Storage Ratio.*

- Average Intersection LOS shown, individual movements and/or approaches may be different. Minor Street Stop Control intersections LOS represents the worst minor approach LOS; major roadway would operate at LOS A.

*- " * " Queue Storage Ratio greater than 1.0 for at least 1 movement, results in failing intersection.*

- " – " At least one movement operates at a LOS F (not noted if intersection is at LOS F)

6.2.2 2050 Build Conditions

The proposed build alternatives would add additional spot location capacity improvements to serve the 2050 Build traffic conditions. The improvements would bring the immediate project area traffic operations analysis to acceptable LOS along both northbound and southbound I-229.

The existing 2-lane freeway segments over both Minnesota Avenue and Cliff Avenue will need 3-lanes to serve the future demands at LOS C; this applies to northbound and southbound I-229. This modification would remove the weaving segment between Exit 3 and Exit 4 as there would no longer be a continuous auxiliary lane between the ramps. Having 3-continuous lanes through both the Exit 3 and Exit 4 interchanges would require the ramps to have standard merge and diverge connections.

Along northbound I-229, the Exit 3 and Exit 4 merge and diverge locations can be designed to current SDDOT standards with the appropriate deceleration and acceleration lanes. Along southbound I-229, the merge locations can also be designed to SDDOT standards. The two diverge locations would require additional deceleration length to achieve LOS C; approximately 500 feet of deceleration is needed at each diverge location.

For the analysis of the Exit 4 IMJR, it was assumed the Exit 3 interchange would remain a standard diamond configuration for the freeway analysis; one diverge and one merge location.

Results for the individual segments and ramp junctions of I-229 are shown in **Figure 18** as well as **Table 17**. The figure is representative of the build Alternative 6 or 7 with a single exit and entrance ramp location for the Exit 4 interchange for southbound I-229; Alternative 1 would split the entrance ramp into two separate ramp access locations as denoted in the table.

Outside of the immediate project area there are LOS D/E operations surrounding the 26th Street and Western Avenue interchanges. As these operations are the same between the No Build and Build conditions, no mitigations are required as part of this evaluation.

It should be noted that the two southbound I-229 weaving segments between Exits 5 and 4 and Exits 3 and 2 still remain at LOS D; however, the change in lane configuration did result in an improved density calculation when compared to the No Build condition.

Figure 18 – 2050 Build Freeway Configuration and LOS

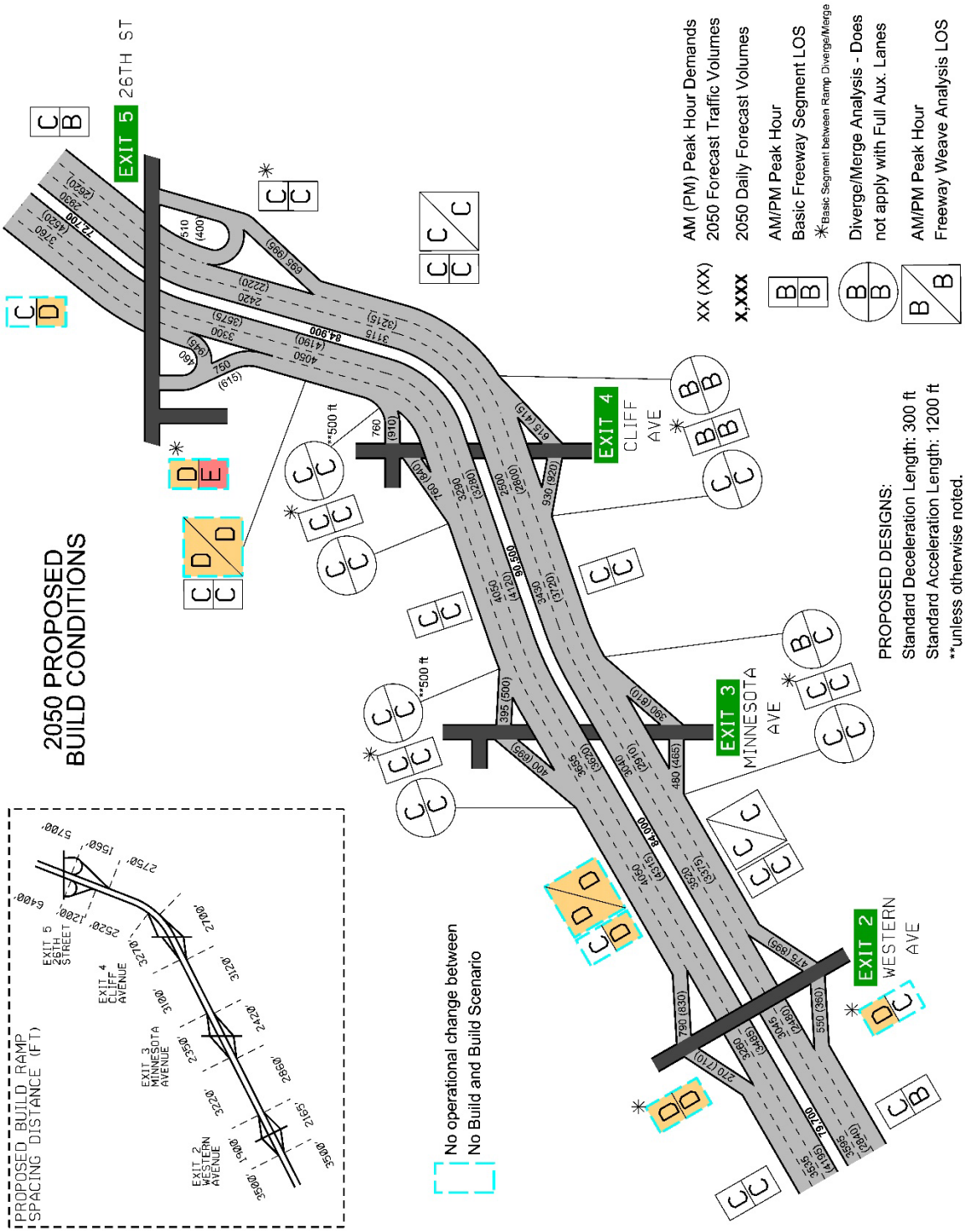


Table 17 – 2050 Build I-229 Freeway Operations Summary

Road	Description	Analysis Type	AM Peak LOS	PM Peak LOS
NB I-229	NB I-229: southwest of Exit 2	Basic	C	B
	NB I-229: between Exit 2 Exit and Entrance Ramps	Basic	**D**	C
	NB I-229: between Exit 2 and Exit 3	Basic	C	C
		Weave	C	C
	NB I-229: Exit 3 Exit Ramp	Diverge	C	C
	NB I-229: between Exit 3 Exit and Entrance Ramps	Basic	C	C
	NB I-229: Exit 3 Entrance Ramp	Merge	B	C
	NB I-229: between Exit 3 and Exit 4	Basic	C	C
	NB I-229: Exit 4 Exit Ramp	Diverge	C	C
	NB I-229: between Exit 4 Exit and Entrance Ramps	Basic	B	B
	NB I-229: Exit 4 Entrance Ramp	Merge	B	B
	NB I-229: between Exit 4 and Exit 5	Basic	C	C
		Weave	C	C
	NB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	C
	NB I-229: northeast of Exit 5	Basic	C	B
SB I-229	SB I-229: northeast of Exit 5	Basic	C	**D**
	SB I-229: between Exit 5 Exit and Entrance Ramps	Basic	**D**	**E**
	SB I-229: between Exit 5 and Exit 4	Basic	C	C
		Weave	**D**	**D**
	SB I-229: Exit 4 Exit Ramp	Diverge	C	C
	SB I-229: between Exit 4 Exit and Entrance Ramps	Basic	C	C
	SB I-229: Exit 4 NB Entrance Ramp **(Alt 1)**	Merge	C	B
	SB I-229: between Exit 4 Entrance Ramps **(Alt 1)**	Basic	C	C
	SB I-229: Exit 4 SB Entrance Ramp **(Alt 1)**	Merge	C	C
	SB I-229: Exit 4 SB Entrance Ramp **(Alt 6/7)**	Merge	C	C
	SB I-229: between Exit 4 and Exit 3	Basic	C	C
	SB I-229: Exit 3 Exit Ramp	Diverge	C	C
	SB I-229: between Exit 3 Exit and Entrance Ramps	Basic	C	C
	SB I-229: Exit 3 Entrance Ramp	Merge	C	C
	SB I-229: between Exit 3 and Exit 2	Basic	C	**D**
		Weave	**D**	**D**
	SB I-229: between Exit 2 Exit and Entrance Ramps	Basic	**D**	**D**
	SB I-229: southwest of Exit 2	Basic	C	C

- **Bold/Shaded** indicates a LOS D or worse
- Along Northbound I-229, all three build alternatives have the same freeway operations.
- Along Southbound I-229, all three build alternatives have the same freeway operations unless otherwise noted.
- There is no operational change between the No Build and Build outside of the immediate interchange area and therefore no mitigations were considered.

The project study area includes twenty-nine arterial intersections identified for operational analysis. Many of these intersections are outside of the immediate Exit 4 interchange area, therefore, mitigations were not considered. **Table 18** summarizes the results of the 2050 Build traffic analysis for the ramp terminal intersections as well as adjacent major intersections within the study area.

The interchange and arterial improvements proposed at the Exit 4 interchange and along the Cliff Avenue corridor will not change operations from the No Build conditions along Western Avenue, Minnesota Avenue, and 26th Street. While no intersection mitigations are required at these intersections, discussion about the operations is provided below.

- Along Western Avenue, the new connection of 49th Street between Western Avenue and Minnesota Avenue draws a lot of traffic to the intersection and major capacity improvements will be necessary at the Western Avenue and 49th Street intersection. The I-229 ramp terminal intersections at Western Avenue have acceptable delays, but there are storage capacity issues for the northbound left turn movement. The Western Avenue at 57th Street intersection has ample capacity for the majority of the turning movements, however the southbound approach is limited by the Big Sioux River bridge and storage capacity is an issue.
- Minnesota Avenue mitigations are being developed as part of the Exit 3 IMJR and will provide recommendations for the immediate I-229 interchange area.
- Along 26th Street there is significant traffic growth by 2050 that the on-going construction improvement project will not be adequate enough to handle. The intersection of 26th Street at Cliff Avenue has acceptable delays, but additional turn lane storage would be needed. The minor stop control intersection at Yeager Road will have long delays for the minor approach and should be considered for a reduced access intersection control. The interchange ramp terminals will operate well through 2050; however, the increased volumes along Southeastern Avenue create long delays at the intersection that would require significant capacity improvements.

Along Cliff Avenue, the intersections outside of the immediate interchange area would have the same traffic operations in all three alternatives. The following improvements are necessary at the intersections outside of the interchange area:

- Cliff at 36th Street: no change, poor LOS but low volume.
- Cliff at 38th Street: possible traffic control change, minor stop fails.
  - RI/RO conversion of Lincoln High School (LHS) Access #1 brings additional left turns out at this intersection.
  - Traffic signal will provide LOS C or better; remove mid-block pedestrian signal.
- Cliff at LHS Access #1: minimum convert to RI/RO
  - Access closure may be more appropriate due to proximity to intersections.
  - The Study Advisory Team recommended that under Alternative 6 this access was later studied as a 4th leg to the 41st Street Intersection.
- Cliff at Spencer Park: no change, minor stop failing but very low volume.
- Cliff at 49th Street: extend storage lanes.

Table 18 – 2050 Build Arterial Intersection Control – LOS Criteria

Major Roadway	Intersecting Roadway	Control Type	AM Peak	PM Peak
Western Avenue	W 49th Street	Signal	C	**E-**
Western Avenue	I-229 SB Ramp Terminal	Signal	C	**C***
Western Avenue	I-229 NB Ramp Terminal	Signal	C	B
Western Avenue	W 57th Street	Signal	**D***	**D-**
Minnesota Avenue	W 37th Street	Signal	C	C
Minnesota Avenue	W 41st Street	Signal	C	**E-**
Minnesota Avenue	W 49th Street	Minor Stop	**F**	**F**
Minnesota Avenue	I-229 SB Ramp Terminal	Signal	B	**C-**
Minnesota Avenue	I-229 NB Ramp Terminal	Signal	C	**E-**
Minnesota Avenue	Yankton Park Entrance	Minor Stop	**B-**	**F**
Minnesota Avenue	W Lotta Street	Minor Stop	**F**	**F**
Minnesota Avenue	W 57th Street	Signal	**C***	**E-**
Cliff Avenue	E 33rd Street	Signal	C	C
Cliff Avenue	36th St/LHS Entrance #4	Minor Stop	**E-**	D
Cliff Avenue	38th St/LHS Entrance #3	**Signal**	C	B
Cliff Avenue	LHS Entrance #2	Minor Stop	D	B
Cliff Avenue	LHS Entrance #1	**RI/RO**	**E**	B
Cliff Avenue	41st St/I-229 SB Exit Ramp	**See Table 19 and Figure 19 for Interchange Alternatives**		
Cliff Avenue	I-229 SB Entrance Ramp			
Cliff Avenue	I-229 NB Ramp Terminal			
Cliff Avenue	Spencer Park Entrance	Minor Stop	D	**E-**
Cliff Avenue	E 49th Street	Signal	**D***	**C***
26th Street	S Cliff Avenue	Signal	**C***	**D***
26th Street	S Yeager Road	Minor Stop	**E**	**F**
26th Street	I-229 SB Ramp Terminal	Signal	B	C
26th Street	I-229 NB Ramp Terminal	Signal	B	C
26th Street	Southeastern Avenue	Signal	**E-**	**E-**
41st Street	S Norton Avenue	Signal	B	B
41st Street	S Phillips Avenue	Signal	**B***	**C***

Notes: *Intersection considered failing due to LOS and/or Queue Storage Ratio.*

- Average Intersection LOS shown, individual movements and/or approaches may be different. Minor Street Stop Control intersections LOS represents the worst minor approach LOS; major roadway would operate at LOS A.

*- " * " Queue Storage Ratio greater than 1.0 for at least 1 movement, results in failing intersection.*

- " – " At least one movement operates at a LOS F (not noted if intersection is at LOS F)

All three proposed build alternatives are able to provide LOS C or better operations at the ramp terminal intersections.

Table 19 summarizes the results of the 2050 Build traffic analysis for the Cliff Avenue ramp terminal intersections.

Table 19 – 2050 Build Interchange Intersection Control – LOS Criteria

ALT	Major Roadway	Intersecting Roadway	Control Type	AM Peak	PM Peak
1	Cliff Avenue	W 41st Street/I-229 SB Ramp	Signal	C	C
	Cliff Avenue	I-229 SB Entrance Ramp	None	A	A
	Cliff Avenue	I-229 NB Ramp Terminal	Signal	C	C
6	Cliff Avenue	41st Street	Signal	B	C
	Cliff Avenue	I-229 SPUI	Signal	C	C
7	Cliff Avenue	W 41st Street/I-229 SB Ramp	Signal	B	C
	Cliff Avenue	I-229 SPUI	Signal	C	C

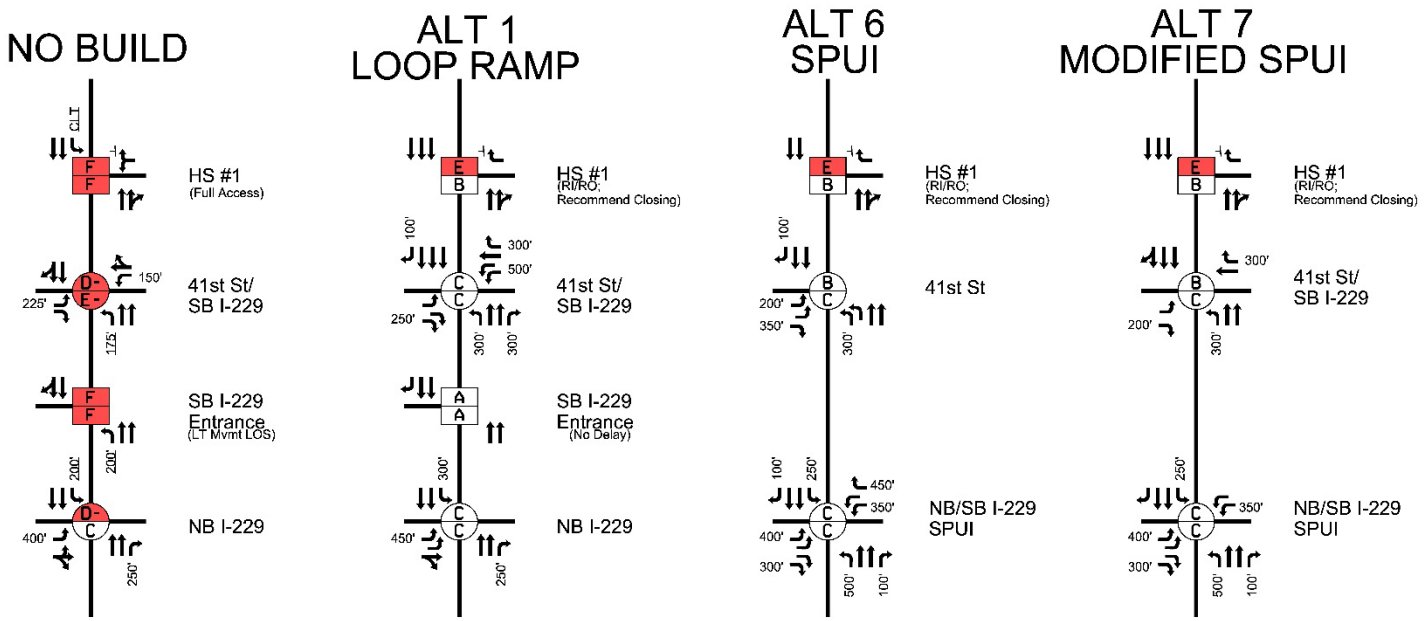
Notes:

- For Alternatives 1, the SB Entrance is a free right turn movement south of the 41st Street intersection; the NB Entrance ramp is located near the 41st Street intersection though it is a free movement as well.

- For Alternative 7, the SB exit ramp splits with SB traffic going to the SPUI and WB/NB traffic going to 41st Street.

The lane configurations needed for each proposed alternative, including the No Build, are represented in **Figure 19**.

Figure 19 – 2050 Build Cliff Avenue Interchange Configurations and LOS



6.3 Mid-Term Year Analysis

As the future year 2050 traffic forecasts resulted in such significant growth and is extended beyond the typical 20-year design standard, a mid-term year of 2035 was evaluated. The 2035 forecast year still shows a significant amount of growth throughout the southern Sioux Falls metropolitan area, including the immediate project area.

The projected traffic forecast volumes resulted in the same volumes between the No Build and Build scenarios. The proposed build alternatives add capacity to the interchange area, but do not add significant capacity that would alter regional route choices.

Poor operational performance outside the immediate project area would not be impacted by proposed build conditions and therefore the project is not required to mitigate these areas. This includes operational problems that may exist along Western Avenue and 26th Street, as well as I-229 outside the immediate interchange area.

Appendix E includes all HCS summary sheets for the 2035 No Build conditions analysis, **Appendix F** includes all HCS summary sheets for the 2035 Build conditions.

6.3.1 2035 No Build Conditions

The summation of the 2035 No Build traffic operations analysis show that mainline I-229 operates with poor LOS along southbound I-229; however, northbound I-229 is expected to operate at a LOS C or better on all freeway segments in 2035.

Southbound I-229 has LOS D operations on the 2-lane segments at each of the four study interchanges. Results for the individual segments and ramp junctions of I-229 are shown in **Figure 20** as well as **Table 20**.

Figure 20 – 2035 No Build Freeway Configuration and LOS

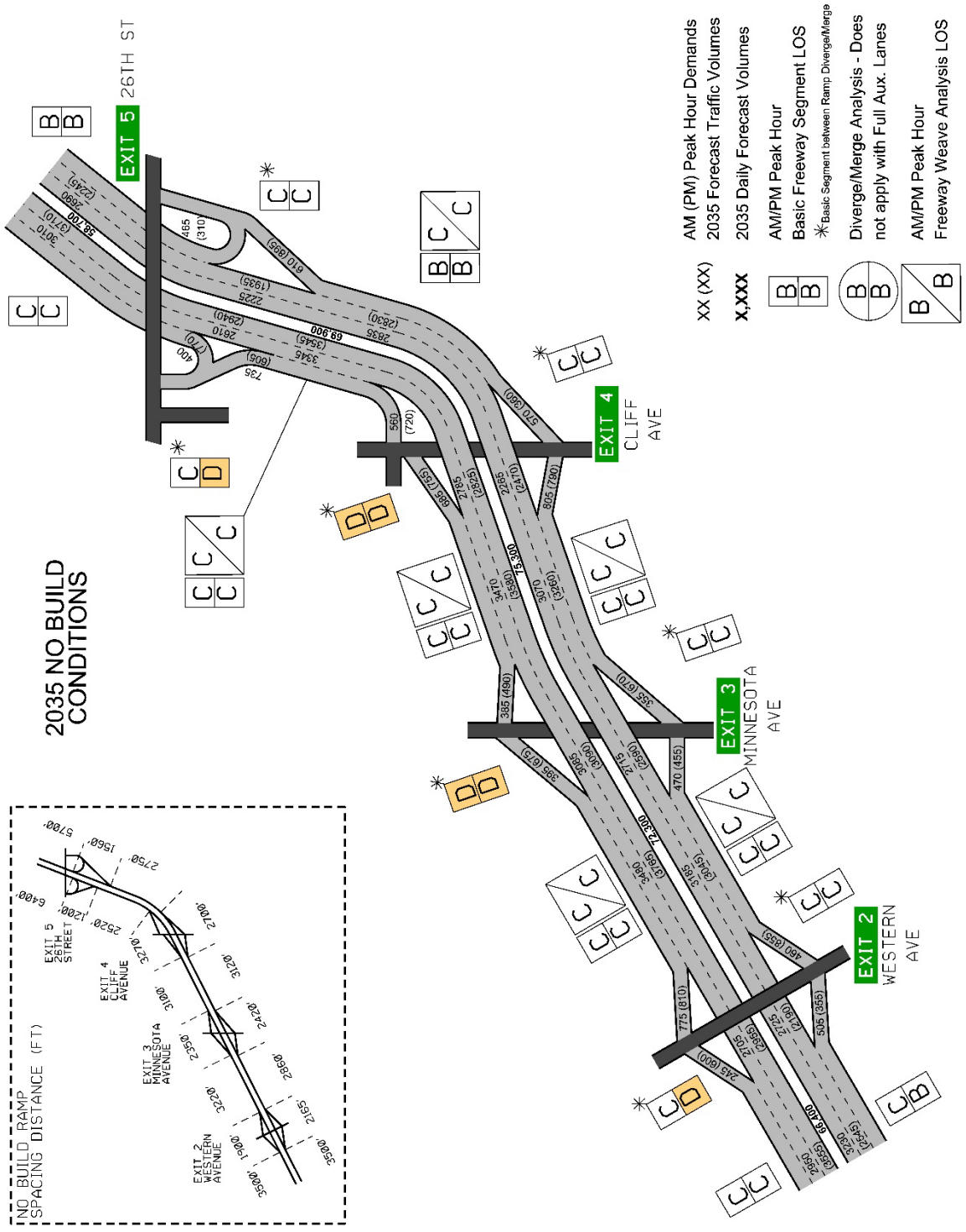


Table 20 – 2035 No Build I-229 Freeway Operations Summary

Road	Description	Analysis Type	AM Peak LOS	PM Peak LOS
NB I-229	NB I-229: southwest of Exit 2	Basic	C	B
	NB I-229: between Exit 2 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 2 and Exit 3	Basic	C	C
		Weave	C	C
	NB I-229: between Exit 3 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 3 and Exit 4	Basic	C	C
		Weave	C	C
	NB I-229: between Exit 4 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 4 and Exit 5	Basic	B	B
		Weave	C	C
	NB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	C
	NB I-229: northeast of Exit 5	Basic	B	B
SB I-229	SB I-229: northeast of Exit 5	Basic	C	C
	SB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	**D**
	SB I-229: between Exit 5 and Exit 4	Basic	C	C
		Weave	C	C
	SB I-229: between Exit 4 Exit and Entrance Ramps	Basic	**D**	**D**
	SB I-229: between Exit 4 and Exit 3	Basic	C	C
		Weave	C	C
	SB I-229: between Exit 3 Exit and Entrance Ramps	Basic	**D**	**D**
	SB I-229: between Exit 3 and Exit 2	Basic	C	C
		Weave	C	C
	SB I-229: between Exit 2 Exit and Entrance Ramps	Basic	C	**D**
	SB I-229: southwest of Exit 2	Basic	C	C

- **Bold/Shaded** indicates a LOS D or worse

The project study area includes twenty-nine arterial intersections identified for operational analysis. **Table 21** summarizes the results of the 2035 No Build traffic analysis for the ramp terminal intersections as well as adjacent major intersections within the study area. The 2035 No Build lane configurations of each study intersection, with turn lane storage and the intersection LOS results, can be found in **Appendix A**.

Throughout all four interchange areas many intersections, including ramp termini, operate at unacceptable LOS during the peak hours. Through planned capacity improvements and signal timing/phasing changes, some intersections are actually improved over the existing conditions; for instance the Western Avenue and 26th Street ramp terminal intersections will operate at a LOS C or better. The total number of failing intersections is slightly reduced compared to the existing conditions, with only 19 study intersections having at least one peak hour operate under failing conditions.

Table 21 – 2035 No Build Arterial Intersection Control – LOS Criteria

Major Roadway	Intersecting Roadway	Control Type	AM Peak	PM Peak
Western Avenue	W 49th Street	Signal	C	**E-**
Western Avenue	I-229 SB Ramp Terminal	Signal	C	C
Western Avenue	I-229 NB Ramp Terminal	Signal	B	B
Western Avenue	W 57th Street	Signal	**D***	**D***
Minnesota Avenue	W 37th Street	Signal	C	C
Minnesota Avenue	W 41st Street	Signal	C	**D-**
Minnesota Avenue	W 49th Street	Minor Stop	**F**	**F**
Minnesota Avenue	I-229 SB Ramp Terminal	Signal	B	**C***
Minnesota Avenue	I-229 NB Ramp Terminal	Signal	C	**D***
Minnesota Avenue	Yankton Park Entrance	Minor Stop	**B-**	**F**
Minnesota Avenue	W Lotta Street	Minor Stop	**F**	**F**
Minnesota Avenue	W 57th Street	Signal	C	**D***
Cliff Avenue	E 33rd Street	Signal	B	C
Cliff Avenue	36th St/LHS Entrance #4	Minor Stop	D	C
Cliff Avenue	38th St/LHS Entrance #3	Minor Stop	**F**	**F**
Cliff Avenue	LHS Entrance #2	Minor Stop	C	B
Cliff Avenue	LHS Entrance #1	Minor Stop	**F**	**F**
Cliff Avenue	41st St/I-229 SB Exit Ramp	Signal	**C***	**E-**
Cliff Avenue	I-229 SB Entrance Ramp	No Control	**F**	**F**
Cliff Avenue	I-229 NB Ramp Terminal	Signal	**C***	C
Cliff Avenue	Spencer Park Entrance	Minor Stop	C	**D-**
Cliff Avenue	E 49th Street	Signal	**D-**	**B***
26th Street	S Cliff Avenue	Signal	**C***	**D***
26th Street	S Yeager Road	Minor Stop	C	**F**
26th Street	I-229 SB Ramp Terminal	Signal	B	B
26th Street	I-229 NB Ramp Terminal	Signal	B	C
26th Street	Southeastern Avenue	Signal	D	D
41st Street	S Norton Avenue	Signal	B	B
41st Street	S Phillips Avenue	Signal	**B***	**B***

Notes: *Intersection considered failing due to LOS and/or Queue Storage Ratio.*

- Average Intersection LOS shown, individual movements and/or approaches may be different. Minor Street Stop Control intersections LOS represents the worst minor approach LOS; major roadway would operate at LOS A.

*- " * " Queue Storage Ratio greater than 1.0 for at least 1 movement, results in failing intersection.*

- " – " At least one movement operates at a LOS F (not noted if intersection is at LOS F)

6.3.2 2035 Build Conditions

The proposed build alternatives would add additional spot location capacity improvements to serve the 2035 Build traffic conditions. The improvements would bring the immediate project area traffic operations analysis along mainline I-229 to an acceptable LOS along southbound I-229; northbound I-229 is already at LOS C or better.

The existing 2-lane freeway segments on southbound I-229, over both Minnesota Avenue and Cliff Avenue, would need 3-lanes to serve the future forecasted demands at LOS C. This modification would remove the weaving segment between Exit 3 and Exit 4 as there would no longer be a continuous auxiliary lane between the ramps. Having 3-continuous southbound lanes through both the Exit 3 and Exit 4 interchanges would require the ramps to have standard merge and diverge connections.

Along northbound I-229, the Exit 3 and Exit 4 merge and diverge locations would not be required to be modified before 2035. As a result, the existing access location can remain unchanged. The proposed bridge structures at the interchange should be designed to accommodate a future 3rd northbound lane to carry the future 2050 traffic demands.

Along southbound I-229, the merge locations can be designed to SDDOT standards; however the two diverge locations would require additional deceleration length to achieve LOS C; approximately 500 feet of deceleration is needed at each diverge location.

For the analysis of the Exit 4 IMJR, it was assumed the Exit 3 interchange would remain a standard diamond configuration for the freeway analysis; with one diverge and one merge location.

Results for the individual segments and ramp junctions of I-229 are shown in **Figure 21** as well as **Table 22**. The figure is representative of the build Alternative 6 or 7, with a single exit and entrance ramp location for the Exit 4 interchange with southbound I-229; Alternative 1 would split the entrance ramp into two separate ramp access locations as denoted in the table.

Outside of the immediate project area there are two LOS D segments along southbound I-229; they are located at the 2-lane segments of the 26th Street and Western Avenue interchanges. As these operations are the same between the No Build and Build conditions, no mitigations are required as part of this evaluation.

Figure 21 – 2035 Build Freeway Configuration and LOS

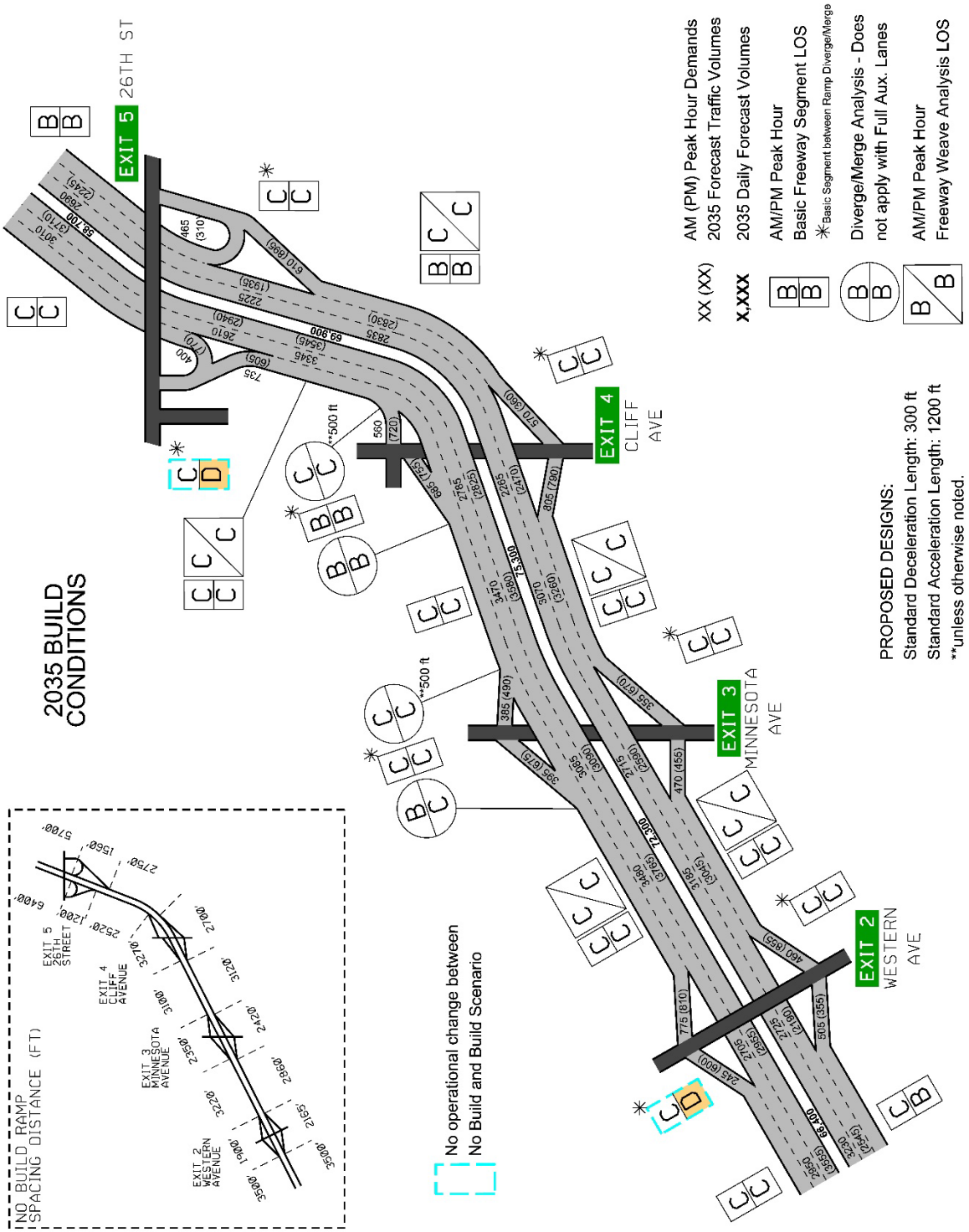


Table 22 – 2035 Build I-229 Freeway Operations Summary

Road	Description	Analysis Type	AM Peak LOS	PM Peak LOS
NB I-229	NB I-229: southwest of Exit 2	Basic	C	B
	NB I-229: between Exit 2 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 2 and Exit 3	Basic	C	C
		Weave	C	C
	NB I-229: between Exit 3 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 3 and Exit 4	Basic	C	C
		Weave	C	C
	NB I-229: between Exit 4 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 4 and Exit 5	Basic	B	B
		Weave	C	C
	NB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	C
	NB I-229: northeast of Exit 5	Basic	B	B
SB I-229	SB I-229: northeast of Exit 5	Basic	C	C
	SB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	**D**
	SB I-229: between Exit 5 and Exit 4	Basic	C	C
		Weave	C	C
	SB I-229: Exit 4 Exit Ramp	Diverge	C	C
	SB I-229: between Exit 4 Exit and Entrance Ramps	Basic	B	B
	SB I-229: Exit 4 NB Entrance Ramp **(Alt 1)**	Merge	B	B
	SB I-229: between Exit 4 Entrance Ramps **(Alt 1)**	Basic	C	C
	SB I-229: Exit 4 SB Entrance Ramp **(Alt 1)**	Merge	B	B
	SB I-229: Exit 4 SB Entrance Ramp **(Alt 6/7)**	Merge	B	B
	SB I-229: between Exit 4 and Exit 3	Basic	C	C
	SB I-229: Exit 3 Exit Ramp	Diverge	C	C
	SB I-229: between Exit 3 Exit and Entrance Ramps	Basic	C	C
	SB I-229: Exit 3 Entrance Ramp	Merge	B	C
	SB I-229: between Exit 3 and Exit 2	Basic	C	C
		Weave	C	C
	SB I-229: between Exit 2 Exit and Entrance Ramps	Basic	C	**D**
	SB I-229: southwest of Exit 2	Basic	C	C

- **Bold/Shaded** indicates a LOS D or worse
- Along Northbound I-229, all three build alternatives have the same freeway operations.
- Along Southbound I-229, all three build alternatives have the same freeway operations unless otherwise noted.
- There is no operational change between the No Build and Build outside of the immediate interchange area and therefore no mitigations were considered.

The project study area includes twenty-nine arterial intersections identified for operational analysis. Many of these intersections are outside of the immediate Exit 3 interchange area, therefore, mitigations were not considered. **Table 23** summarizes the results of the 2035 Build traffic analysis for the ramp terminal intersections as well as adjacent major intersections within the study area.

The interchange and arterial improvements proposed at the Exit 3 interchange and along the Minnesota Avenue corridor will not change operations from the No Build conditions along Western Avenue, Cliff Avenue, and 26th Street. While no intersection mitigations are required at these intersections, discussion about the operations is provided below.

- Along Western Avenue, the new connection of 49th Street between Western Avenue and Minnesota Avenue draws a lot of traffic and capacity improvements will be necessary at the Western Avenue and 49th Street intersection. The I-229 ramp terminal intersections at Western Avenue operate at a LOS C or better. The Western Avenue at 57th Street intersection has ample capacity for the majority of the turning movements, however the southbound approach is limited by the Big Sioux River bridge and storage capacity is an issue.
- Minnesota Avenue mitigations are being developed as part of the Exit 3 IMJR and will provide recommendations for the immediate I-229 interchange area.
- Along 26th Street, the intersection of 26th Street at Cliff Avenue has acceptable delays, but additional turn lane storage will be needed. The minor stop control intersection at Yeager Road will have delay issues for the minor approach and should be considered for a reduced access intersection control. The interchange ramp terminal intersections and the intersection of Southeastern Avenue will all operate at acceptable levels.

Along Cliff Avenue, the intersections outside of the immediate interchange area would have the same traffic operations in all three alternatives. The following improvements are necessary at the intersections outside of the interchange area:

- Cliff at 36th Street: no change, poor LOS but low volume.
- Cliff at 38th Street: possible traffic control change, minor stop fails.
  - RI/RO conversion of Lincoln High School (LHS) Access #1 brings additional left turns out at this intersection.
  - Traffic signal will provide LOS C or better; remove mid-block pedestrian signal.
- Cliff at LHS Access #1: minimum convert to RI/RO
  - Access closure may be more appropriate due to proximity to intersections.
- Cliff at Spencer Park: no change, minor stop failing but very low volume.
- Cliff at 49th Street: extend storage lanes.

Table 23 – 2035 Build Arterial Intersection Control – LOS Criteria

Major Roadway	Intersecting Roadway	Control Type	AM Peak	PM Peak
Western Avenue	W 49th Street	Signal	C	**E-**
Western Avenue	I-229 SB Ramp Terminal	Signal	C	C
Western Avenue	I-229 NB Ramp Terminal	Signal	B	B
Western Avenue	W 57th Street	Signal	**D***	**D***
Minnesota Avenue	W 37th Street	Signal	C	C
Minnesota Avenue	W 41st Street	Signal	C	**D-**
Minnesota Avenue	W 49th Street	Minor Stop	**F**	**F**
Minnesota Avenue	I-229 SB Ramp Terminal	Signal	B	**C***
Minnesota Avenue	I-229 NB Ramp Terminal	Signal	C	**D***
Minnesota Avenue	Yankton Park Entrance	Minor Stop	**B-**	**F**
Minnesota Avenue	W Lotta Street	Minor Stop	**F**	**F**
Minnesota Avenue	W 57th Street	Signal	C	**D***
Cliff Avenue	E 33rd Street	Signal	B	C
Cliff Avenue	36th St/LHS Entrance #4	Minor Stop	D	C
Cliff Avenue	38th St/LHS Entrance #3	**Signal**	B	B
Cliff Avenue	LHS Entrance #2	Minor Stop	C	B
Cliff Avenue	LHS Entrance #1	**RI/RO**	D	B
Cliff Avenue	41st St/I-229 SB Exit Ramp	**See Table 24 and Figure 22 for Interchange Alternatives**		
Cliff Avenue	I-229 SB Entrance Ramp			
Cliff Avenue	I-229 NB Ramp Terminal			
Cliff Avenue	Spencer Park Entrance	Minor Stop	C	**D-**
Cliff Avenue	E 49th Street	Signal	**C***	**B***
26th Street	S Cliff Avenue	Signal	**C***	**D***
26th Street	S Yeager Road	Minor Stop	C	**F**
26th Street	I-229 SB Ramp Terminal	Signal	B	B
26th Street	I-229 NB Ramp Terminal	Signal	B	C
26th Street	Southeastern Avenue	Signal	D	D
41st Street	S Norton Avenue	Signal	B	B
41st Street	S Phillips Avenue	Signal	**B***	**B***

Notes: *Intersection considered failing due to LOS and/or Queue Storage Ratio.*

- Average Intersection LOS shown, individual movements and/or approaches may be different. Minor Street Stop Control intersections LOS represents the worst minor approach LOS; major roadway would operate at LOS A.

*- " * " Queue Storage Ratio greater than 1.0 for at least 1 movement, results in failing intersection.*

- " – " At least one movement operates at a LOS F (not noted if intersection is at LOS F)

All three proposed build alternatives are able to provide LOS C or better operations at the ramp terminal intersections; the interchange capacity for the design year 2050 analysis was maintained for the 2035 build analysis.

Table 24 summarizes the results of the 2035 Build traffic analysis for the Minnesota Avenue ramp terminal intersections.

Table 24 – 2035 Build Interchange Intersection Control – LOS Criteria

ALT	Major Roadway	Intersecting Roadway	Control Type	AM Peak	PM Peak
1	Cliff Avenue	W 41st Street/I-229 SB Ramp	Signal	C	C
	Cliff Avenue	I-229 SB Entrance Ramp	None	A	A
	Cliff Avenue	I-229 NB Ramp Terminal	Signal	B	C
6	Cliff Avenue	41st Street	Signal	B	C
	Cliff Avenue	I-229 SPUI	Signal	C	C
7	Cliff Avenue	W 41st Street/I-229 SB Ramp	Signal	B	B
	Cliff Avenue	I-229 SPUI	Signal	C	B

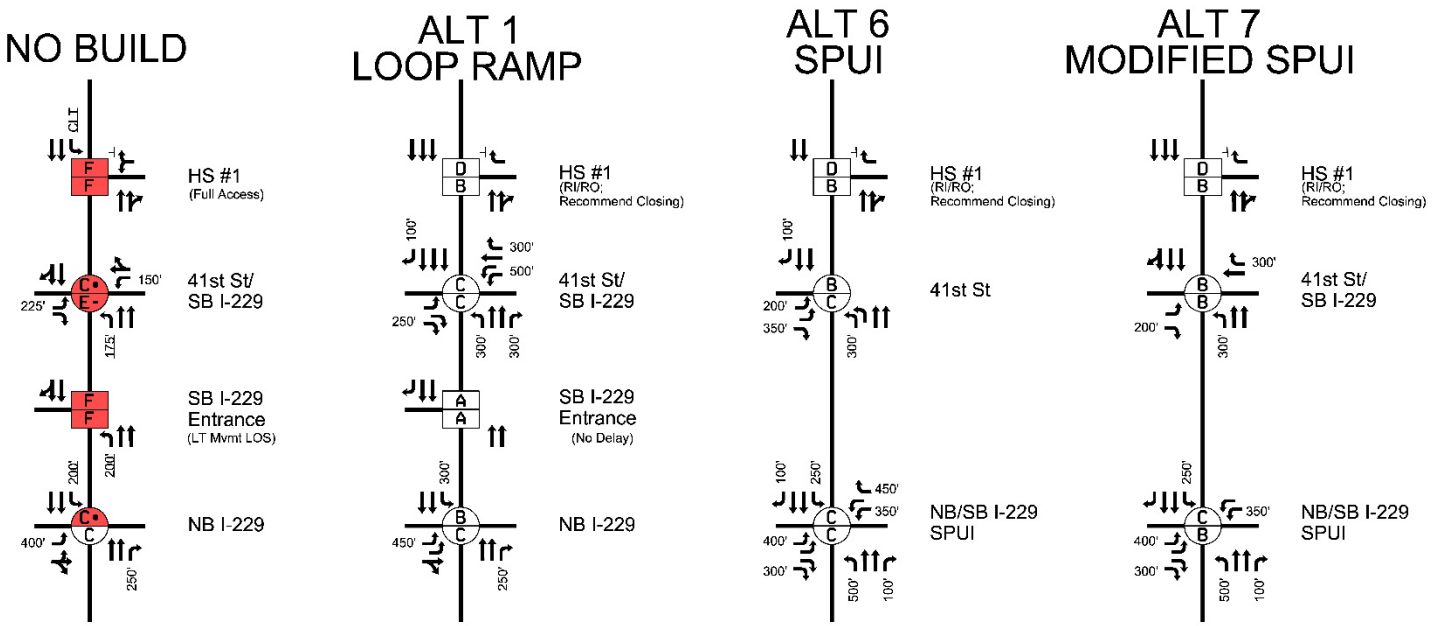
Notes:

- For Alternatives 1, the SB Entrance is a free right turn movement south of the 41st Street intersection; the NB Entrance ramp is located near the 41st Street intersection though it is a free movement as well.

- For Alternative 7, the SB exit ramp splits with SB traffic going to the SPUI and WB/NB traffic going to 41st Street.

The lane configurations needed for each proposed alternative, including the No Build, are represented in **Figure 22**.

Figure 22 – 2035 Build Cliff Avenue Interchange Configurations and LOS



6.4 Year of Opening Analysis

The interchange project is expected to be open to traffic by the year 2024. The forecast opening year still shows some areas of significant growth throughout the southern Sioux Falls metropolitan area, including the immediate project area.

The projected traffic forecast volumes resulted in the same volumes between the No Build and Build scenarios. The proposed build alternatives add capacity to the interchange area, but do not add significant capacity that would alter regional route choices.

Poor operational performance outside the immediate project construction area would not be impacted by proposed build conditions and therefore the project is not required to mitigate these areas. This includes operational problems that may exist along Western Avenue and 26th Street, as well as I-229 outside the immediate interchange area.

Appendix G includes all HCS summary sheets for the 2024 No Build conditions analysis, **Appendix H** includes all HCS summary sheets for the 2024 Build conditions.

6.4.1 2024 No Build Conditions

The summation of the 2024 No Build traffic operations analysis show that mainline I-229 is expected to continue to operate at a LOS C or better on all freeway segments in 2024.

Results for the individual segments and ramp junctions of I-229 are shown in **Figure 23** as well as **Table 25**.

Figure 23 – 2024 No Build Freeway Configuration and LOS

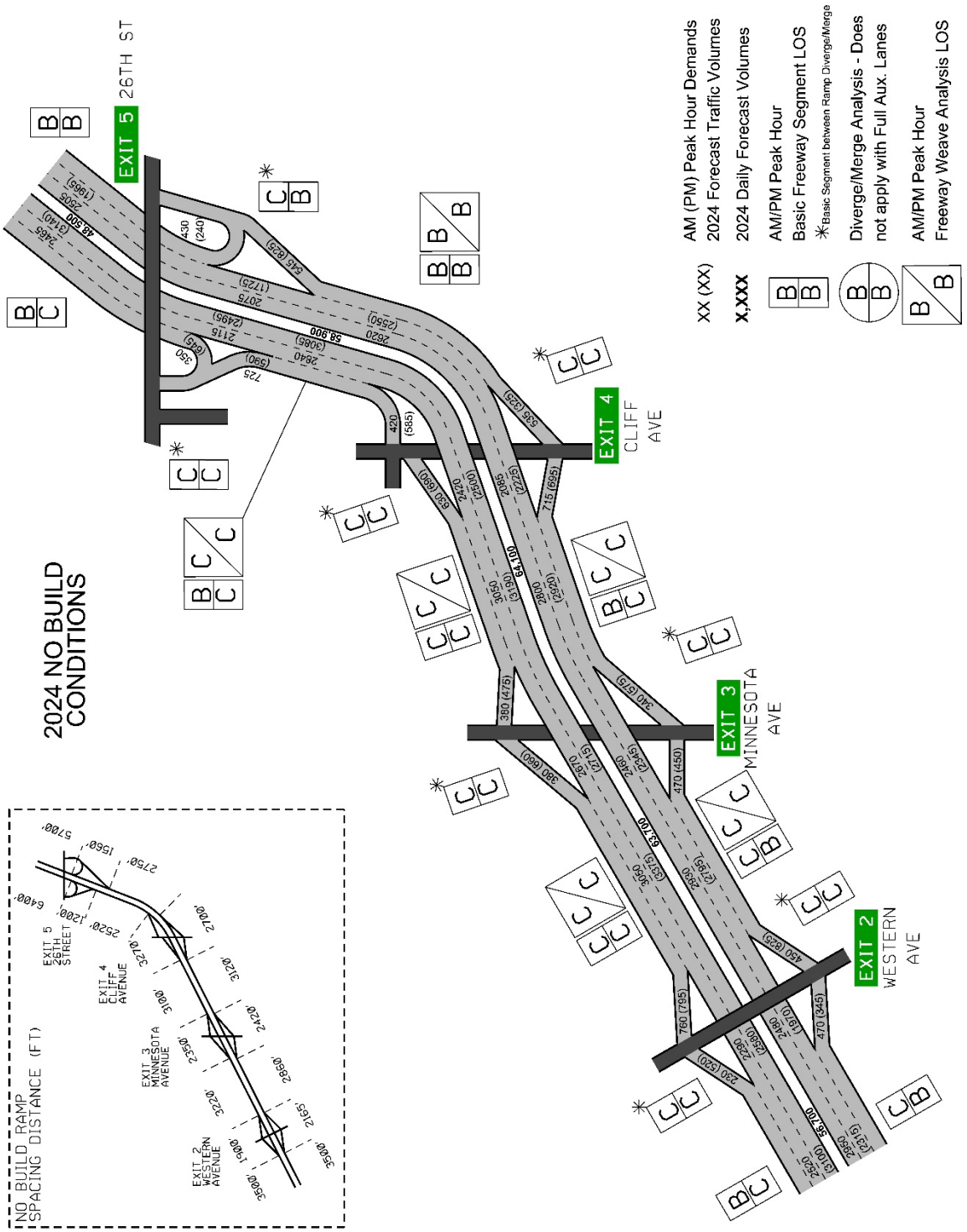


Table 25 – 2024 No Build I-229 Freeway Operations Summary

Road	Description	Analysis Type	AM Peak LOS	PM Peak LOS
NB I-229	NB I-229: southwest of Exit 2	Basic	C	B
	NB I-229: between Exit 2 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 2 and Exit 3	Basic	C	B
		Weave	C	C
	NB I-229: between Exit 3 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 3 and Exit 4	Basic	B	C
		Weave	C	C
	NB I-229: between Exit 4 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 4 and Exit 5	Basic	B	B
		Weave	B	B
	NB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	B
	NB I-229: northeast of Exit 5	Basic	B	B
SB I-229	SB I-229: northeast of Exit 5	Basic	B	C
	SB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	C
	SB I-229: between Exit 5 and Exit 4	Basic	B	C
		Weave	C	C
	SB I-229: between Exit 4 Exit and Entrance Ramps	Basic	C	C
	SB I-229: between Exit 4 and Exit 3	Basic	C	C
		Weave	C	C
	SB I-229: between Exit 3 Exit and Entrance Ramps	Basic	C	C
	SB I-229: between Exit 3 and Exit 2	Basic	C	C
		Weave	C	C
	SB I-229: between Exit 2 Exit and Entrance Ramps	Basic	C	C
	SB I-229: southwest of Exit 2	Basic	B	C

- **Bold/Shaded** indicates a LOS D or worse

The project study area includes twenty-nine arterial intersections identified for operational analysis. **Table 26** summarizes the results of the 2024 No Build traffic analysis for the ramp terminal intersections as well as adjacent major intersections within the study area. The 2024 No Build lane configurations of each study intersection, with turn lane storage and the intersection LOS results, can be found in **Appendix A**.

Throughout all four interchange areas many intersections, including ramp termini, operate at unacceptable LOS during the peak hours. Through planned capacity improvements and signal timing/phasing changes, some intersections are actually improved over the existing conditions; for instance the Western Avenue and 26th Street ramp terminal intersections will operate at a LOS C or better. The total number of failing intersections is slightly reduced compared to the existing conditions, with only 17 study intersections having at least one peak hour operate under failing conditions.

Table 26 – 2024 No Build Arterial Intersection Control – LOS Criteria

Major Roadway	Intersecting Roadway	Control Type	AM Peak	PM Peak
Western Avenue	W 49th Street	Signal	B	D
Western Avenue	I-229 SB Ramp Terminal	Signal	B	C
Western Avenue	I-229 NB Ramp Terminal	Signal	B	B
Western Avenue	W 57th Street	Signal	**D***	**D***
Minnesota Avenue	W 37th Street	Signal	B	B
Minnesota Avenue	W 41st Street	Signal	C	**D-**
Minnesota Avenue	W 49th Street	Minor Stop	**F**	**F**
Minnesota Avenue	I-229 SB Ramp Terminal	Signal	B	**B***
Minnesota Avenue	I-229 NB Ramp Terminal	Signal	B	**C***
Minnesota Avenue	Yankton Park Entrance	Minor Stop	B	**F**
Minnesota Avenue	W Lotta Street	Minor Stop	**F**	**F**
Minnesota Avenue	W 57th Street	Signal	C	**D***
Cliff Avenue	E 33rd Street	Signal	B	C
Cliff Avenue	36th St/LHS Entrance #4	Minor Stop	C	C
Cliff Avenue	38th St/LHS Entrance #3	Minor Stop	**F**	**F**
Cliff Avenue	LHS Entrance #2	Minor Stop	C	A
Cliff Avenue	LHS Entrance #1	Minor Stop	**F**	**E**
Cliff Avenue	41st St/I-229 SB Exit Ramp	Signal	**B***	**D-**
Cliff Avenue	I-229 SB Entrance Ramp	No Control	C	**F**
Cliff Avenue	I-229 NB Ramp Terminal	Signal	B	C
Cliff Avenue	Spencer Park Entrance	Minor Stop	C	**D-**
Cliff Avenue	E 49th Street	Signal	**C***	B
26th Street	S Cliff Avenue	Signal	**C***	**D***
26th Street	S Yeager Road	Minor Stop	C	**F**
26th Street	I-229 SB Ramp Terminal	Signal	B	B
26th Street	I-229 NB Ramp Terminal	Signal	B	B
26th Street	Southeastern Avenue	Signal	C	C
41st Street	S Norton Avenue	Signal	B	B
41st Street	S Phillips Avenue	Signal	B	**B***

Notes: *Intersection considered failing due to LOS and/or Queue Storage Ratio.*

- Average Intersection LOS shown, individual movements and/or approaches may be different. Minor Street Stop Control intersections LOS represents the worst minor approach LOS; major roadway would operate at LOS A.

*- " * " Queue Storage Ratio greater than 1.0 for at least 1 movement, results in failing intersection.*

- " – " At least one movement operates at a LOS F (not noted if intersection is at LOS F)

6.4.2 2024 Build Conditions

The proposed build alternatives would not require capacity improvements to I-229 in the 2024 year of opening.

However, the 2035 mid-term forecast year showed a need for southbound I-229 capacity, the existing 2-lane freeway segments over both Minnesota Avenue and Cliff Avenue have impacts. These segments should be constructed with 3-lanes to serve the future forecast demands at LOS C. This modification would remove the weaving segment between Exit 3 and Exit 4 as there would no longer be a continuous auxiliary lane between the ramps. Having 3-continuous southbound lanes through both the Exit 3 and Exit 4 interchanges would require the ramps to have standard merge and diverge connections.

Along northbound I-229, the Exit 3 and Exit 4 merge and diverge locations would not be required to be modified before 2035 and the existing access location can remained unchanged for the year of opening condition. The proposed bridge structures at the interchange should be designed to accommodate a future 3rd northbound lane to carry the 2050 traffic demands.

For the analysis of the Exit 4 IMJR, it was assumed the Exit 3 interchange would remain a standard diamond configuration for the freeway analysis; with one diverge and one merge location.

Results for the individual segments and ramp junctions of I-229 are shown in **Figure 24** as well as **Table 27**. The figure is representative of the build Alternative 6 and 7, with a single exit and entrance ramp location for the Exit 4 interchange with southbound I-229; Alternative 1 would split the entrance ramp into two separate ramp access locations as denoted in the table.

Figure 24 – 2024 Build Freeway Configuration and LOS

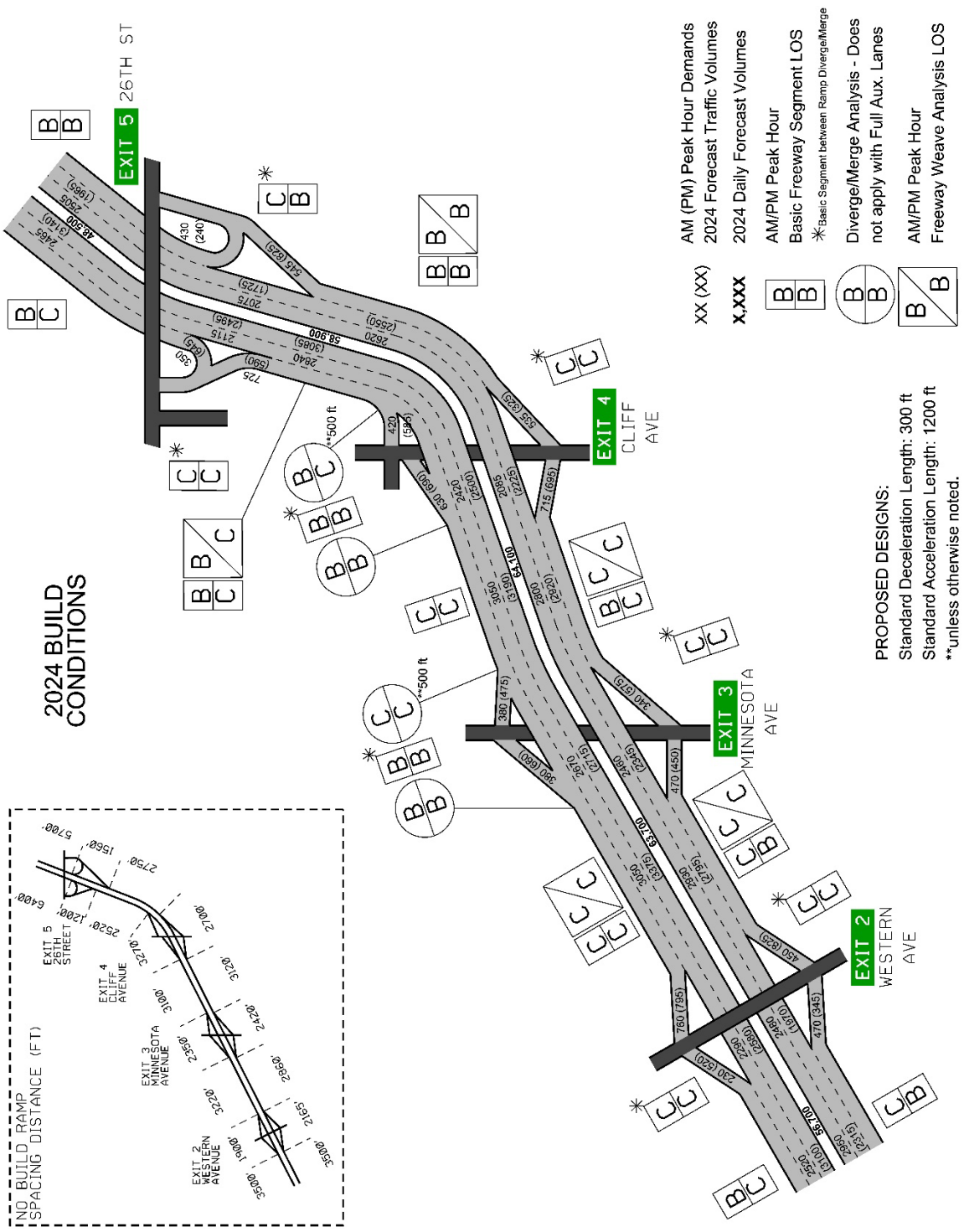


Table 27 – 2024 Build I-229 Freeway Operations Summary

Road	Description	Analysis Type	AM Peak LOS	PM Peak LOS
NB I-229	NB I-229: southwest of Exit 2	Basic	C	B
	NB I-229: between Exit 2 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 2 and Exit 3	Basic	C	B
		Weave	C	C
	NB I-229: between Exit 3 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 3 and Exit 4	Basic	B	C
		Weave	C	C
	NB I-229: between Exit 4 Exit and Entrance Ramps	Basic	C	C
	NB I-229: between Exit 4 and Exit 5	Basic	B	B
		Weave	B	B
	NB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	B
	NB I-229: northeast of Exit 5	Basic	B	B
SB I-229	SB I-229: northeast of Exit 5	Basic	B	C
	SB I-229: between Exit 5 Exit and Entrance Ramps	Basic	C	C
	SB I-229: between Exit 5 and Exit 4	Basic	B	C
		Weave	B	C
	SB I-229: Exit 4 Exit Ramp	Diverge	B	C
	SB I-229: between Exit 4 Exit and Entrance Ramps	Basic	B	B
	SB I-229: Exit 4 NB Entrance Ramp **(Alt 1)**	Merge	B	B
	SB I-229: between Exit 4 Entrance Ramps **(Alt 1)**	Basic	B	B
	SB I-229: Exit 4 SB Entrance Ramp **(Alt 1)**	Merge	B	B
	SB I-229: Exit 4 SB Entrance Ramp **(Alt 6/7)**	Merge	B	B
	SB I-229: between Exit 4 and Exit 3	Basic	C	C
	SB I-229: Exit 3 Exit Ramp	Diverge	C	C
	SB I-229: between Exit 3 Exit and Entrance Ramps	Basic	B	B
	SB I-229: Exit 3 Entrance Ramp	Merge	B	B
	SB I-229: between Exit 3 and Exit 2	Basic	C	C
		Weave	C	C
	SB I-229: between Exit 2 Exit and Entrance Ramps	Basic	C	C
	SB I-229: southwest of Exit 2	Basic	B	C

- **Bold/Shaded** indicates a LOS D or worse
- Along Northbound I-229, all three build alternatives have the same freeway operations.
- Along Southbound I-229, all three build alternatives have the same freeway operations unless otherwise noted.
- There is no operational change between the No Build and Build outside of the immediate interchange area and therefore no mitigations were considered.

The project study area includes twenty-nine arterial intersections identified for operational analysis. Many of these intersections are outside of the immediate Exit 3 interchange area, therefore, mitigations were not considered. **Table 28** summarizes the results of the 2024 Build traffic analysis for the ramp terminal intersections as well as adjacent major intersections within the study area.

The interchange and arterial improvements proposed at the Exit 3 interchange and along the Minnesota Avenue corridor will not change operations from the No Build conditions along Western Avenue, Cliff Avenue, and 26th Street. While no intersection mitigations are required at these intersections, discussion about the operations is provided below.

- Along Western Avenue, the new connection of 49th Street will be constructed with enough capacity to serve the 2024 demands at the Western Avenue and 49th Street intersection. The I-229 ramp terminal intersections at Western Avenue operate at a LOS C or better. The Western Avenue at 57th Street intersection has ample capacity for the majority of the turning movements, however the southbound approach is limited by the Big Sioux River bridge and storage capacity is an issue.
- Minnesota Avenue mitigations are being developed as part of the Exit 3 IMJR and will provide recommendations for the immediate I-229 interchange area.
- Along 26th Street, the intersection of 26th Street at Cliff Avenue has acceptable delays, but additional turn lane storage will be needed. The minor stop control intersection at Yeager Road will have delay issues for the minor approach and should be considered for a reduced access intersection control. The interchange ramp terminal intersections and the intersection of Southeastern Avenue will all operate at acceptable levels.

Along Cliff Avenue, the intersections outside of the immediate interchange area would have the same traffic operations in all three alternatives. The following improvements are necessary at the intersections outside of the interchange area:

- Cliff at 36th Street: no change, poor LOS but low volume.
- Cliff at 38th Street: possible traffic control change, minor stop fails.
  - RI/RO conversion of Lincoln High School (LHS) Access #1 brings additional left turns out at this intersection.
  - Traffic signal will provide LOS C or better; remove mid-block pedestrian signal.
- Cliff at LHS Access #2: no change.
- Cliff at LHS Access #1: minimum convert to RI/RO
  - Access closure may be more appropriate due to proximity to intersections.
- Cliff at Spencer Park: no change, minor stop failing but very low volume.
- Cliff at 49th Street: extend storage lanes.

Table 28 – 2024 Build Arterial Intersection Control – LOS Criteria

Major Roadway	Intersecting Roadway	Control Type	AM Peak	PM Peak
Western Avenue	W 49th Street	Signal	B	D
Western Avenue	I-229 SB Ramp Terminal	Signal	B	C
Western Avenue	I-229 NB Ramp Terminal	Signal	B	B
Western Avenue	W 57th Street	Signal	**D***	**D***
Minnesota Avenue	W 37th Street	Signal	B	B
Minnesota Avenue	W 41st Street	Signal	C	**D-**
Minnesota Avenue	W 49th Street	Minor Stop	**F**	**F**
Minnesota Avenue	I-229 SB Ramp Terminal	Signal	B	**B***
Minnesota Avenue	I-229 NB Ramp Terminal	Signal	B	**C***
Minnesota Avenue	Yankton Park Entrance	Minor Stop	B	**F**
Minnesota Avenue	W Lotta Street	Minor Stop	**F**	**F**
Minnesota Avenue	W 57th Street	Signal	C	**D***
Cliff Avenue	E 33rd Street	Signal	B	C
Cliff Avenue	36th St/LHS Entrance #4	Minor Stop	C	C
Cliff Avenue	38th St/LHS Entrance #3	**Signal**	B	B
Cliff Avenue	LHS Entrance #2	Minor Stop	C	A
Cliff Avenue	LHS Entrance #1	**RI/RO**	C	B
Cliff Avenue	41st St/I-229 SB Exit Ramp	**See Table 29 and Figure 25 for Interchange Alternatives**		
Cliff Avenue	I-229 SB Entrance Ramp			
Cliff Avenue	I-229 NB Ramp Terminal			
Cliff Avenue	Spencer Park Entrance	Minor Stop	C	**D-**
Cliff Avenue	E 49th Street	Signal	**C***	B
26th Street	S Cliff Avenue	Signal	**C***	**D***
26th Street	S Yeager Road	Minor Stop	C	**F**
26th Street	I-229 SB Ramp Terminal	Signal	B	B
26th Street	I-229 NB Ramp Terminal	Signal	B	B
26th Street	Southeastern Avenue	Signal	C	C
41st Street	S Norton Avenue	Signal	B	B
41st Street	S Phillips Avenue	Signal	B	**B***

Notes: *Intersection considered failing due to LOS and/or Queue Storage Ratio.*

- Average Intersection LOS shown, individual movements and/or approaches may be different. Minor Street Stop Control intersections LOS represents the worst minor approach LOS; major roadway would operate at LOS A.

*- " * " Queue Storage Ratio greater than 1.0 for at least 1 movement, results in failing intersection.*

- " – " At least one movement operates at a LOS F (not noted if intersection is at LOS F)

All three proposed build alternatives are able to provide LOS C or better operations at the ramp terminal intersections; the interchange capacity for the design year 2050 analysis was maintained for the 2024 build analysis.

Table 29 summarizes the results of the 2024 Build traffic analysis for the Minnesota Avenue ramp terminal intersections.

Table 29 – 2024 Build Interchange Intersection Control – LOS Criteria

ALT	Major Roadway	Intersecting Roadway	Control Type	AM Peak	PM Peak
1	Cliff Avenue	W 41st Street/I-229 SB Ramp	Signal	B	C
	Cliff Avenue	I-229 SB Entrance Ramp	None	A	A
	Cliff Avenue	I-229 NB Ramp Terminal	Signal	B	B
6	Cliff Avenue	41st Street	Signal	B	B
	Cliff Avenue	I-229 SPUI	Signal	C	B
7	Cliff Avenue	W 41st Street/I-229 SB Ramp	Signal	B	B
	Cliff Avenue	I-229 SPUI	Signal	B	B

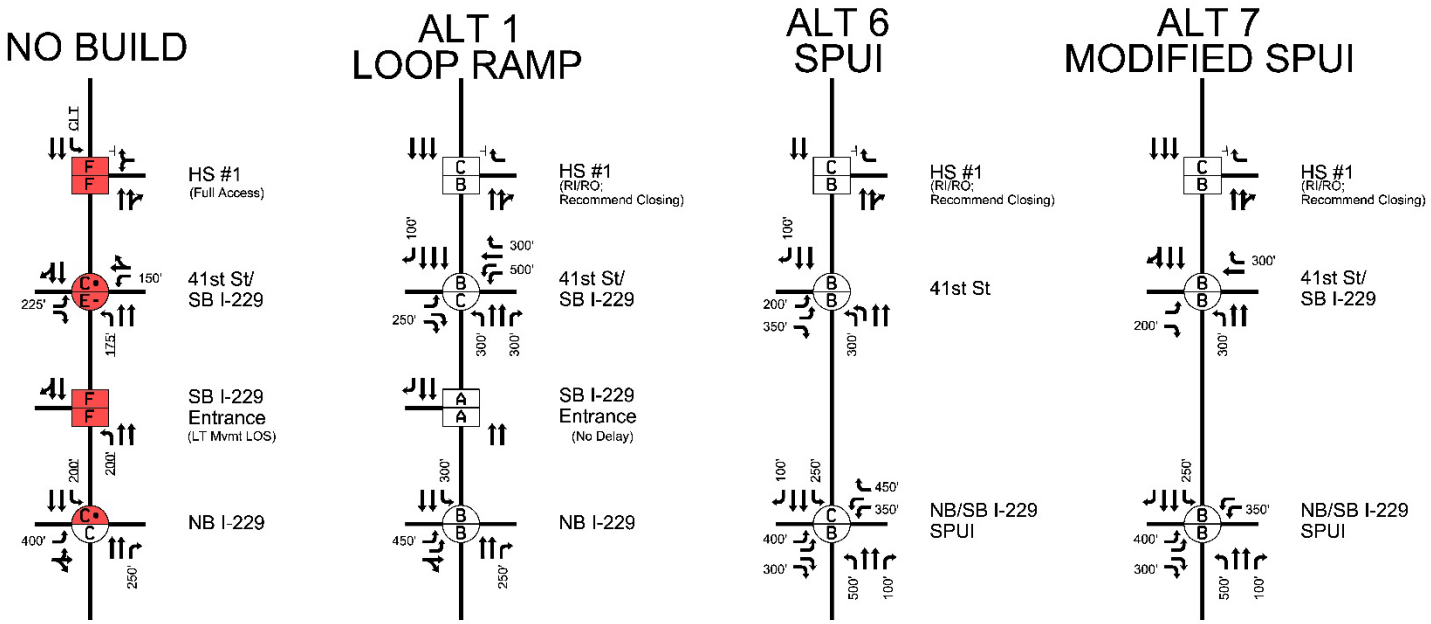
Notes:

- For Alternatives 1, the SB Entrance is a free right turn movement south of the 41st Street intersection; the NB Entrance ramp is located near the 41st Street intersection though it is a free movement as well.

- For Alternative 7, the SB exit ramp splits with SB traffic going to the SPUI and WB/NB traffic going to 41st Street.

The lane configurations needed for each proposed alternative, including the No Build, is represented in **Figure 25**.

Figure 25 – 2024 Build Cliff Avenue Interchange Configurations and LOS



6.5 Design Year Sensitivity Analysis

As all of the proposed alternatives were designed to provide acceptable traffic operations through the 2050 design year, a sensitivity analysis was conducted at the interchange to test for excess capacity of the proposed interchange designs.

A 10% increase in the 2050 traffic volumes was used to evaluate the proposed designs. **Table 30** represents the LOS results of the sensitivity analysis; all three alternatives would have movements that operate under failing conditions.

Alternative 1 would have LOS F movements at both the ramp terminal intersections and would require additional capacity to improve operations.

In Alternatives 6 and 7, the SPUI intersection would remain at a LOS C. For Alternative 6, the eastbound approach at 41st Street fails; while this is outside of the interchange area, it is still considered failing based on an overall approach failure. For Alternative 7 the failing movement is part of the interchange and would require additional capacity to improve operations.

Therefore Alternatives 6 and 7 have more excess capacity out of the three proposed interchange alternatives.

Table 30 – 2050 Build Sensitivity Interchange Intersection Control – LOS Criteria

ALT	Major Roadway	Intersecting Roadway	Control Type	AM Peak	PM Peak
1	Cliff Avenue	W 41st Street/I-229 SB Ramp	Signal	**D-**	**D-**
	Cliff Avenue	I-229 SB Entrance Ramp	None	A	A
	Cliff Avenue	I-229 NB Ramp Terminal	Signal	**C-**	**D-**
6	Cliff Avenue	41st Street	Signal	B	**D-**
	Cliff Avenue	I-229 SPUI	Signal	C	C
7	Cliff Avenue	W 41st Street/I-229 SB Ramp	Signal	C	**D-**
	Cliff Avenue	I-229 SPUI	Signal	C	C

Notes: *Intersection considered failing due to LOS and/or Queue Storage Ratio.*

- Average Intersection LOS shown, individual movements and/or approaches may be different.

*- " * " Queue Storage Ratio greater than 1.0 for at least 1 movement, results in failing intersection.*

- " – " At least one movement operates at a LOS F (not noted if intersection is at LOS F)

7 Alternatives Analysis

The interchange alternatives were analyzed and compared to determine which may be the most appropriate for meeting the project needs. The areas of analysis and comparison are discussed in the following sections.

7.1 Conformance with Transportation Plans

State and local transportation plans have consistently identified a need for an improved interchange at I-229 and Cliff Avenue (Exit 4) that meets design standards and provides adequate safety and capacity improvements to serve the existing and future travel demand. The following transportation plans have identified the study interchange:

- Sioux Falls MPO 2040 Long Range Transportation Plan
- 2010 Decennial Interstate Corridor Study
- I-229 Major Investment Study

All retained interchange alternatives satisfy this conformance.

7.2 Compliance with Policies and Engineering Standards

Alternative 0, the No Build condition, by its definition will not address the known geometric needs of the existing interchange and therefore does not comply with these standards.

Each of the proposed interchange alternatives has used the latest design guidance from AASHTO, FHWA, and SDDOT; final design of any of the options may be accomplished without conflict with geometric design standards.

Access management was examined at adjacent local street intersections and driveway locations; this includes the SDDOT and City of Sioux Falls spacing.

- SDDOT design standards call for access spacing of at least 100’ from the radius of the ramp termini when rebuilding an existing urban interchange. However, it is further recommended extending the control of access to meet the access spacing requirements established by South Dakota Administrative Rule 70:09; the Administrative Rules call for unsignalized access spacing of 100’ to 660’ and minimum signalized access spacing of 1320’, depending on the classification of the arterial street (Cliff Avenue is not within SDDOT jurisdiction and is not currently classified in the State system). With reconstructing an existing interchange, a minimum spacing of 100’ is required for the first unsignalized access.
- City of Sioux Falls design standards call for ¼ mile full access spacing on arterial roadways like Cliff Avenue, but list spacing of unsignalized partial access as “varies”. Other guidelines and research recommends signalized intersections no closer than ¼ mile from interchange ramp termini, but allow unsignalized partial access at spacing less than ¼ mile.

To the south of I-229, all three alternatives fully satisfy both spacing standards; the first unsignalized access is approximately 180’ south of the SPUI right turn merge and the first signalized access would be approximately 2,700’ south.

To the north of I-229, all three alternatives would satisfy the unsignalized access spacing with between 300’ and 400’ of spacing. However, none of the alternatives would fully satisfy the signalized spacing criteria; however all are improved over the existing conditions.

- Alternative Cliff-1 would have the first unsignalized access approximately 400 ft north at Pam Road and the first signalized intersection approximately 2,000 feet at 33rd Street; however 38th Street may become signalized and be approximately 750 feet north.
- Alternative Cliff-6 would provide more separation between 41st Street and the interchange; this provides at least 340' of spacing. The next unsignalized access approximately 500 ft north at 38th Street; however this intersection may become signalized and would require coordination.
- Alternative Cliff-7 would have the first unsignalized access approximately 400 ft north at Pam Road and the first signalized intersection approximately 2,000 feet north at 33rd Street; however 38th Street may become signalized and be approximately 750 feet north.

7.3 Environmental Impacts

An Environmental Scan Report (ESR) is being developed in conjunction with the IMJR. This document will compare each alternative and their environmental impacts compared to the No Build alternative. The ESR will ultimately recommend the NEPA documentation necessary for the proposed interchange project.

7.4 Safety

All Build alternatives are expected to show a safety benefit when compared to the No Build alternative. A predictive analysis of the alternatives was conducted using FHWA's Interactive Highway Safety Design Model (IHSDM); this is a faithful implementation of the crash prediction methods documented in Part C of the Highway Safety Manual (HSM). IHSDM output sheets are provided in **Appendix L**.

The IHSDM model limits include I-229 from the eastern gore area of Exit 3 and the western gore area of Exit 5; the arterial corridor includes Cliff Avenue from 33rd Street to 49th Street. It should be noted that the ramp terminal intersections are now included in the arterial corridor analysis; previous versions of IHSDM had the ramp terminals separated out from the arterial.

Table 31 shows the analysis results, all proposed Build alternatives have a significant reduction in predicted crashes when compared to the No Build condition.

Table 31 – Predicted Crashes (IHSDM) Results (2024 to 2050)

Facility Type	Crash Type	No Build	Build 1	Build 6	Build 7
Freeway Mainline	Fatal/Injury	186	175	176	176
	Property Only	366	338	331	331
Ramp Connections	Fatal/Injury	35	35	38	35
	Property Only	34	35	47	42
Arterial Corridor & Intersections	Fatal/Injury	378	367	279	290
	Property Only	734	671	560	591
ALTERNATIVE TOTALS	Fatal/Injury	599	576	493	501
	Property Only	1,134	1,045	938	965
	TOTAL	**1,733**	**1,621**	**1,431**	**1,465**
	% Reduction	**-**	**6.4%**	**17.4%**	**15.4%**

When comparing the crashes by facility type, the freeway mainline crashes are predicted to have a reduction of approximately 40 crashes for each build alternative; this is approximately an 8% reduction in freeway mainline crashes. The additional southbound entrance ramp access in alternative 1 has a negligible change compared to the other alternatives.

For the ramp connections, the difference between the No Build and all three build alternatives are fairly minor in the total quantity of crashes predicted; however, alternatives 6 and 7 see a slight increase in total crashes on the ramp connections.

The biggest impact in reduction of predicted crashes occurs on the arterial corridor. The changes on the arterial include a significant amount of center median being constructed, as well as some access changes along the corridor. Build alternatives 6 and 7 provide essentially the same crash benefit; these two alternatives provides more of a crash reduction due to the reduced number of intersections at the interchange junction.

Utilizing the FHWA's Grant Program guidance on estimated crash costs by severity, a monetary value for each alternative was calculated based on the linear crash estimations between 2024 and 2050. The FHWA guideline for crash cost estimation is as follows:

- Fatal Crash: ……..$9,600,000
- Severity A Crash: ……$459,100
- Severity B Crash: ……$125,000
- Severity C Crash: ……..$63,900
- Property Damage Only Crash: ……..$3,200

Applying the above crash costs to the estimated IHSDM information for each alternative produced the following total crash costs over the 26-year analysis period:

- No Build: $76,793,783
- Alternative 1: $73,892,885; reduction of $2,900,898
- Alternative 6: $60,823,664; reduction of $15,970,119
- Alternative 7: $62,015,545; reduction of $14,778,238

Based on the safety analysis, both Alternatives 6 and 7 have a significant safety benefit over the existing, No Build, and Alternative 1 conditions.

7.5 Operational Performance

The operations analysis of the alternative scenarios were evaluated using appropriate level of service techniques. All alternatives were evaluated with forecast demands for the opening year of 2024, a mid-term year of 2035, and a design year of 2050.

The existing roadway network has both safety and operational deficiencies within the project area, these problems will be exacerbated as traffic levels increase. The proposed interchange alternatives will provide acceptable traffic operations for all users within the project area based on the traffic operations analysis as discussed in **Section 6.0** of this document.

Regardless of the recommended interchange configuration, the 2050 analysis indicated that both directions of I-229 will need capacity improvements at the existing 2-lane segments between the exit and entrance ramps over both Minnesota Avenue and Cliff Avenue. The 2035 analysis indicated that southbound I-229 would also need capacity improvements at these two locations, but northbound I-229 would not require these improvements in 2035.

It is recommended to construct the southbound 3-lane segments as part of the initial construction project, the northbound 3-lane segment are not necessary at this time or through 2035. However, if no mainline improvements are initiated as part of the initial construction, the proposed I-229 bridges should be designed to accommodate the 3-lane section in each direction of I-229. It should be noted that Alternatives 2C and 2D would require a 4-lane bridge section for southbound I-229 over Minnesota Avenue to accommodate the three mainline through lanes and the loop ramp acceleration lane.

The majority of the 29 study intersections are not impacted by the proposed build alternatives and did not require mitigation as there was no operational change between the No Build and Build scenarios.

The intersections along Cliff Avenue between 33rd Street and W 49th Streetill need additional capacity and signal timing/phasing improvements to serve the future traffic demands. The AM peak hour has a high northbound volume using Cliff Avenue, however the existing two through lanes are able to serve the traffic as the minor street approaches are relatively low. In the PM peak hour, southbound Cliff Avenue has not only a significant through demand, but the minor street approaches are also at their peak volumes, this combination results in the need for capacity improvements surrounding the interchange area.

In alternatives 1 and 7, Cliff Avenue will require a 3rd southbound through lane from north of 41st Street to the I-229 interchange ramps; alternative 6 did not require the 3rd southbound lane. The intersection of Cliff Avenue at 38th Street will need to have a traffic signal installed to provide acceptable LOS for the minor street approaches; the existing mid-block pedestrian signal can be removed and reconfiguration of the high school parking lot may be required.

At the Cliff Avenue and I-229 interchange, all three proposed build alternatives provide acceptable traffic operations through the 2050 design year; the lane configurations for all three alternatives result in approximately the same roadway width near the 41st Street intersection. However, the sensitivity analysis showed that Alternatives 6 and 7 have more excess capacity when compared to Alternative 1.

7.6 Evaluation of Alternatives

A matrix comparing the No Build alternative to each Build alternative is shown in **Table 32** below. Based on the information within the matrix, Alternative 6 or Alternative 7 provide a better technical solution than the No Build or Alternative 1.

Table 32 – Alternatives Evaluation Matrix

	Evaluation Criteria	Alternative 0	Build Alternatives		
		No Build	Cliff-1	Cliff-6	Cliff-7
Plans	Meets SDDOT Design Criteria	No	Yes	Yes	Yes
	Meets SDDOT Access Spacing Criteria	No	Yes	Yes	Yes
	Meets City Access Spacing Criteria	No	No	No	No
	Access Closures	0	1	2	1
ROW	Acquisitions - Residential	n/a	1	6	1
	Acquisitions - Business	n/a	0	1	0
	Total Acreage of ROW Required *	n/a	0.8	2.7	1.1
Environmental	Wetlands (acres)	0.0	1.1	1	1.9
	City Parks (acres) - **Section 4(f)**	0.0	0.31	0.31	0.31
	City Parks (acres) - **Section 6(f)**	0.0	0.0	0.0	0.0
	Sioux Falls Bike Trail - **Section 4(f)**	0.0	Note[1]	Note[1]	Note[1]
	Sioux Falls Bike Trail - **Section 6(f)**	0.0	Note[1]	Note[1]	Note[1]
	Former RR - ROW acres (SHPO impact)	0.0	0.17	0.64	0.41
Traffic Safety & Operations	Safety Improvement (2024 through 2050 Crashes)	No (1733 crashes)	Yes (1624 crashes)	Yes (1431 crashes)	Yes (1465 crashes)
	Operational Performance	Poor	Good	Good	Good
	Sensitivity Performance (10% Increase)	Poor	Fair LOS D	Good LOS C	Fair LOS D
	Worst I-229 Performance 2050 (within Project Limits)	LOS D	LOS C	LOS C	LOS C
	Worst Ramp Terminal Performance 2050	LOS F (queue issues)	LOS C	LOS C	LOS C
	Non-Motorized Facilities (assumes all build alternatives would benefit from RRFB's)	Poor - narrow sidewalks only	Good - Trail and Sidewalk Provided; North Ramp has free right movements	Fair - Trail and Sidewalk Provided; Both Ramps have multiple free right movements	Fair - Trail and Sidewalk Provided; Both Ramps have multiple free right movements
Construction	Maintenance of Traffic During Construction	n/a	Fair	Fair	Fair
	Allows for Phased Construction	n/a	Yes	Yes	Yes
	Interchange Stucture Costs ($M)	n/a	$5.0	$14.0	$14.0
	Interchange Roadway Costs ($M)	n/a	$9.6	$14.0	$14.2
	Arterial Roadway Costs ($M)	n/a	$3.8	$3.6	$3.9
	Arterial Roadway Costs - city portion ($M)	n/a	$0.7	$0.9	$0.6
	Costs (Millions in 2018 dollars)	**n/a**	**$19.1**	**$32.5**	**$32.7**
	Additional considerations				
	Interstate Pavement Replacement Cost ($M)	n/a	$6.2	$3.6	$3.6
	Total Project Costs (Millions in 2018 dollars)	**n/a**	**$25.3**	**$36.1**	**$36.3**
	Relocate Trail Cost ($M)	n/a	$1.4	$1.4	$1.4

* Does not include City owned Park parcels

Note 1: Temporary disturbance during construction/relocate in place.

7.7 Coordination

The Cliff Avenue interchange project is being done in conjunction with a City of Sioux Falls project to reconstruct the Cliff Avenue corridor with the interchange area. As such, coordination between City and SDDOT staff has been ongoing and will continue through the construction phase of both projects.

The Cliff Avenue corridor, including the interchange with I-229, has been the subject of agency coordination and public involvement as part of both the I-229 MIS and the current interchange study and NEPA process. Public meetings have been held for both the MIS and the current project.

A significant amount of information regarding the current project can be found at the following web address:

https://www.i229exits3and4.com/

7.8 Alternative Recommendation

Based on the technical analysis contained in this Interchange Modification Justification Report (IMJR), and input from the Study Advisory Team, it was determined that **Alternative 6** provides the best technical solution for the transportation needs in the study area and is recommended to move forward for FHWA approval.

8 Funding Plan

The 2020-2023 Statewide Transportation Improvement Program (STIP) does not contain a project for reconstruction of the I-229 and Cliff Avenue interchange. Preliminary engineering funds are included in 2025 for I-229 at Cliff Avenue.

The interchange reconstruction project is in the SDDOT's developmental program and anticipated to be constructed in 2025. Current SDDOT budget estimates for interchange improvements are shown below.

Current construction cost estimates for the interchange and I-229 mainline work are $36.1 Million in 2018 dollars.

Table 33 – Anticipated Funding Allocation Breakdown

Project Number	State Category	Federal Category	Federal Funds ($ million)	State Funds ($ million)	City Funds ($ million)	Other Funds ($ million)	Total Funds ($ million)
Minn05HN	Interstate	National Highway Performance Program (NHPP)	$28.747	$2.853	$0.00	$0.00	**$31.60**
Minn05HN	Local Urban System	Surface Transportation Block Grant Program	$3.688	$0.812	$0.00	$0.00	**$4.50**
X	Sioux Falls Capital Improvements Program	None	$0.00	$0.00	$0.00	$0.00	**$0.00**
TOTALS			**$32.44**	**$3.66**	$0.00	$0.00	**$36.10**

Note: As funding is fluid, category breakdown may be different at the time of project authorization.

It should be noted that the analysis year of opening (2024) was anticipated to occur prior to funding allocations and programming of the construction in 2025.

9 Recommendations

Section 111 of Title 23 USC provides that before proceeding with the modification of existing access or the addition of access to the Interstate System, it is necessary to gain approval from the U.S. Secretary of Transportation.

The authority to administer 23 USC 111 has been delegated to the FHWA pursuant to 49 CFR 1.48(b)(10). The FHWA published a policy statement in the Federal Reserve on October 22, 1990 (55 FR 42670), which was modified on February 11, 1998 (63 FR 7045) and on August 27, 2009 (74 FR 20679). The latest update to the policy statement was on May 22, 2017 (23 CFR 630C).

The FHWA Policy on Access to the Interstate System requires all requests for new or revised access points on completed Interstate highways must closely adhere to the planning and environmental review processes as required in 23 CFR 450 and 771.

In this statement of policy, two technical policy requirements were identified for use by FHWA to do a technical evaluation of new or revised access points to the Interstate System. The policy requirements and a discussion of the proposed project conformance to each requirement are discussed in the following sections.

The technical analysis contained in this Interchange Modification Justification Report (IMJR) has found that **Alternative 6** provides the best technical solution for the transportation needs in the study area.

9.1 Policy Number One

An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, and ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (Title 23, Code of Federal Regulations (CFR), paragraphs 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)).

Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute, and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request should also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).

An extensive safety and operations analysis was conducted for the study area, as previous sections of this report presented. The results show that the proposed build scenarios are not expected to adversely affect the safety or efficiency of the Interstate system. The proposed build alternative is expected to improve safety, operations, and access management on the crossroad in the interchange area.

Results indicate the freeway mainline segments of I-229 will need capacity improvements, regardless of any interchange design alternative, by the design year 2050 due to regional growth in the Sioux Falls metropolitan area. The analysis showed that southbound I-229 would need capacity improvements by the mid-term year of 2035, northbound I-229 would still operate acceptably.

As the interchange build alternatives themselves do not cause an adverse impact to the interstate system, the interchanges could be constructed with no improvements along I-229 and tie back into the existing auxiliary lanes. However, with capacity needs within 10-years of the project construction, the additional lanes will be included at the time of the interchange reconstruction.

Figures 26 and 27 are repeated from Section 6 of this report representing the 2050 design year No Build and Build freeway operational results.

Arterial network operations analysis was conducted on 29 intersections within the study area as previous sections have presented. The proposed build alternatives have no change in operations at the surrounding interchanges and arterial corridors and therefore no improvements were deemed necessary on the surrounding arterial intersections.

Along Cliff Avenue, spot turn lane capacity and storage lane extensions were also found to be necessary. These improvements bring the ramp terminal intersections to a LOS C or better and all other intersections to a LOS D or better.

Two intersection control changes are necessary to improve both safety and operations:

- Cliff Avenue at 38th Street should be controlled by a traffic signal.
- Cliff Avenue at southern high school access should at a minimum be converted to a RI/RO access at the new 41st Street intersection created with Alternative 6.
  - The City of Sioux Falls is currently working with Lincoln High School on the potential to include an east leg into the school site as part of the alternative. The analysis showed the additional leg would operate acceptably until the 2050 design year, where the PM peak hour would begin to have some failing operations. As this intersection is not connected to the interstate system as part of this alternative, and does not make any changes within the interchange area, the decision to include the additional leg at the intersection is not required at this time.
    - It should be noted that converting the S Cliff Avenue southbound right turn lane at 41st Street to a shared through-right lane would provide acceptable operations in the 2050 design year with only a lane marking change and no reconstruction.

Figure 28 represents the preferred Alternative 6 interchange design, as well as the potential improvement to the 41st Street intersection to incorporate access into Lincoln High School as described above.

The predictive crash modeling showed the proposed build alternative would provide approximately a 15% reduction in predicted crashes between 2024 and 2050; this includes a reduction of up to 8% of crashes along the interstate and ramp connections. Based on estimated crash costs, this will provide a crash savings of approximately $16 million over the No Build.

A signing plan has been developed for the proposed interchange and interstate improvements which is provided in **Appendix M** and is represented in **Figure 29**.

Figure 26 – 2050 No Build Freeway Configuration and LOS

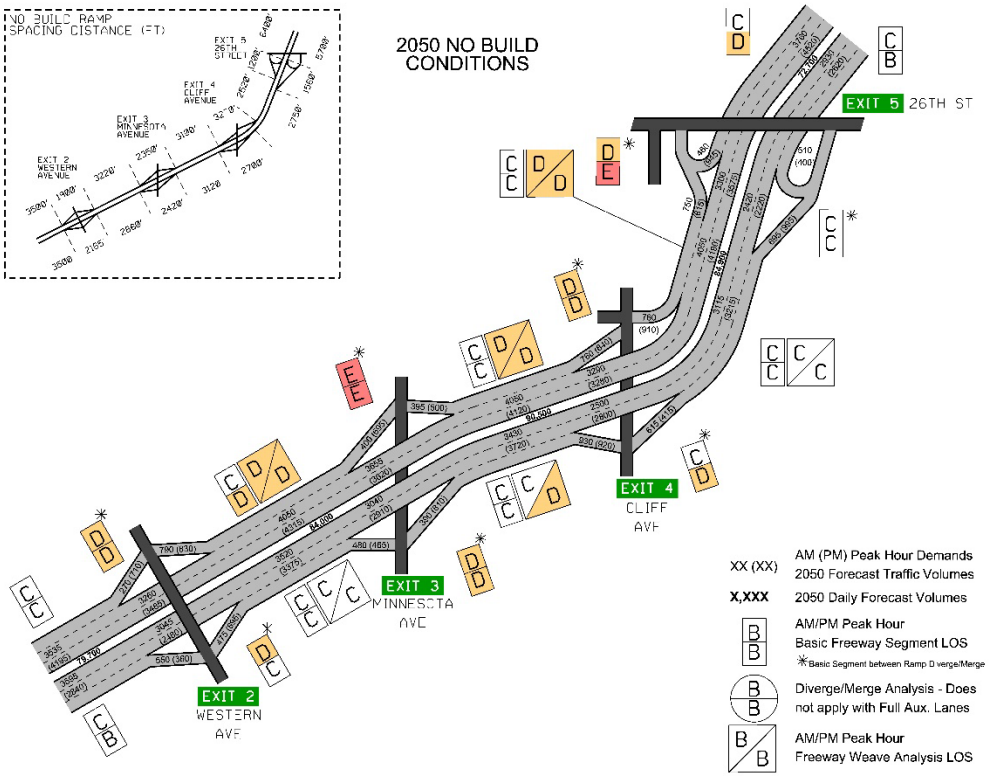


Figure 27 – 2050 Build Freeway Configuration and LOS

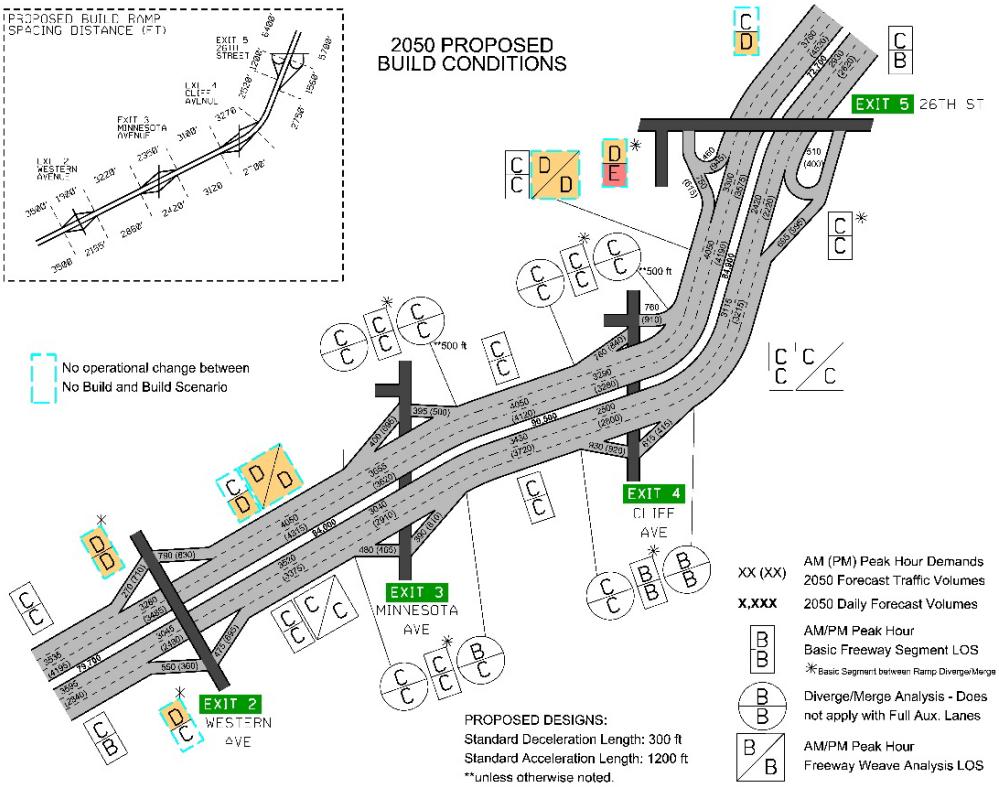


Figure 28 – Preferred Interchange Design – Alternative 6

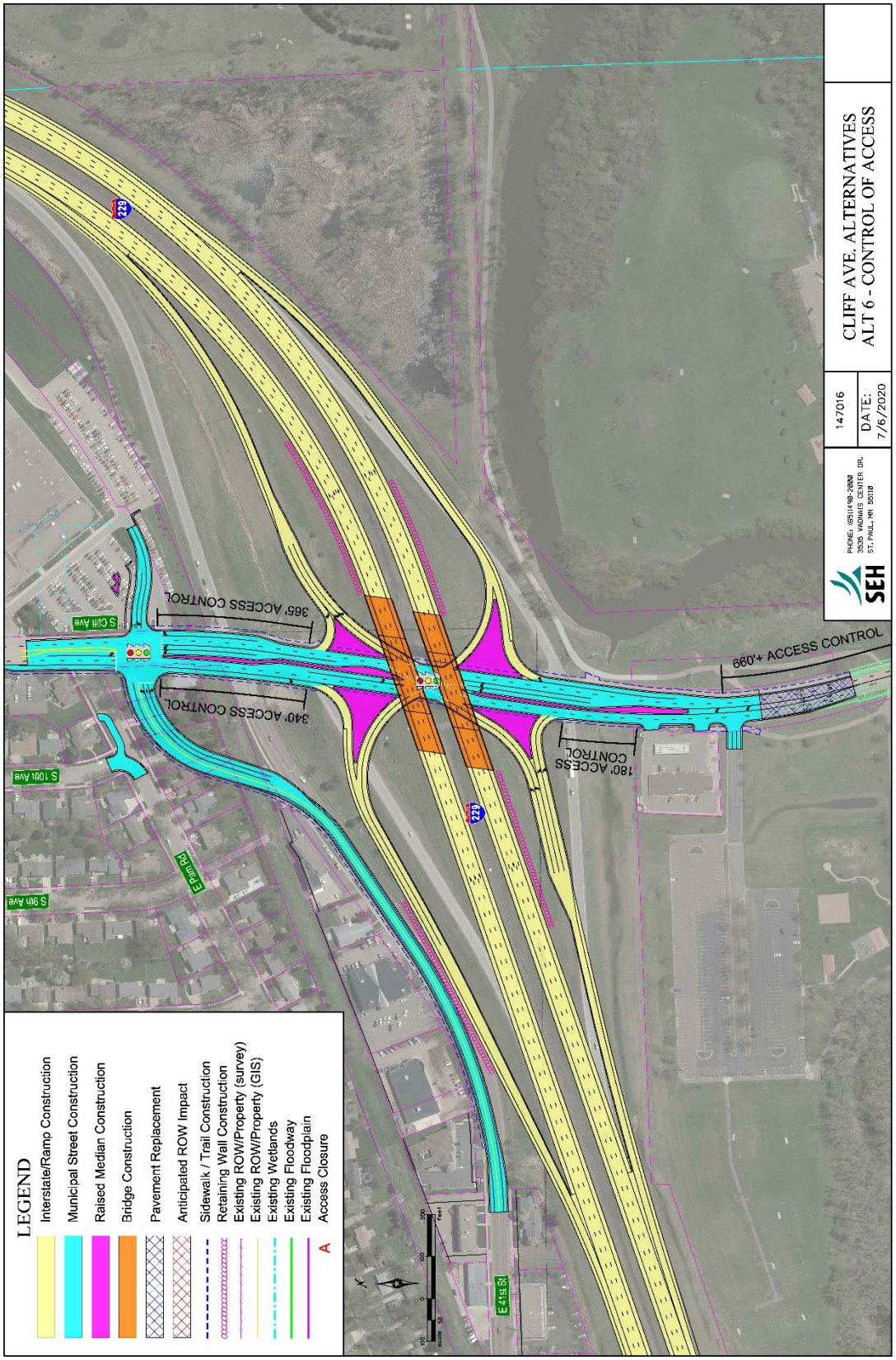
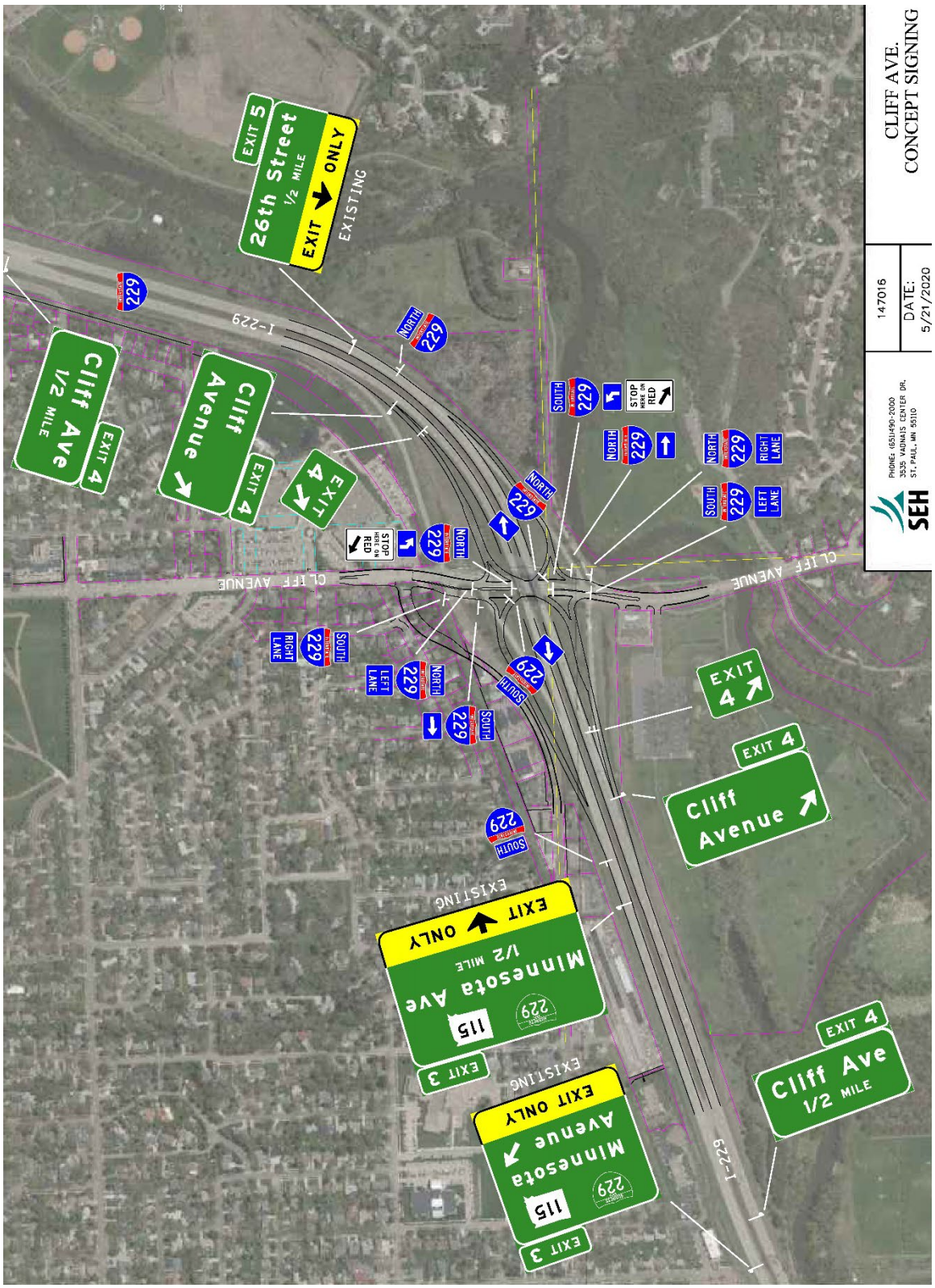


Figure 29 – Alternative 6 – Conceptual Signing Plan



9.2 Policy Number Two

The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit or high occupancy vehicle and high occupancy toll lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)). In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. The report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc. The report should describe whether future provision of a full interchange is precluded by the proposed design.

Upon completion, all connections associated with the project will connect to public roads, and will provide for all traffic movements. The design geometrics have been developed in accordance with SDDOT and FHWA design standards for interchanges.

Interstate Modification Justification Report – Appendix Materials

Contents Page:

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