

**INTERSTATE 90/INTERSTATE 229
INTERSTATE ACCESS MODIFICATION REQUEST**

SIOUX FALLS, SD

FINAL

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URS

Prepared for:

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1.1 STUDY BACKGROUND

1.1.1 I-90/I-229 Interchange Study

The South Dakota Department of Transportation (SDDOT) in cooperation with the City of Sioux Falls and the Sioux Falls Metropolitan Planning Organization (Sioux Falls MPO) have initiated the assessment of the infrastructure needs for the Interstate 90 (I-90)/Interstate 229 (I-229) Interchange. The study area is shown in Figure 1. The I-90/I-229 interchange is located at I-90 Exit 400, which is approximately one mile east of the I-90/Cliff Avenue interchange (Exit 399), approximately two miles west of the I-90/Timberline Road interchange (Exit 402) and approximately one and one-quarter miles north of the I-229/Benson Road (Exit 9) interchange. This study is also evaluating the level of access and mobility provided to residents and businesses within the study area. An Environmental Assessment (EA) is currently being conducted, analyzing the impacts/benefits of providing an upgraded interchange at the intersection of I-90 and I-229 in northeastern Sioux Falls, Minnehaha County, South Dakota.

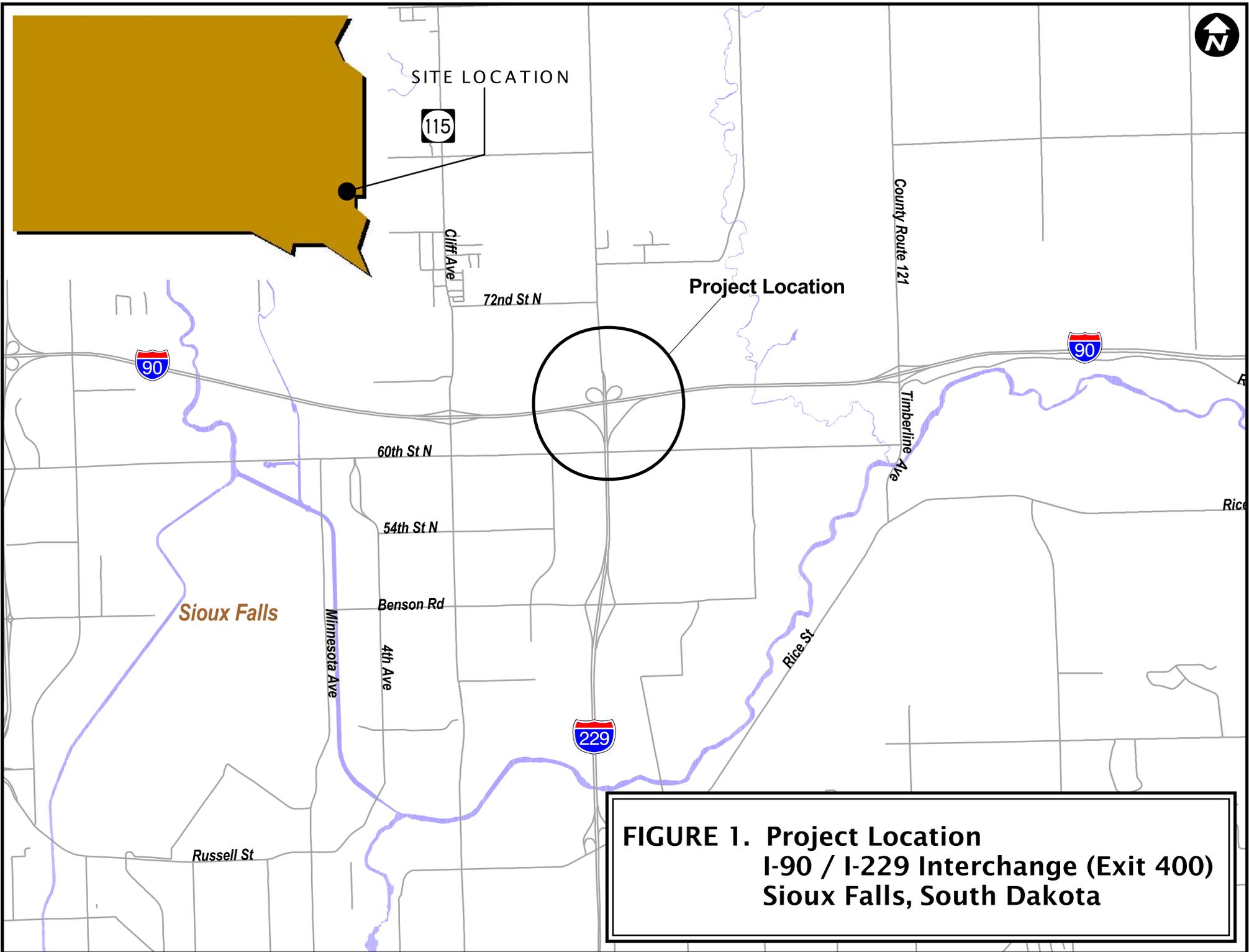
Existing Design

The existing I-90 / I-229 system interchange has three full access legs and one partial access leg. Characteristics for this interchange are provided below:

- Four lanes are provided on both I-90 and I-229 in the vicinity of this interchange.
- All system ramps for this interchange contain a single lane. All of these ramps connect directly to I-90 or I-229.
- Right-hand movements utilize direct ramps while left-hand movements use loop ramps. The loop ramps result in a weaving segment on I-90.
- Access to the north leg is only provided for I-229 and no access is provided for I-90.
- This system interchange is located approximately 1, 1.25, and 2 miles from the I-90/Cliff Avenue, I-229/Benson Road, and I-90/Timberline Avenue interchanges, respectively.

The I-90/Cliff Avenue, I-229/Benson Road, and I-90/Timberline Avenue interchanges all currently utilize a diamond type interchange design. A grade-separated overcrossing of I-229 is currently provided at 60th Street.

Industrial and business land uses are located in the southwest quadrant of the I-90/I-229 interchange. Other quadrants currently have scattered rural residences, but zoning includes numerous industrial/economic development parcels.



**FIGURE 1. Project Location
I-90 / I-229 Interchange (Exit 400)
Sioux Falls, South Dakota**

The following geometric design deficiencies were identified for this interchange as part of the *South Dakota Interstate Corridor Study: Phase I Report*.

- Inslope for mainline and ramp junction.
- Superelevation rate for ramp roadway.
- Minimum radius for ramp roadway (i.e., loop ramps).
- Lane width on ramp roadway(s).
- On-ramp taper for ramp junction.

Proposed Action

The proposed action is to construct an upgraded interchange at the junction of I-90 and I-229, which would provide access to/from I-90 and I-229, while maintaining the desired level of service (LOS) through the planning horizon. The proposed project would be located primarily within and along the existing right-of-way (ROW), with additional ROW required for new roadway alignments and for those alternatives that include new interchanges. The design and construction of the interchange would comply, to the extent practical, with SDDOT standards interstate and interchange facilities, as documented in the SDDOT Road Design Manual.

Project Planning

The immediate interchange analysis area is located in Growth Area Sanitary Sewer Basins 17 and 25. The 2015 Growth Management Plan (Sioux Falls Planning Department) identifies these basins as locations where development would potentially expand in the period from 2008 through the end of the 2015 horizon. In the 2025 Growth Area mapping, areas of the Sioux Falls metropolitan area adjacent to the I-90/I-229 system interchange are anticipated to be developed in the period from 2015 through 2025. Thus, consistency in development timing is provided between the various land use planning documents.

Through review of the current level of development in the area relative to the household and employment information contained in the regional travel model, the area north and south of I-90 between Cliff Avenue and Timberline Road is an area identified for extensive development through the 2025 horizon. Development in this area would contribute to sizeable increases in traffic between the developed area and the interstate system. The I-90 and I-229 corridors would be the primary access routes to/from area development. Therefore, Sioux Falls initiated a more detailed evaluation of an upgraded I-90/I-229 interchange through preliminary engineering and completion of an EA.

The purpose of this Interstate Access Modification Request is to complete a more detailed analysis of the interchange improvement concepts developed for the I-90/I-229 interchange to determine whether there are, from a traffic operations perspective, fatal flaws associated with any of the proposed concepts. Demonstrating that no fatal flaws exist does not endorse any specific action. The only conclusion that should be drawn is whether or not any of the concepts under consideration are flawed from a traffic operations and a safety perspective, as required by

the Federal Highway Administration (FHWA) prior to being included as an action alternative in the EA. Fatal flaws would include:

- Not providing a full access at the interchange.
- Creating a condition where mainline traffic operations are negatively impacted and the negative effects cannot be mitigated.
- Creating a condition where mainline/interchange safety is impaired and cannot be mitigated.
- The interchange concept/location is in conflict with or is inconsistent with local/regional plans.
- Modifying the interchange creates potential unmitigable environmental consequences.

The study area is located within the transportation planning area of the Sioux Falls MPO. Thus, part of the metropolitan area's ongoing long-range transportation planning process. The action evaluated for this Interstate Access Modification Request is consistent with the projected growth and development for the area. Based on the projected growth of Sioux Falls and the proposed projects described above, a need has been identified at the I-90/I-229 Interchange for design changes to maintain system continuity.

In addition to the proposed action, planning activities are ongoing or recently completed for other elements of the regional transportation system in Sioux Falls. These include the following improvement projects:

- I-90 and Cliff Avenue Interchange. The area surrounding the I-90/Cliff Avenue Interchange is rapidly developing. Access to the developed area would be enhanced with a proposed project intended to provide more efficient flow of traffic and access to the developing area. Presently, the SDDOT has preliminary plans to construct a single point interchange at I-90 and Cliff Avenue to replace the existing diamond interchange.
- I-90 and Timberline Road. The I-90/Timberline Road interchange is located two miles east of the I-90/I-229 interchange, northeast of Sioux Falls. Residential development in the area just north of I-90 is projected in the future, and this area would be accessed via Timberline Road. The I-90/Timberline Road interchange is also the northern terminus of the proposed Eastside Corridor. The capacity of the existing interchange would not be within the acceptable flow level for the projected development. The SDDOT has plans to upgrade this interchange to provide sufficient capacity for the projected development.
- East Side Corridor. Past Sioux Falls area comprehensive plans and studies have indicated a desire to construct a corridor outside the existing interstate system that would serve future growth of Sioux Falls. The 1995 Sioux Falls Regional Transportation Study recommended the development of a system of high-speed, limited access arterial roadways to serve the new development outside of the existing interstate corridors. This arterial corridor would provide a bypass between I-90 east of Sioux Falls and I-29 south of the City. The northern terminus of this corridor is the I-90/Timberline Avenue interchange. Additional information on this corridor can be found in the Sioux Falls East Side Corridor Final Environmental Assessment (City of Sioux Falls 2003).

1.2 STUDY APPROACH

This Interstate Access Modification Request was developed through the following steps:

- Establish an appropriate study area. As documented in Figure 2, the study area extended from west of the I-90/Cliff Avenue Interchange to east of the I-90/Timberline Avenue Interchange. The study area also extended south of the I-229/Benson Road Interchange.
- Collect current traffic volume data, crash data and existing and future land use information for the study area.
- Identify and address the FHWA requirements for Interstate access modifications. This step includes completion of the necessary analyses and evaluations that document the benefits/impacts of the access modification as it relates to the FHWA requirements. These analyses include:
 - Development of horizon year traffic forecasts. Daily and peak hour traffic forecasts for 2025 were prepared for I-90 and I-229 adjacent to the existing interchange based on the Sioux Falls MPO travel demand (TP+) model. As a basis for much of the analysis completed to address the FHWA requirements, the traffic forecasts were developed to reflect projected future Build and No-Build Scenarios traffic demands.
 - Analysis of the current and future traffic operations along study area roadway links. The traffic analyses were completed using the procedures and methodologies found in the 2000 Highway Capacity Manual. In addressing the FHWA requirements, this report includes documentation of predicted traffic operations with and without the interchange concept.
 - Evaluation of the access impacts to adjacent development associated with the access modification. The FHWA requirements include documentation of the relative quality of access offered by the interchange concept.
 - Evaluation of the current and future safety along I-90 and I-229 within the study area. The FHWA requirements include provisions that the interchange does not have a negative impact on Interstate facility safety.

1.3 FHWA REQUIREMENTS

FHWA has developed a series of requirements that need to be addressed when evaluating changes to access points on Interstate facilities (Federal Register, Volume 63, Number 28, February 11, 1998). The requirements are part of a policy that was put in place to maintain high levels of safety and mobility on the Interstate System. The policy is constructed of eight requirements that new access locations should meet. These eight requirements are:

1. The existing interchanges / local roads and streets in the corridor can neither provide the necessary access nor be improved to satisfactorily accommodate the design-year traffic demands while at the same time providing the access intended by the proposal.
2. All reasonable alternatives for design options, location and transportation system management type improvements (such as ramp metering, mass transit and High Occupancy

Vehicle [HOV] facilities have been assessed and provided for if currently justified, or provisions are included for accommodating such facilities if a future need is identified.

3. The proposed access point does not have a significant adverse impact on the safety and operation of the Interstate facility based on an analysis of current and future traffic. The operational analysis for existing conditions shall, particularly in urbanized areas, include an analysis of sections of Interstate to and including at least the first adjacent existing or proposed interchange on either side. Crossroads and other roads and streets shall be included in the analysis to the extent necessary to assure their ability to collect and distribute traffic to and from the interchange with new or revised access points.
4. The proposed access connects to a public road only and would provide for all traffic movements. Less than "full interchanges" for special purpose access for transit vehicles, for HOVs, or into park and ride lots may be considered on a case-by-case basis. The proposed access will be designed to meet or exceed current standards for Federal-aid projects on the Interstate System.
5. The proposal considers and is consistent with local and regional land use and transportation plans. Prior to final approval, all requests for new or revised access must be consistent with the metropolitan and/or statewide transportation plan, as appropriate, the applicable provisions of 23 Code of Federal Regulations (CFR) part 450 and the transportation conformity requirements of 40 CFR parts 51 and 93.
6. In areas where the potential exists for future multiple interchange additions, all requests for new or revised access are supported by a comprehensive Interstate network study with recommendations that address all proposed and desired access within the context of a long-term plan.
7. The request for a new or revised access generated by new or expanded development demonstrates appropriate coordination between the development and related or otherwise required transportation system improvements.
8. The request for new or revised access contains information relative to the planning requirements and the status of the environmental processing of the proposal.

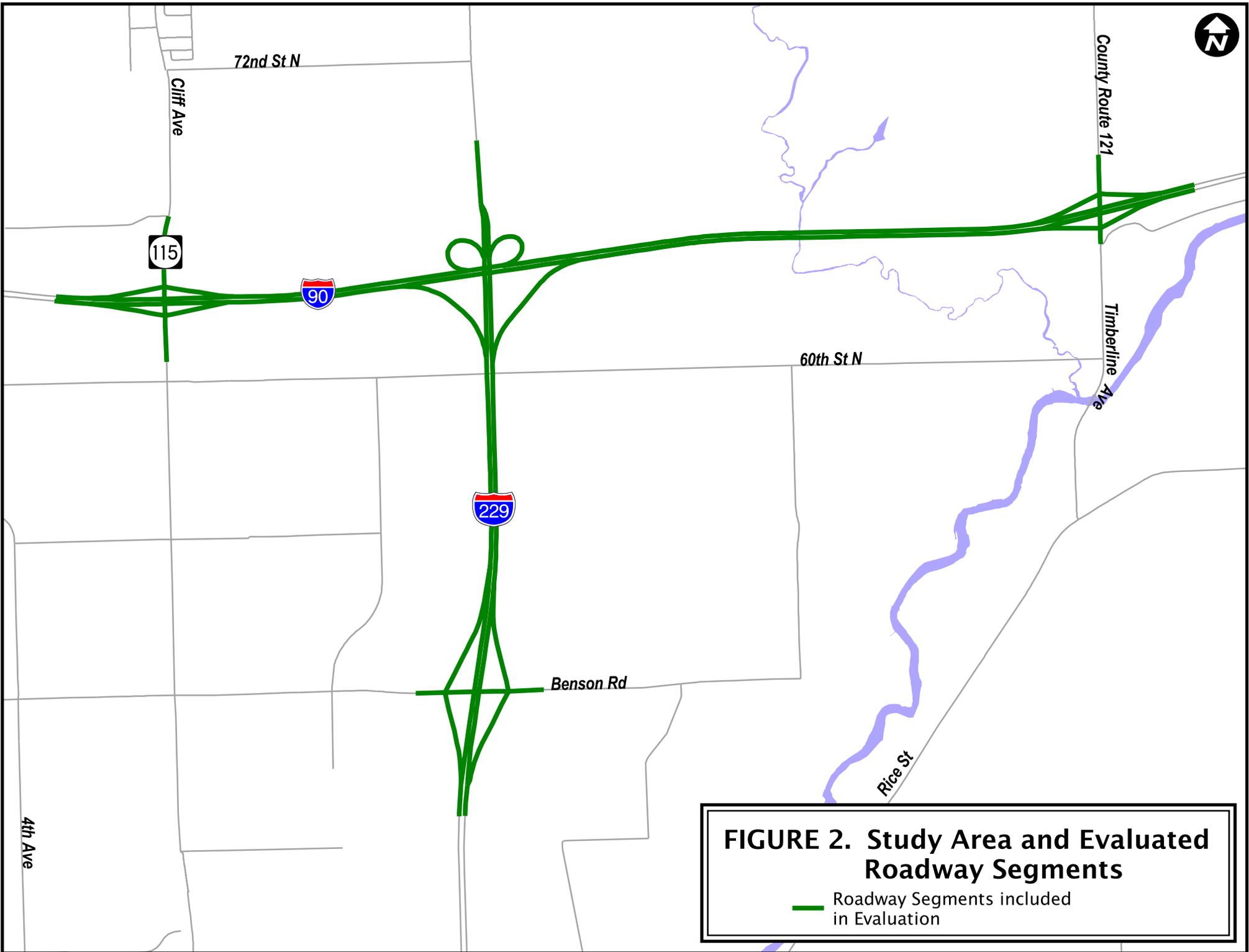


FIGURE 2. Study Area and Evaluated Roadway Segments
— Roadway Segments included in Evaluation

Key inputs used to address the requirements of the Interstate Access Modification Request were existing and future traffic volumes and the products of the traffic analyses associated with the alternate condition volumes. As the basis for evaluating the relative need for and the impacts associated with an upgraded I-90 interchange at I-229, a quantitative evaluation of existing and future traffic levels and operations was conducted. The traffic forecasts and traffic operations associated with existing, No-Build 2025 and Build 2025 Scenarios are documented in this section.

2.1 EXISTING AND FUTURE TRAFFIC DEMANDS

Traffic levels were evaluated for both existing and future (2025) conditions. Existing traffic volumes in the study area were collected from existing SDDOT data sources and by URS staff as part of the Sioux Falls Interstate Access Alternatives Analysis – Traffic Analysis Report. The evaluation of existing and future traffic conditions for the I-90/I-229 interchange consisted of traffic operations analyses for the freeway system and the arterial street system.

Development of peak hour freeway volumes required a conversion from daily traffic volumes. For this study the only peak hour traffic volume data available for the mainline freeway came from the ramp counts the SDDOT conducted at the I-29/I-229 and I-90/I-229 interchanges. These counts along with the service interchange ramp counts developed from intersection turn movement counts served as the starting point for developing peak hour freeway volumes. Typical peak hour percentages and directional distribution of traffic were evaluated when developing these peak hour volumes.

Freeway ramp counts that included hourly and daily volumes were conducted by the SDDOT. Average daily traffic (ADT) was obtained from the following sources:

- Traffic Volumes Counts for the City of Sioux Falls, 1999-2003
- 2003 South Dakota Traffic Flow Map produced by the SDDOT
- A spreadsheet of link volumes provided by the SDDOT

Existing daily and peak hour traffic volumes on the studied links are documented in Figures 3 and 4.

In the I-90/I-229 Access Modification Request analysis, the traffic forecasts were based on application of the Sioux Falls MPO Regional Travel Model. Forecasts of daily traffic volumes were developed by evaluating the growth in daily traffic volumes projected by application of the travel model between 2000 and 2025. After discussions with SDDOT and Sioux Falls MPO staff, it was decided that the level of model detail adjacent to the I-90/I-229 interchange should be improved.

Based on these discussions, Sioux Falls MPO staff adjusted the travel model by subdividing an existing traffic analysis zone (TAZ) into three TAZs. The subdivided TAZ was located west of Timberline and north of I-90. This additional level of detail allowed the travel model to more precisely reflect how traffic would access development in the relatively large area adjacent to I-90 and located between the I-90/I-229 interchange and the I-90/Timberline Avenue interchange.

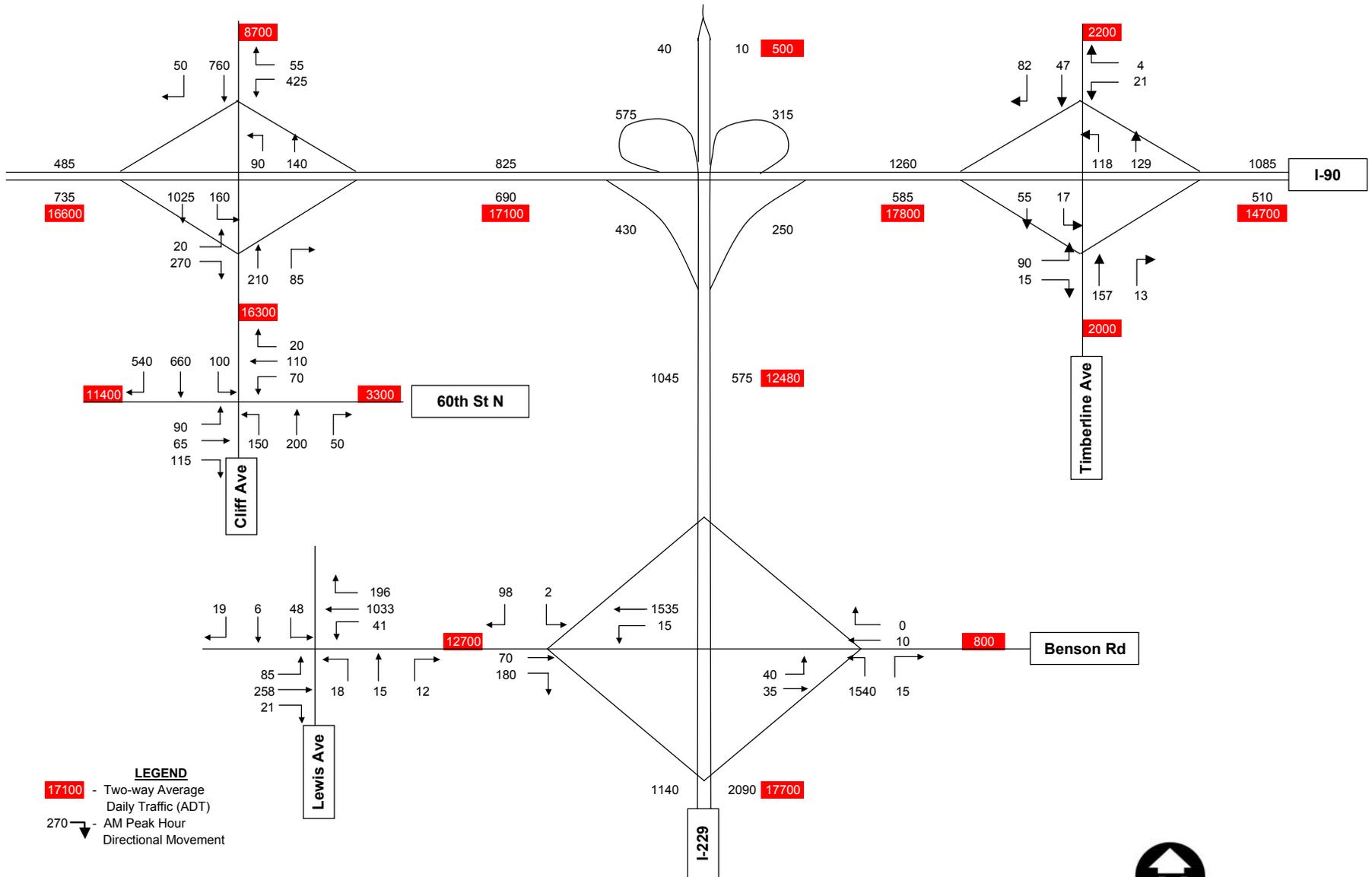


Figure 3. Existing AM Peak Hour Traffic Volumes Interstate 90/Interstate 229 Interchange Area

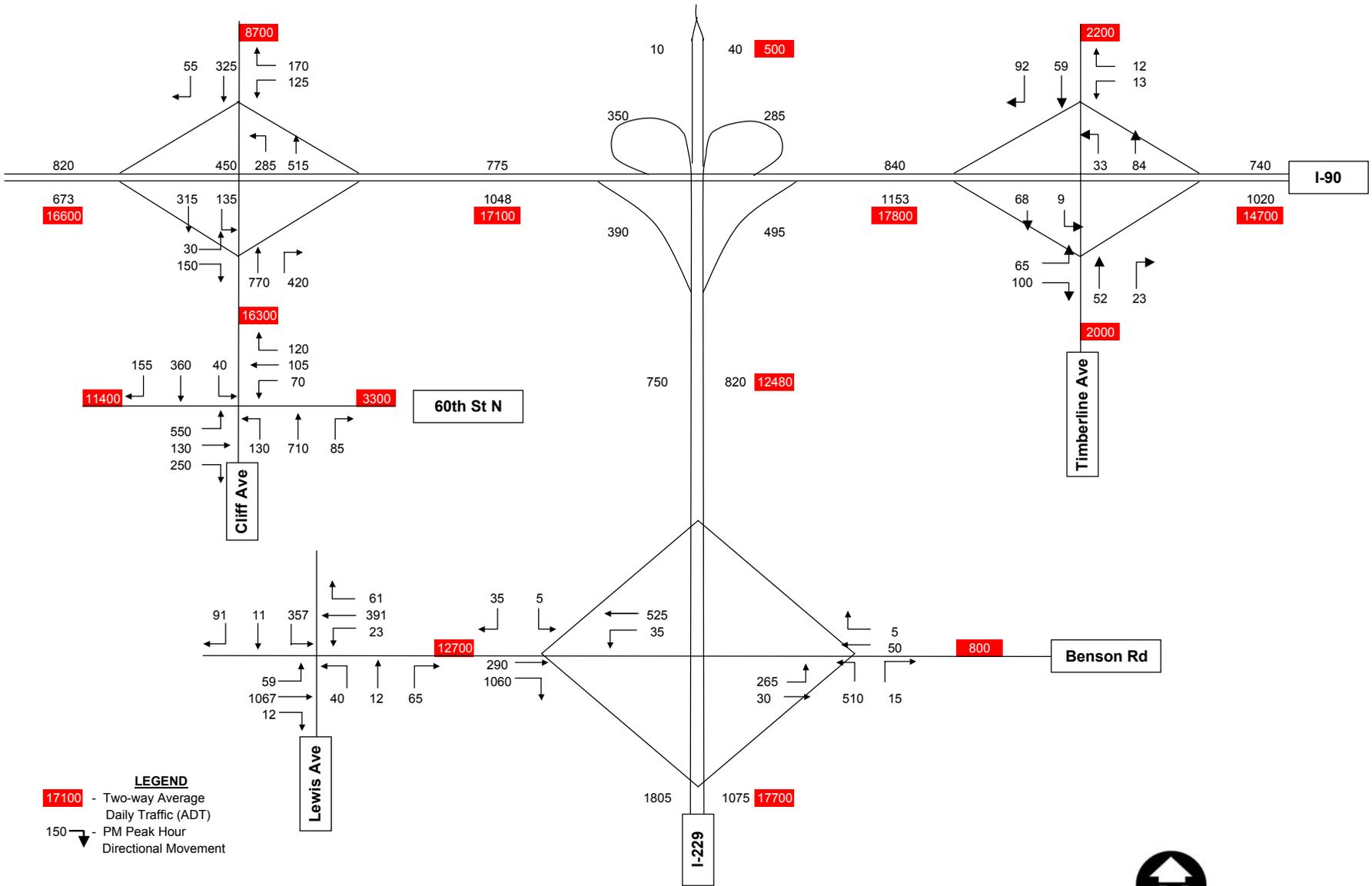


Figure 4. Existing PM Peak Hour Traffic Volumes Interstate 90/Interstate 229 Interchange Area

The peak hour traffic forecasts were developed by reviewing:

- *Current peak hour traffic characteristics:* The existing peak hour percentages of daily traffic and turning movement proportions were used as a starting point for developing 2025 peak hour turning movement forecasts. Several of the interstate segments currently experience peak hour volumes that are in the range of 12 to 13 percent of daily traffic. It was assumed that as traffic volumes increase through the planning horizon, the percentage of daily traffic occurring during the peak hours would somewhat decline.
- *Model Projected Travel Patterns:* The Timberline Avenue interchange is projected to experience substantial traffic growth through the planning horizon (2025), such that current travel patterns through the corridor are likely not representative of the future condition. Model output was reviewed to determine the projected orientation of travel through the interchange.
- *MPO-Projected Socio-Economic Patterns:* The 2025 socioeconomic/land use scenario was reviewed to evaluate how peak hour travel would likely change from existing patterns. Adjustments were made to peak hour percentages of daily traffic and peak hour directional split based on identified locations of new employment and housing.

The products of the forecasting task were No-Build and Build Scenario 2025 peak hour (both AM and PM) turning movements and link traffic volumes for the key routes in the study area. The No-Build Scenario 2025 peak hour turning movement and link volumes are documented in Figures 5 and 6. A total of five Build Scenario alternatives were considered and traffic forecasts were developed for each alternative, documented in Figures 7 through 14. The full directional and partial cloverleaf with flyover alternatives are very similar and only one forecast is provided for both alternatives.

2.2 EXISTING AND FUTURE TRAFFIC OPERATIONS

In support of this Interstate Access Modification Request, a traffic operations analysis of ramp terminal intersections and freeway facilities was conducted. The evaluation of freeway operations was conducted using the Highway Capacity Software (HCS), which utilizes the procedures and methodologies documented in the *2000 Highway Capacity Manual* (HCM). The type of freeway facilities analyzed included basic freeway segments, ramp junctions, and weaving segments. The intersection analyses were conducted using the Synchro software program that also utilizes the methodologies found in the 2000 HCM.

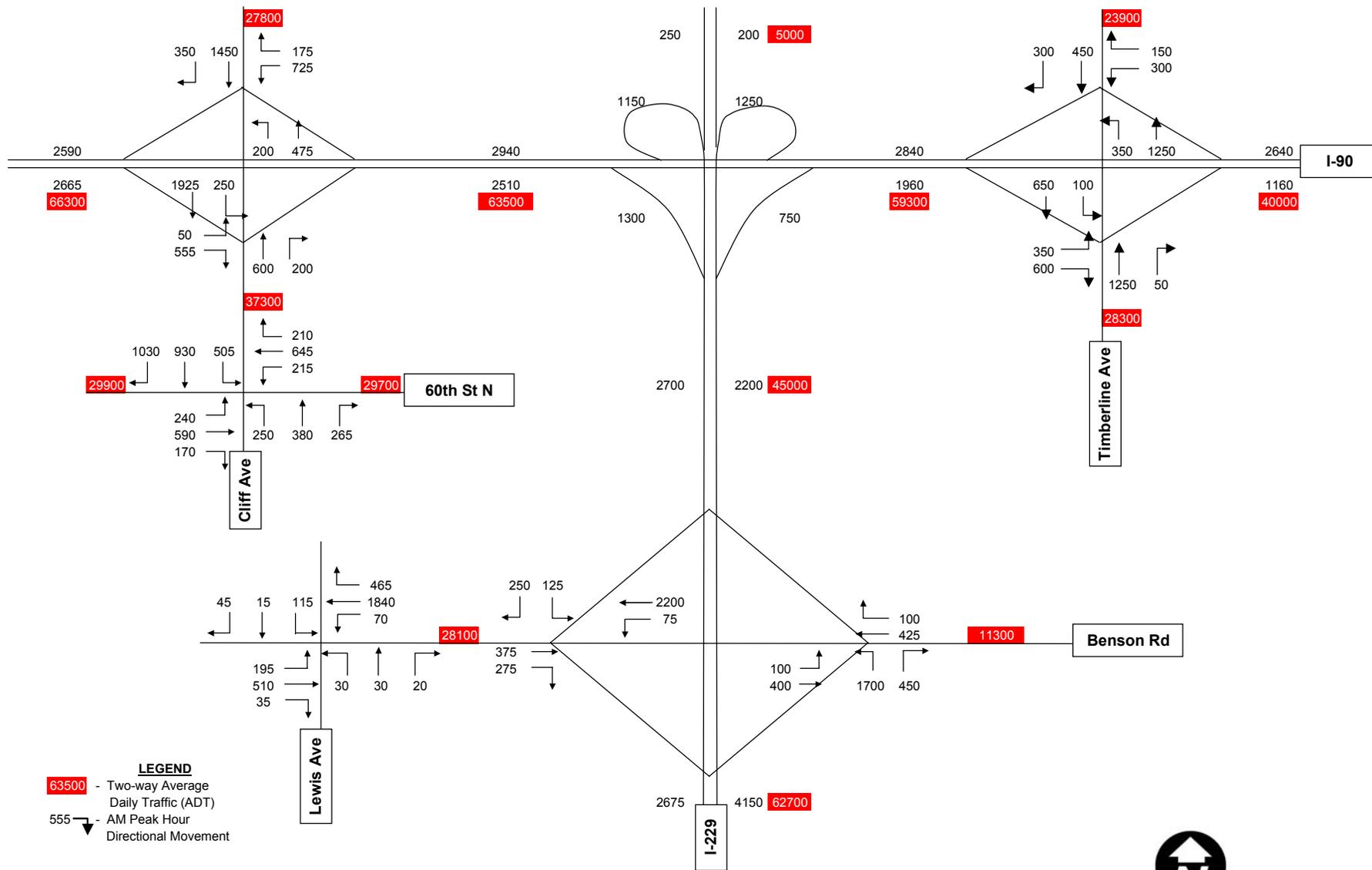
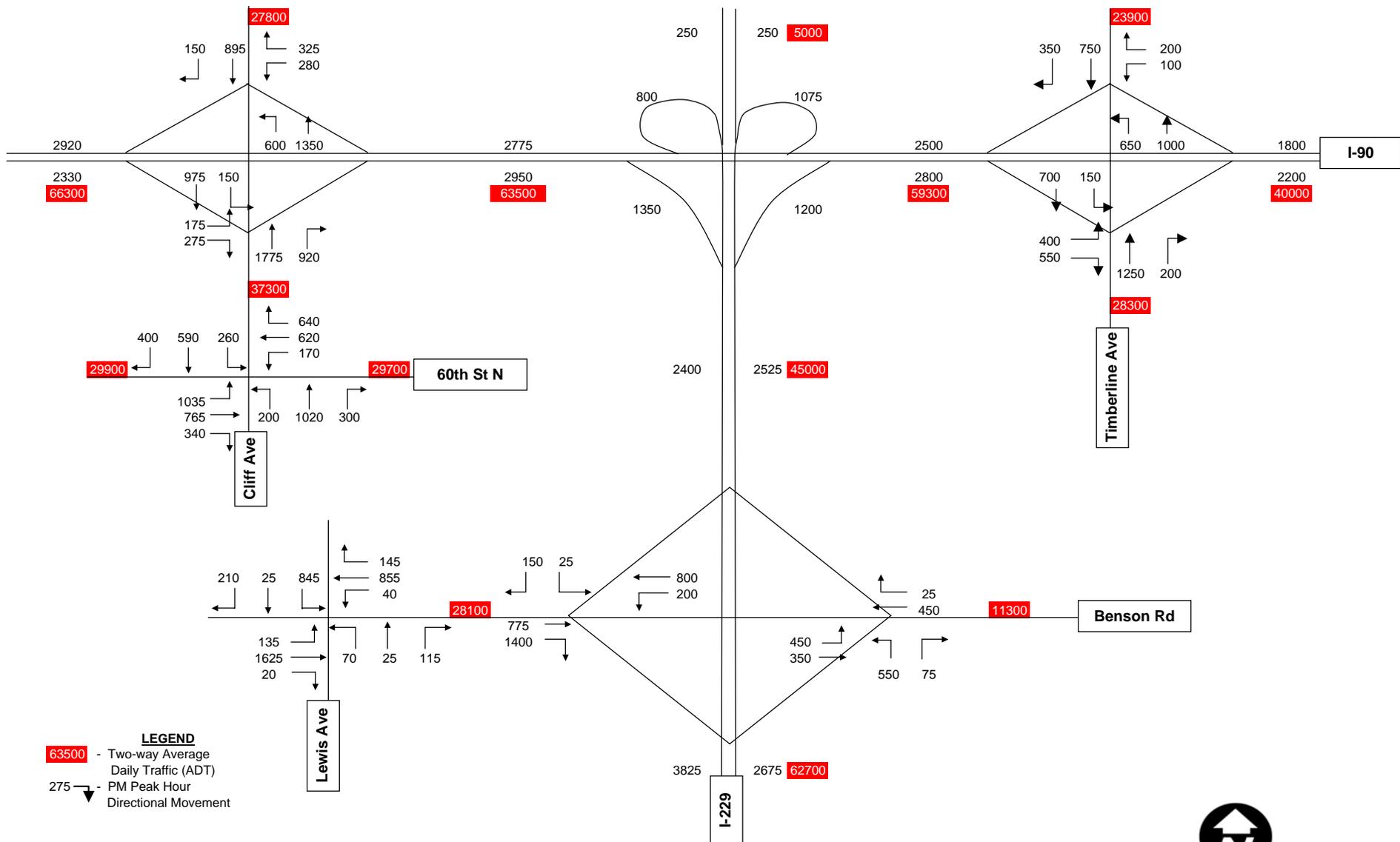
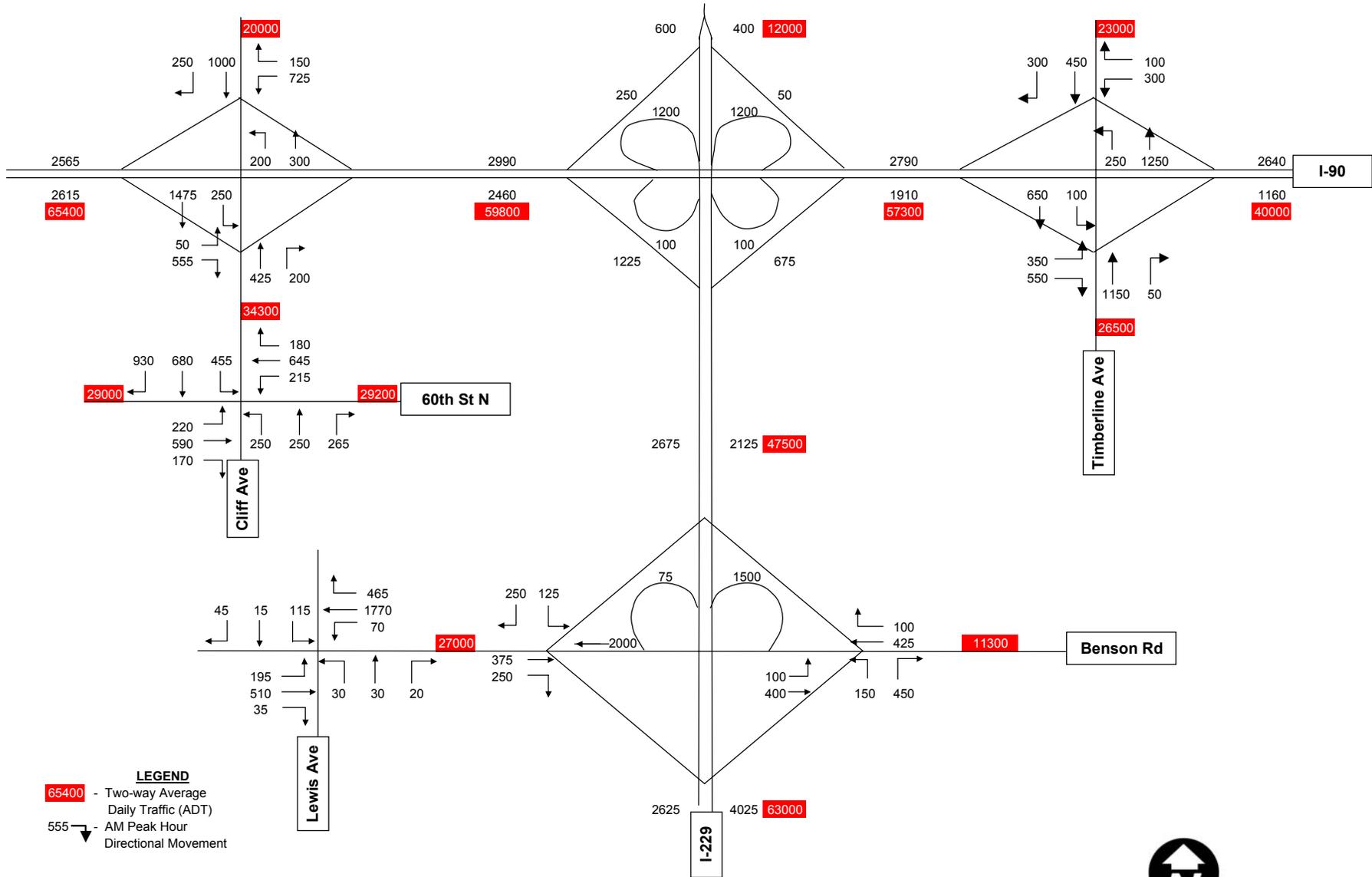


Figure 5. 2025 AM Peak Hour Traffic Forecasts
Interstate 90/Interstate 229 Interchange Area

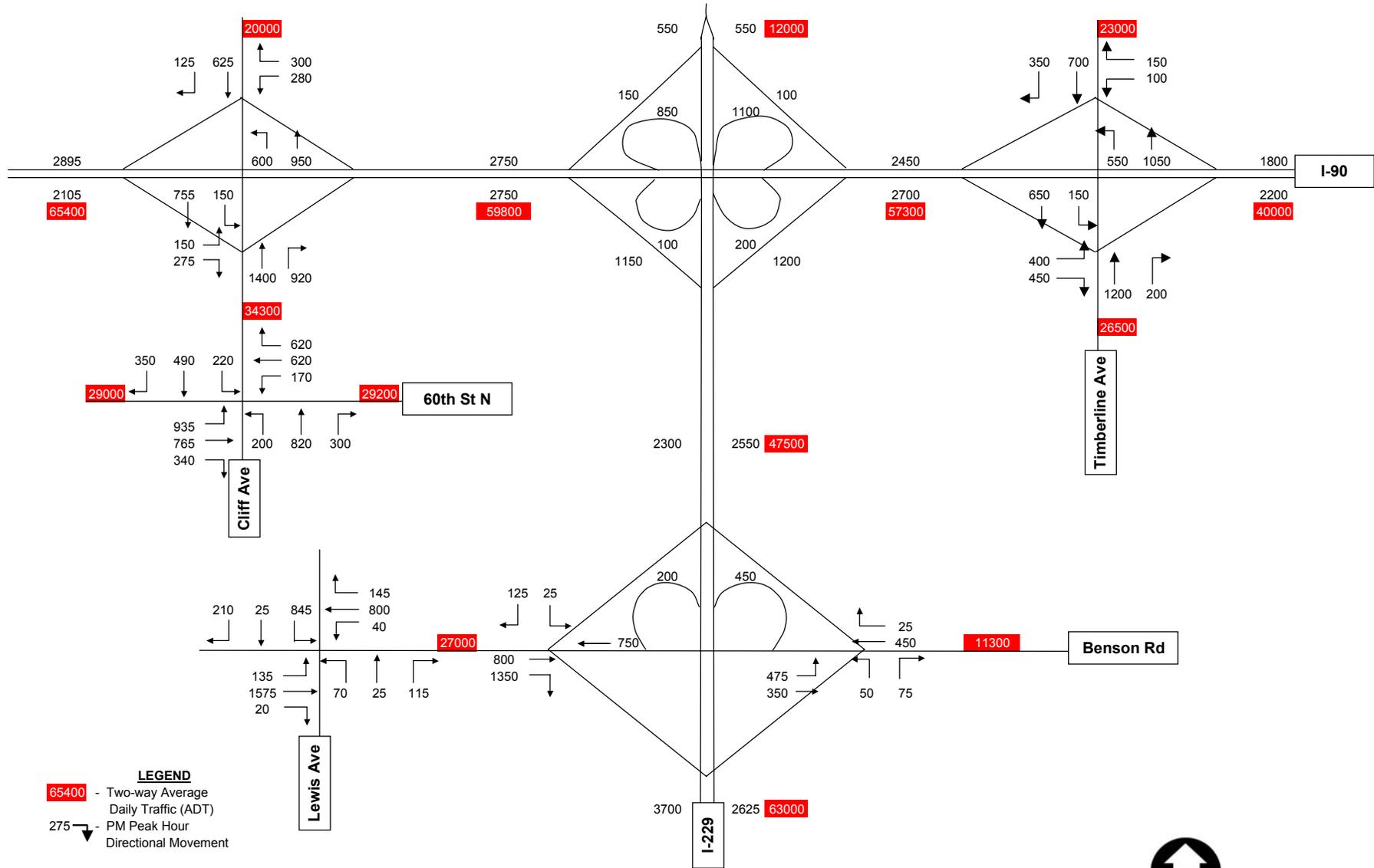


**Figure 6. 2025 PM Peak Hour Traffic Forecasts
Interstate 90/Interstate 229 Interchange Area**

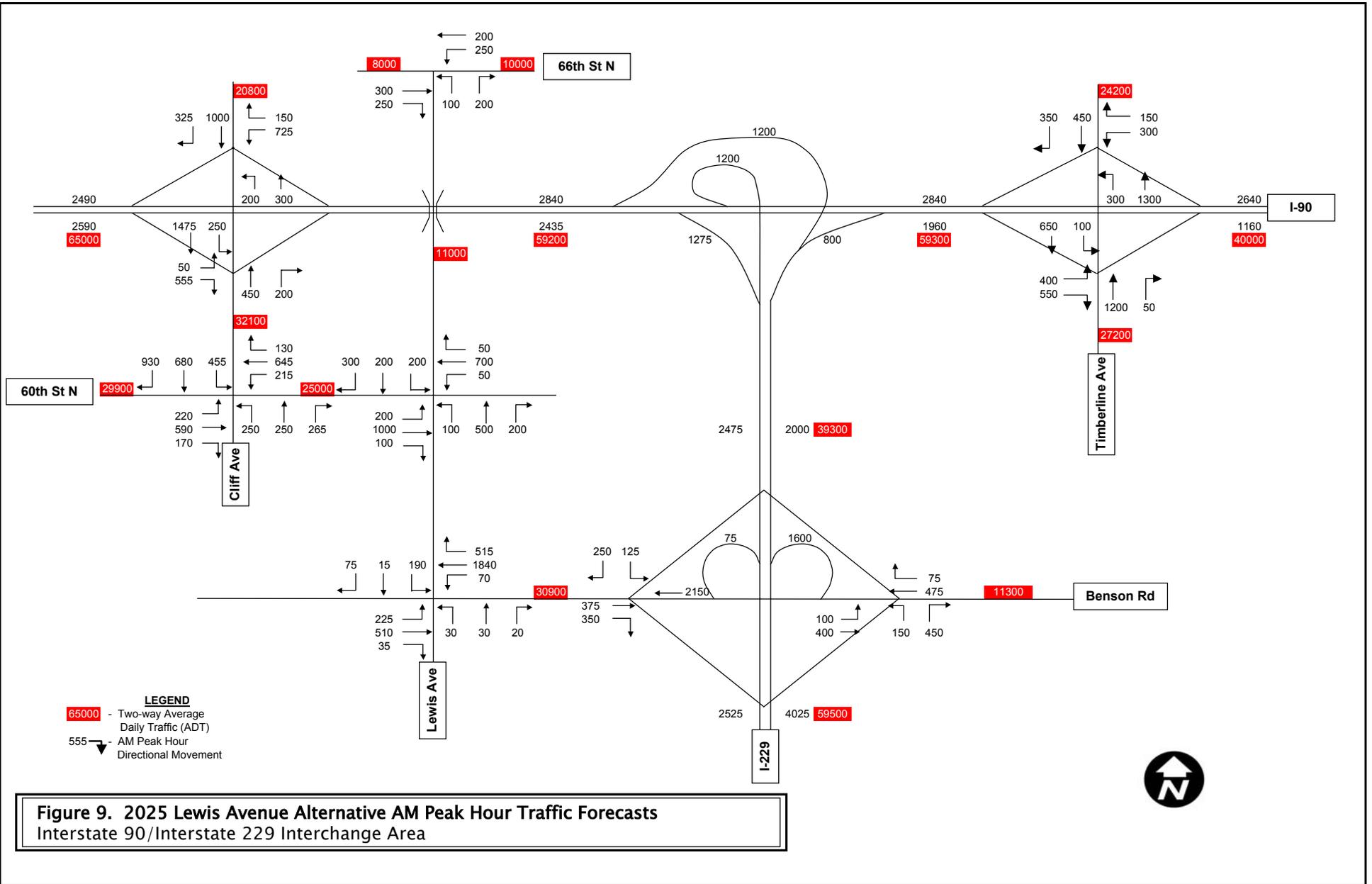


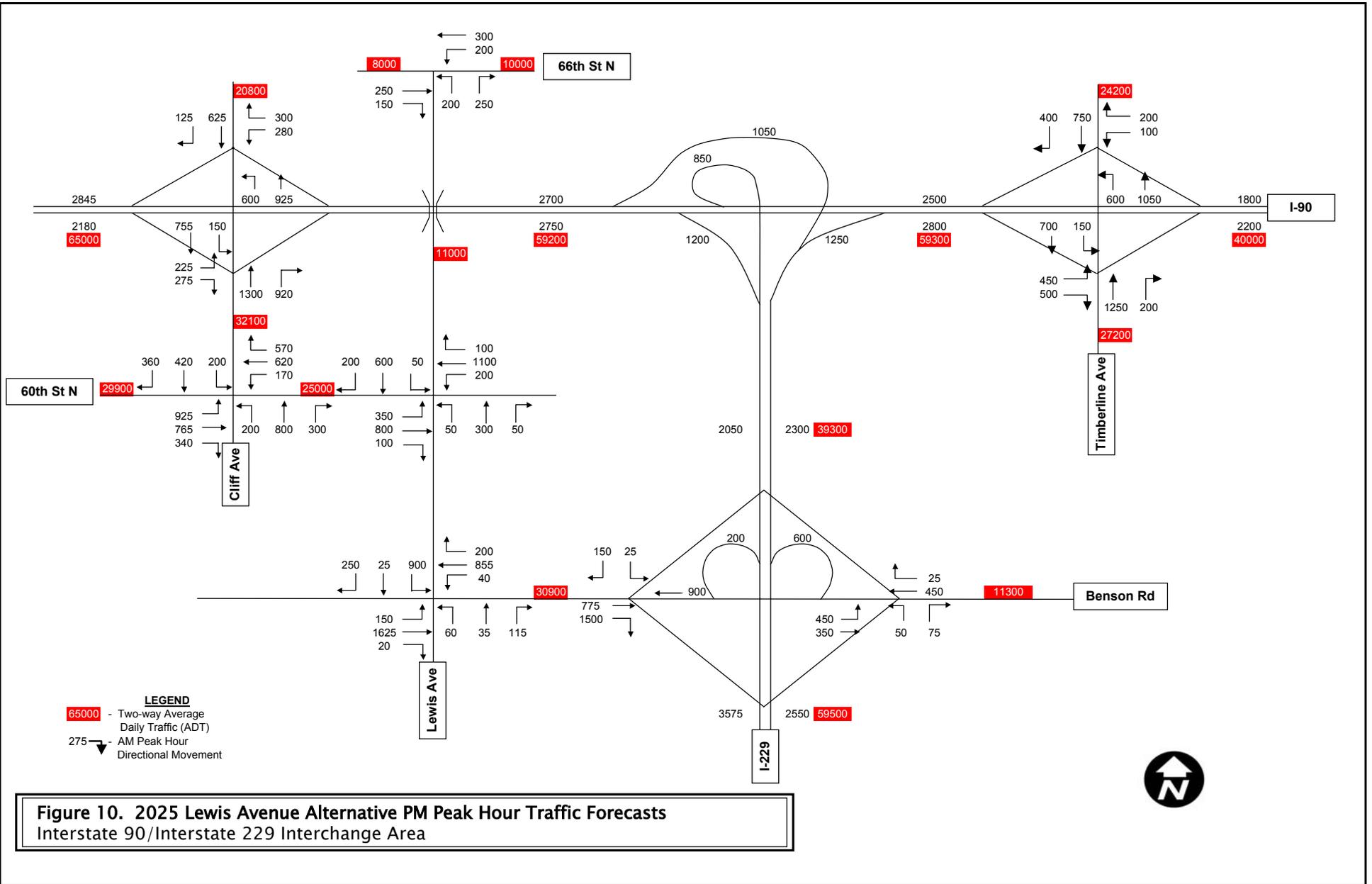


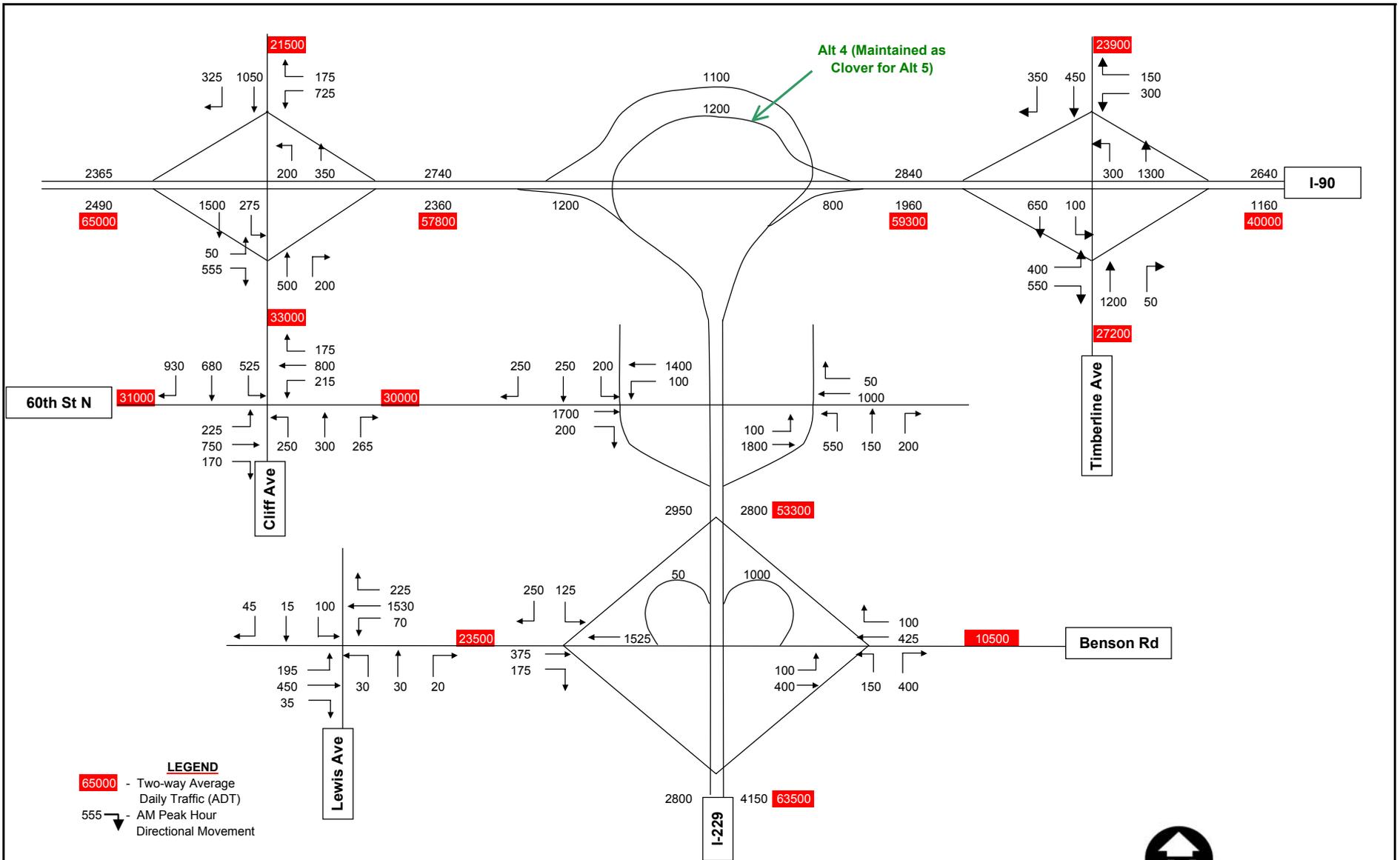
**Figure 7. 2025 Cloverleaf Alternative AM Peak Hour Traffic Forecasts
Interstate 90/Interstate 229 Interchange Area**



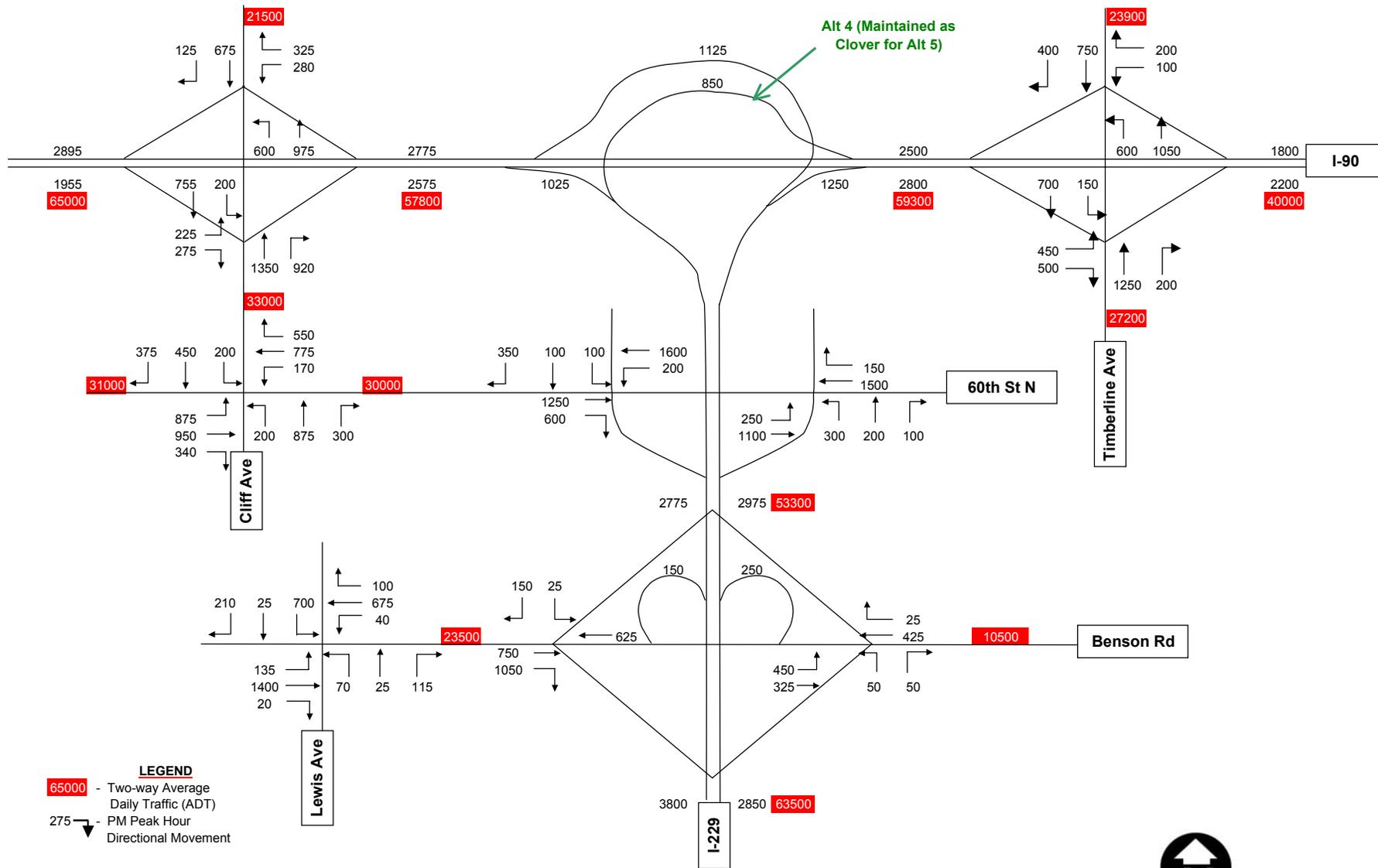
**Figure 8. 2025 Cloverleaf Alternative PM Peak Hour Traffic Forecasts
Interstate 90/Interstate 229 Interchange Area**







**Figure 11. 2025 Full Directional/Partial Cloverleaf with Fly-Over Alternatives
 AM Peak Hour Traffic Forecasts
 Interstate 90/Interstate 229 Interchange Area**



**Figure 12. 2025 Full Directional/Partial Cloverleaf with Fly-Over Alternatives
PM Peak Hour Traffic Forecasts
Interstate 90/Interstate 229 Interchange Area**

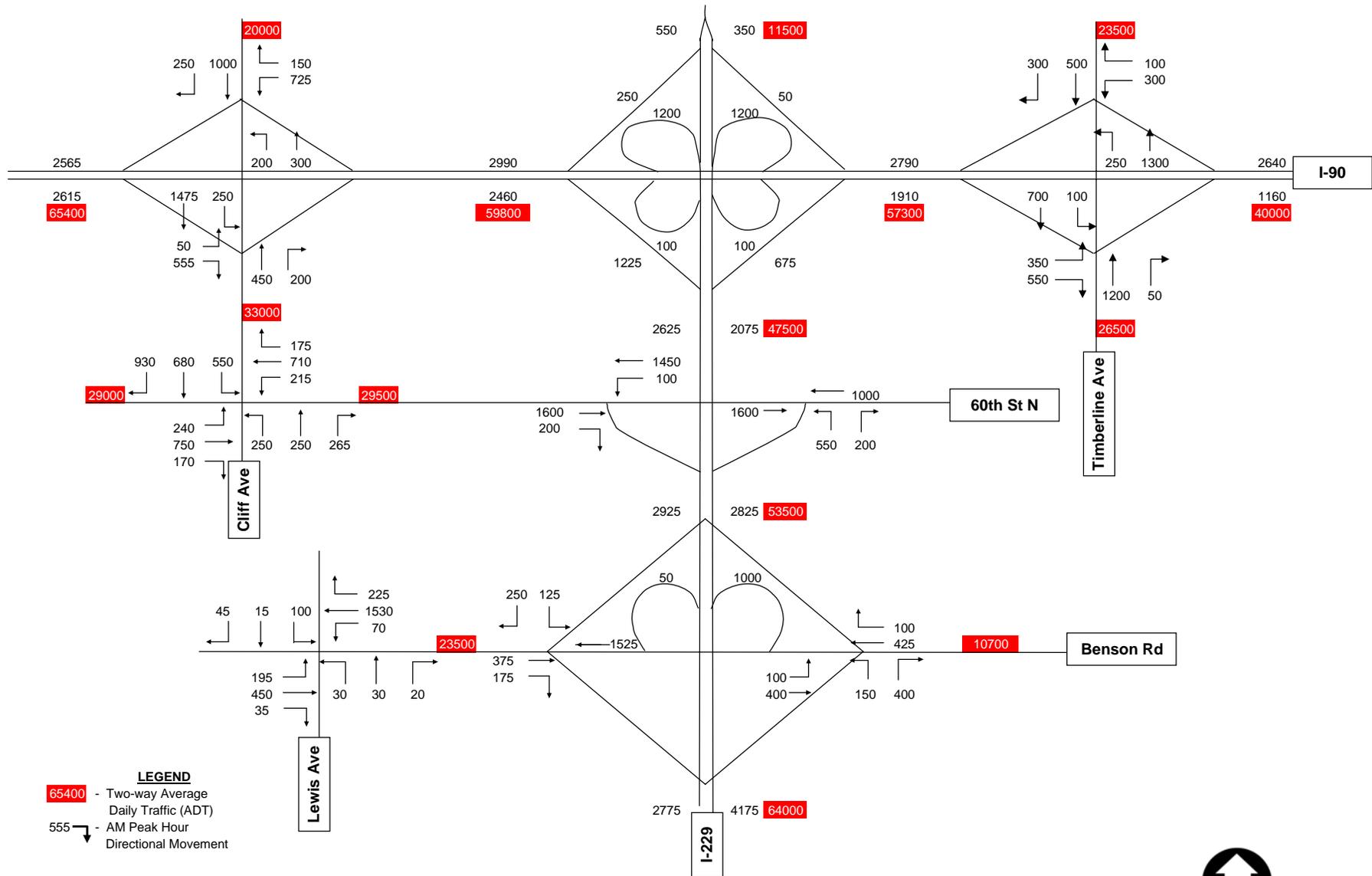


Figure 13. 2025 Cloverleaf with 60th St Half Diamond Alternative AM Peak Hour Traffic Forecasts Interstate 90/Interstate 229 Interchange Area

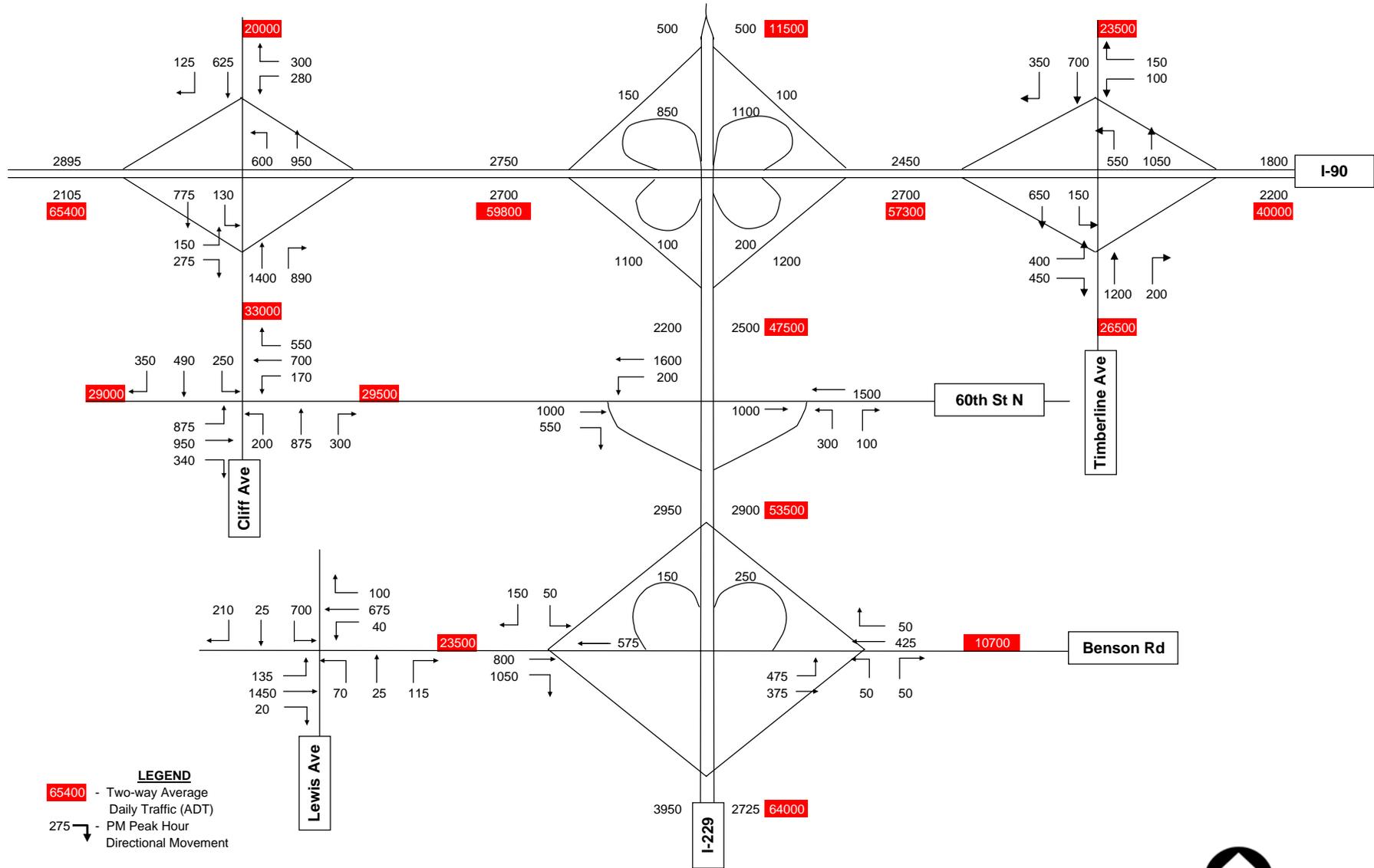


Figure 14. 2025 Cloverleaf with 60th St Half Diamond Alternative PM Peak Hour Traffic Forecasts Interstate 90/Interstate 229 Interchange Area



Observations of traffic volumes provide an understanding of the general nature of traffic, but are insufficient to indicate either the ability of the street network to carry additional traffic or the quality of service provided by the street system. For this reason, the concept of level of service (LOS) has been developed to correlate numerical traffic volume data to subjective descriptions of traffic performance at intersections, along freeway segments, and at ramp junctions. Level of service is a term used to qualitatively describe roadway and intersection traffic operations. LOS categories range from A (best) to F (worst) as shown in Tables 1 through 4.

The measures of effectiveness for basic freeway segments and ramp junctions are discussed below:

- *Intersections* – At signalized intersections, level of service is based on the weighted average of all approach delays. For unsignalized intersections, the LOS is based on the worst condition minor street movement delay (usually the left turn movements on the cross street). Table 1 provides the LOS criteria for signalized and unsignalized intersections.
- *Basic Freeway Segments* – The LOS of a basic freeway segment is defined by the density of traffic flow in passenger cars per mile per lane (pc/mile/lane). Density is a measure of the quality of the speed of flow, the ability to maneuver, and the proximity to other vehicles on the freeway (described in Table 2).
- *Ramp Junctions* – The LOS of a ramp junction is also defined by the density of traffic flow in passenger cars per mile per lane (pc/mile/lane) within the influence (merge or diverge) area of the ramp junction (described in Table 3).
- *Weaving Segments* – The level of service for a weaving segment is also defined by the density of traffic flow in passenger cars per mile per lane (pc/mile/lane) within the weaving segment. Table 4 provides the LOS criteria for weaving segments.

For the purposes of this project, a deficiency is defined as level of service D (LOS D) or worse.

TABLE 1: LEVEL OF SERVICE DESCRIPTIONS FOR INTERSECTIONS

Level of Service	Delay per Vehicle (Seconds)		Description
	Signalized	Unsignalized	
A	≤10	≤10	Free flow, minimal delays
B	>10 and ≤20	>10 and ≤15	Stable flow, occasional delays
C	>20 and ≤35	>15 and ≤25	Stable flow, periodic delays
D	>35 and ≤55	>25 and ≤35	Restricted flow, regular delays
E	>55 and ≤80	>35 and ≤50	Maximum capacity, extended delays
F	>80	>50	Forced flow, excessive delays

Source: 2000 Highway Capacity Manual, Transportation Research Board
 Signalized LOS Criteria taken from Exhibit 16-2; Unsignalized LOS Criteria taken from Exhibit 17-2

TABLE 2: LEVEL OF SERVICE DESCRIPTIONS FOR BASIC FREEWAY SEGMENTS

Level of Service	Performance Measures		Description
	Maximum Density (pc/mile/lane) ¹	Minimum Speed (mph)	
A	≤11	65	Free flow, minimal delays
B	>11 and ≤18	65	Stable flow, occasional delays
C	>18 and ≤26	64.6	Stable flow, periodic delays
D	>26 and ≤35	59.7	Restricted flow, regular delays
E	>35 and ≤45	52.2	Maximum capacity, extended delays
F	>45	---	Forced flow, excessive delays

Note: 1: pc/mi/ln = passenger cars/mile/lane

Source: 2000 Highway Capacity Manual, Transportation Research Board
 Maximum density and minimum speed criteria taken from Exhibit 23-2
 Minimum speed criteria based on a free-flow speed of 65 mph

TABLE 3. LEVEL OF SERVICE CRITERIA FOR RAMP JUNCTIONS

Level of Service	Density (pc/mile/lane)
A	≤ 10.0
B	> 10.0 – 20.0
C	> 20.0 – 28.0
D	> 28.0 – 35.0
E	> 35.0
F	Demand exceeds Capacity

Note: Density is the primary determinant of LOS for ramp junctions. Other factors (e.g., maximum volumes for merge/diverge area) can result in lower LOS.

Source: 2000 Highway Capacity Manual, Exhibit 25-7.

TABLE 4. LEVEL OF SERVICE CRITERIA FOR WEAVING SEGMENTS

Level of Service	Density (pc/mile/lane)
A	≤ 10.0
B	> 10.0 – 20.0
C	> 20.0 – 28.0
D	> 28.0 – 35.0
E	> 35.0 – 43.0
F	> 43.0

Note: Density is the primary determinant of LOS for weaving segments. Other factors (e.g., maximum weaving volumes) can result in lower LOS.

Source: 2000 Highway Capacity Manual, Exhibit 24-2.

2.2.1 Existing Conditions Analysis

Existing traffic conditions were analyzed for I-90 and I-229 study area interchanges and intersections based on the existing conditions peak hour traffic volumes documented previously in Figures 3 and 4. The existing and No-Build conditions analyses describe the anticipated “baseline” traffic operations in the study area, where the Build condition illustrates the relative impact associated with the interchange access modification concepts.

The results of the freeway traffic operations analyses for existing conditions indicate the majority of the existing freeway facilities within the I-90 and I-229 study area operate at LOS B or better. The results of the intersection traffic operation analyses indicate some congestion (LOS D or worse) for certain movements in the Cliff Avenue corridor. The results of the freeway traffic operations analyses are provided in the following tables:

- Basic freeway segment analyses are summarized in Table 5.
- Ramp junction analyses are summarized in Table 6.
- Weaving analyses are summarized in Table 7.
- Intersection operation analyses are summarized in Table 8
- The results of all of these analyses are shown graphically in Figure 15.

TABLE 5. EXISTING CONDITIONS BASIC FREEWAY OPERATIONS ANALYSIS

Basic Freeway Segment	Number of Lanes	AM Peak		PM Peak	
		Density	LOS	Density	LOS
<i>Eastbound</i>					
I-90 west of Cliff Ave off-ramp	2	7.6	A	5.9	A
I-90 east of Cliff Ave off-ramp	2	5.1	A	4.4	A
I-90 east of Cliff Ave on-ramp	2	7.5	A	9.5	A
I-90 east of I-229 off-ramp	2	3.3	A	5.9	A
I-90 east of I-229 on-ramp	2	5.5	A	10.0	A
I-90 east of Timberline Ave off-ramp	2	4.4	A	8.6	A
I-90 east of Timberline Ave on-ramp	2	4.7	A	8.9	A
<i>Westbound</i>					
I-90 east of Timberline Ave off-ramp	2	10.0	A	6.4	A
I-90 west of Timberline Ave off-ramp	2	9.8	A	6.2	A
I-90 west of Timberline Ave on-ramp	2	11.6	B	7.3	A
I-90 west of I-229 loop on-ramp	3	10.1	A	6.8	A
I-90 west of I-229 loop off-ramp	2	9.6	A	7.0	A
I-90 west of Cliff Ave off-ramp	2	5.0	A	4.4	A
I-90 west of Cliff Ave on-ramp	2	6.1	A	7.2	A
<i>Northbound</i>					
I-229 north of Rice St on-ramp	3	14.0	B	6.6	A
I-229 north of Benson Rd off-ramp	2	5.3	A	4.9	A
I-229 north of Benson Rd on-ramp	2	5.8	A	7.6	A
I-229 north of I-90 EB off-ramp	2	3.2	A	2.8	A
<i>Southbound</i>					
I-229 south of I-90 WB loop on-ramp	2	5.8	A	3.3	A
I-229 south of I-90 EB on-ramp	2	10.5	A	7.2	A
I-229 south of Benson Rd off-ramp	2	9.3	A	6.7	A
I-229 south of Benson Rd on-ramp	3	7.3	A	11.1	B

Note: Density in passenger cars per mile per lane (pc/mi/ln) is the basic freeway level of service criteria

TABLE 6. EXISTING CONDITIONS RAMP JUNCTION OPERATIONS ANALYSIS

Ramp Junction	Number of Lanes	AM Peak		PM Peak	
		Density ^e	LOS	Density ^e	LOS
Eastbound					
Cliff Ave off-ramp	2 / 1	9.8	A	7.7	A
Cliff Ave on-ramp	2 / 1	11.3	B	13.5	B
I-90 EB to I-229 SB off-ramp	2 / 1	9.3	A	11.7	B
I-229 NB to I-90 EB on-ramp	2 / 1	9.8	A	14.6	B
Timberline Ave off-ramp	2 / 1	7.3	A	12.7	B
Timberline Ave on-ramp	2 / 1	9.2	A	13.6	B
Westbound					
Timberline Ave off-ramp	2 / 1	12.7	B	8.4	A
Timberline Ave on-ramp	2 / 1	16.4	B	11.9	B
I-229 NB to I-90 WB on-ramp (lane add) ^b	2 / 1	18.0	B	12.9	B
I-90 WB to I-229 SB off-ramp (lane drop) ^b	3 / 1	15.8	B	10.0	B
Cliff Ave off-ramp	2 / 1	11.8	B	8.8	A
Cliff Ave on-ramp	2 / 1	10.4	B	11.5	B
Northbound					
Benson Rd off-ramp (lane drop)	3 / 1	18.5	B	6.8	A
Benson Rd on-ramp	2 / 1	9.6	A	11.2	B
I-229 NB to I-90 EB off-ramp	2 / 1	6.9	A	8.9	A
I-229 NB to I-90 WB off-ramp (lane drop)	2 / 1	1.1	A	0.5	A
Southbound					
I-90 WB to I-229 SB on-ramp (lane add) ^d	1 / 1	n/a	n/a	n/a	n/a
I-90 EB to I-229 SB on-ramp	2 / 1	13.8	B	10.7	B
Benson Rd off-ramp	2 / 1	12.0	B	8.4	A
Benson Rd on-ramp (lane add)	2 / 1	13.4	B	19.7	B

Notes:

a -- 2 / 1 = number of freeway lanes / number of ramp lanes

b – Ramp junction is part of a weave section; ramp junction analysis results are approximate.

c – Ramp junction is classified as a major diverge junction; ramp junction analysis results are approximate.

d – Ramp junction cannot be analyzed using HCM methodologies because the number of freeway lanes is less than two lanes.

e -- Density in passenger cars per mile per lane (pc/mi/ln) is the ramp junction level of service criteria.

TABLE 7. EXISTING CONDITIONS WEAVING SECTIONS FOR WESTBOUND I-90

Weave Section	Density ^a	Speed ^b	LOS
<i>AM Peak</i>			
I-229 NB/I-90 WB On-ramp to I-90 WB/I-229 SB Off-ramp	16.4	33 / 59	B
<i>PM Peak</i>			
I-229 NB/I-90 WB On-ramp to I-90 WB/I-229 SB Off-ramp	8.4	50 / 58	A

Notes:

a – Density in passenger cars per mile per lane (pc/mi/ln) is the basic freeway level of service criteria.

b – Free flow speed is assumed to be 70 mph and the values shown in the table is the speeds for “weave / non-weave” vehicles.

TABLE 8. EXISTING CONDITIONS INTERSECTION OPERATIONS ANALYSIS

Intersection	Peak Period	Intersection Approach				Overall Delay / LOS
		Eastbound	Westbound	Northbound	Southbound	
		Delay / LOS	Delay / LOS	Delay / LOS	Delay / LOS	
Cliff Ave @ I-90 EB Ramp	AM	27.8 / C	--	11.5 / B	11.2 / B	14.2 / B
	PM	8.0 / A	--	10.3 / B	9.0 / A	9.6 / A
Cliff Ave @ I-90 WB Ramp	AM	--	21.0 / C	21.0 / C	35.7 / D	29.0 / C
	PM	--	9.9 / A	7.2 / A	18.8 / B	10.8 / B
Cliff Ave @ 60 th St	AM	27.7 / C	28.5 / C	36.7 / D	61.9 / E	49.3 / D
	PM	29.5 / C	23.8 / C	44.9 / D	18.4 / B	32.6 / C
Timberline Ave @ I-90 EB Ramp ^a	AM	12.2 / B	--	n/a	n/a	n/a
	PM	10.5 / B	--	n/a	n/a	n/a
Timberline Ave @ I-90 WB Ramp ^a	AM	--	14.1 / B	n/a	n/a	n/a
	PM	--	10.3 / B	n/a	n/a	n/a
Benson Rd @ I-229 NB Ramp	AM	31.6 / C	27.7 / C	7.3 / A	--	8.9 / A
	PM	11.5 / B	8.4 / A	11.5 / B	--	11.2 / B
Benson Rd @ I-229 SB Ramp ^a	AM	n/a	n/a	--	38.8 / E	n/a
	PM	n/a	n/a	--	11.9 / B	n/a
Benson Rd @ Lewis Ave	AM	11.5 / B	17.6 / B	25.2 / C	30.6 / C	17.0 / B
	PM	27.4 / C	22.8 / C	17.3 / B	27.6 / C	26.1 / C

Notes:

a – Unsignalized intersection

Control delay in (sec/veh) is the intersection level of service criteria.

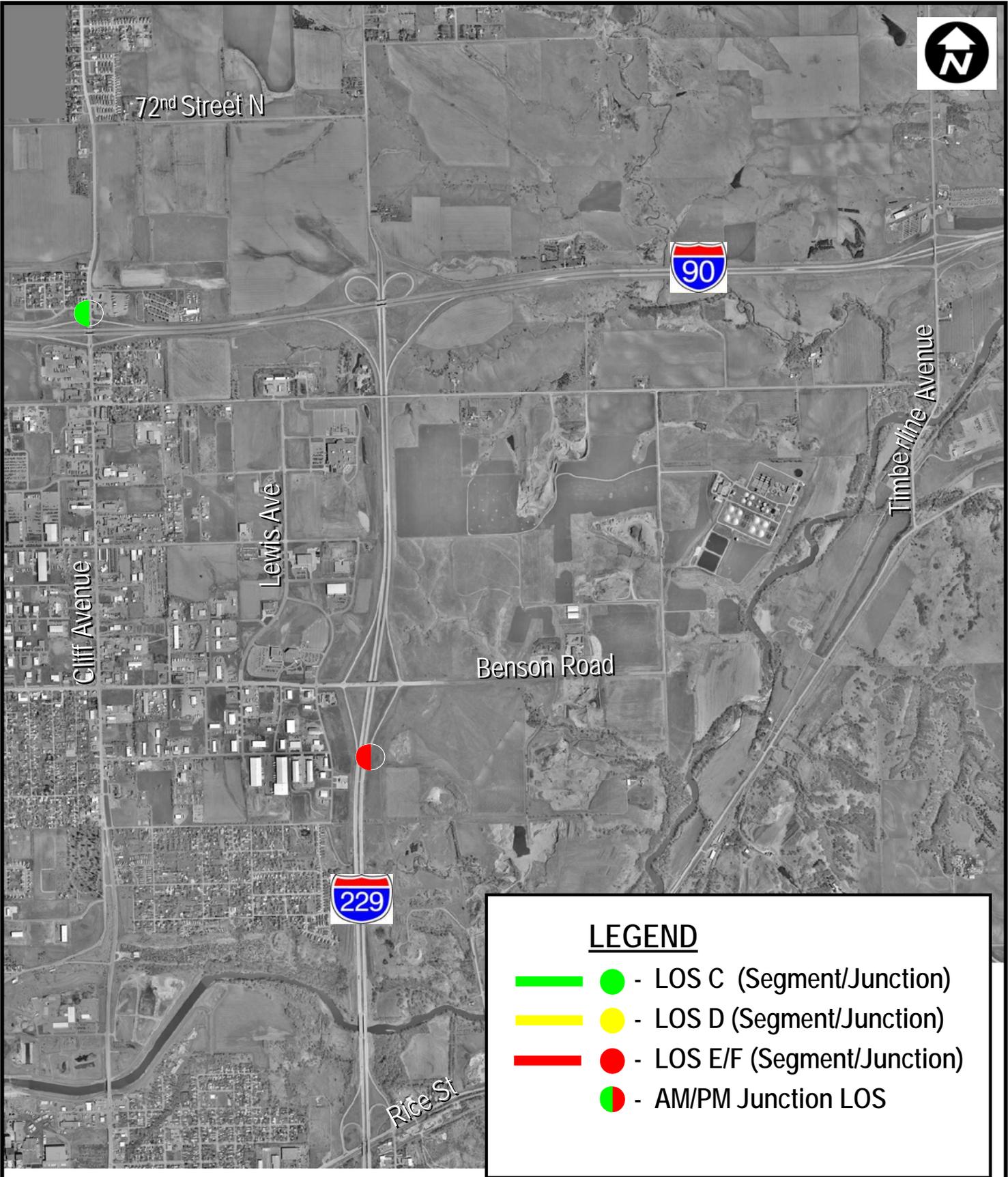


FIGURE 15. I-90/I-229 Traffic Operations Summary, Existing Conditions

2.2.2 2025 No-Build Scenario Analysis

Based on the traffic forecasts developed for the study area, the projected 2025 peak hour traffic volumes associated with a No-Build scenario was analyzed. The No-Build scenario assumes that no improvements for the I-90/I-229 interchange would be implemented. An improved single point urban interchange is assumed for the I-90/Cliff Avenue under this scenario. The results of the freeway traffic operations analyses for 2025 No-Build conditions are provided in the following tables and figure:

- Basic freeway segment analyses are summarized in Table 9.
- Ramp junction analyses are summarized in Table 10.
- Weaving analyses are summarized in Table 11.
- Intersection operation analyses are summarized in Table 12
- The results of all of these analyses are shown graphically in Figure 16.

TABLE 9. FUTURE YEAR (2025) NO-BUILD CONDITIONS BASIC FREEWAY OPERATIONS ANALYSIS

Basic Freeway Segment	Number of Lanes	AM Peak		PM Peak	
		Density	LOS	Density	LOS
<i>Eastbound</i>					
I-90 west of Cliff Ave off-ramp	2	22.9	C	19.0	C
I-90 east of Cliff Ave off-ramp	2	18.1	C	15.6	B
I-90 east of Cliff Ave on-ramp	2	23.9	C	25.6	C
I-90 east of I-229 off-ramp	2	10.6	A	13.3	B
I-90 east of I-229 on-ramp	2	17.0	B	23.0	C
I-90 east of Timberline Ave off-ramp	2	8.6	A	14.9	B
I-90 east of Timberline Ave on-ramp	2	9.9	A	17.7	B
<i>Westbound</i>					
I-90 east of Timberline Ave off-ramp	2	22.6	C	14.5	B
I-90 west of Timberline Ave off-ramp	2	18.6	C	12.1	B
I-90 west of Timberline Ave on-ramp	2	24.9	C	20.4	C
I-90 west of I-229 loop on-ramp	3	24.7	C	21.0	C
I-90 west of I-229 loop off-ramp	2	26.7	D	24.6	C
I-90 west of Cliff Ave off-ramp	2	17.9	B	18.0	C
I-90 west of Cliff Ave on-ramp	2	22.5	C	23.9	C
<i>Northbound</i>					
I-229 north of Rice St on-ramp	3	24.8	C	15.3	B
I-229 north of Benson Rd off-ramp	2	17.7	B	17.8	B
I-229 north of Benson Rd on-ramp	2	20.1	C	22.1	C
I-229 north of I-90 EB off-ramp	2	12.6	B	11.0	B
<i>Southbound</i>					
I-229 south of I-90 WB loop on-ramp	2	11.2	B	7.5	A
I-229 south of I-90 EB on-ramp	2	25.1	C	20.3	C
I-229 south of Benson Rd off-ramp	2	21.5	C	18.6	C
I-229 south of Benson Rd on-ramp	3	16.1	B	21.2	C

Note: Density in passenger cars per mile per lane (pc/mi/ln) is the basic freeway level of service criteria

TABLE 10. FUTURE YEAR (2025) NO-BUILD CONDITIONS RAMP JUNCTION OPERATIONS ANALYSIS

Ramp Junction	Number of Lanes	AM Peak		PM Peak	
		Density ^e	LOS	Density ^e	LOS
<i>Eastbound</i>					
Cliff Ave off-ramp	2 / 1	28.0	D	23.6	C
Cliff Ave on-ramp	2 / 1	28.2	D	29.8	D
I-90 EB to I-229 SB off-ramp	2 / 1	28.2	D	30.0	D
I-229 NB to I-90 EB on-ramp	2 / 1	22.0	C	28.1	D
Timberline Ave off-ramp	2 / 1	21.1	C	28.2	D
Timberline Ave on-ramp	2 / 1	14.7	B	23.2	C
<i>Westbound</i>					
Timberline Ave off-ramp	2 / 1	27.7	C	18.1	B
Timberline Ave on-ramp	2 / 1	29.9	D	25.6	C
I-229 NB to I-90 WB on-ramp (lane add) ^b	2 / 1	40.2	F	34.8	D
I-90 WB to I-229 SB off-ramp (lane drop) ^b	3 / 1	41.5	F	35.4	E
Cliff Ave off-ramp	2 / 1	31.1	D	29.1	D
Cliff Ave on-ramp	2 / 1	27.9	C	29.2	D
<i>Northbound</i>					
Benson Rd off-ramp (lane drop)	3 / 1	29.1	F	16.2	B
Benson Rd on-ramp	2 / 1	23.0	C	25.4	C
I-229 NB to I-90 EB off-ramp	2 / 1	22.3	C	24.5	C
I-229 NB to I-90 WB off-ramp (lane drop)	2 / 1	11.1	B	9.8	A
<i>Southbound</i>					
I-90 WB to I-229 SB on-ramp (lane add) ^d	1 / 1	n/a	n/a	n/a	n/a
I-90 EB to I-229 SB on-ramp	2 / 1	27.8	C	23.1	C
Benson Rd off-ramp	2 / 1	27.9	C	22.6	C
Benson Rd on-ramp (lane add)	2 / 1	26.9	C	34.3	D

Notes:

- a – 2 / 1 = number of freeway lanes / number of ramp lanes
- b – Ramp junction is part of a weave section; ramp junction analysis results are approximate.
- c – Ramp junction is classified as a major diverge junction; ramp junction analysis results are approximate.
- d – Ramp junction cannot be analyzed using HCM methodologies because the number of freeway lanes is less than two lanes.
- e – Density in passenger cars per mile per lane (pc/mi/ln) is the ramp junction level of service criteria.

TABLE 11. FUTURE YEAR (2025) NO-BUILD CONDITIONS WEAVING SECTIONS FOR WESTBOUND I-90

Weave Section	Density ^a	Speed ^b	LOS
<i>AM Peak</i>			
I-229 NB/I-90 WB On-ramp to I-90 WB/I-229 SB Off-ramp	57.0	23 / 41	F
<i>PM Peak</i>			
I-229 NB/I-90 WB On-ramp to I-90 WB/I-229 SB Off-ramp	44.1	25 / 46	F

Notes:

a – Density in passenger cars per mile per lane (pc/mi/ln) is the basic freeway level of service criteria.

b – Free flow speed is assumed to be 70 mph and the values shown in the table is the speeds for “weave / non-weave” vehicles.

TABLE 12. FUTURE YEAR (2025) NO-BUILD INTERSECTION OPERATIONS ANALYSIS

Intersection	Peak Period	Intersection Approach				Overall
		Eastbound	Westbound	Northbound	Southbound	
		Delay / LOS	Delay / LOS	Delay / LOS	Delay / LOS	Delay / LOS
Cliff Ave @ I-90 Ramps	AM	27.4 / C	47.0 / D	25.7 / C	95.1 / F	71.6 / E
	PM	31.4 / C	33.3 / C	20.8 / C	28.5 / C	24.8 / C
Timberline Ave @ I-90 EB Ramp ^a	AM	* / F	--	n/a	n/a	n/a
	PM	* / F	--	n/a	n/a	n/a
Timberline Ave @ I-90 WB Ramp ^a	AM	--	* / F	n/a	n/a	n/a
	PM	--	* / F	n/a	n/a	n/a
Benson Rd @ I-229 NB Ramp	AM	66.6 / E	43.1 / D	56.5 / E	--	55.9 / E
	PM	62.1 / E	8.7 / A	20.3 / C	--	35.0 / D
Benson Rd @ I-229 SB Ramp ^a	AM	n/a	n/a	--	* / F	n/a
	PM	n/a	n/a	--	* / F	n/a

Notes:

a – Assumed to remain an unsignalized intersection

Control delay in (seconds/vehicle) is the intersection level of service criteria.

I-90/Cliff Avenue interchange assumed to be a single-point urban interchange.

As documented in Figure 16, a few freeway segments and several ramp junctions exceed the threshold LOS established for this project. Some additional freeway segments and ramp junctions are approaching the threshold between LOS C/D for the projected volumes. The projected traffic volumes for the Cliff Avenue, Timberline Avenue, and Benson Road intersections are predicted to exceed the capacity of those facilities.

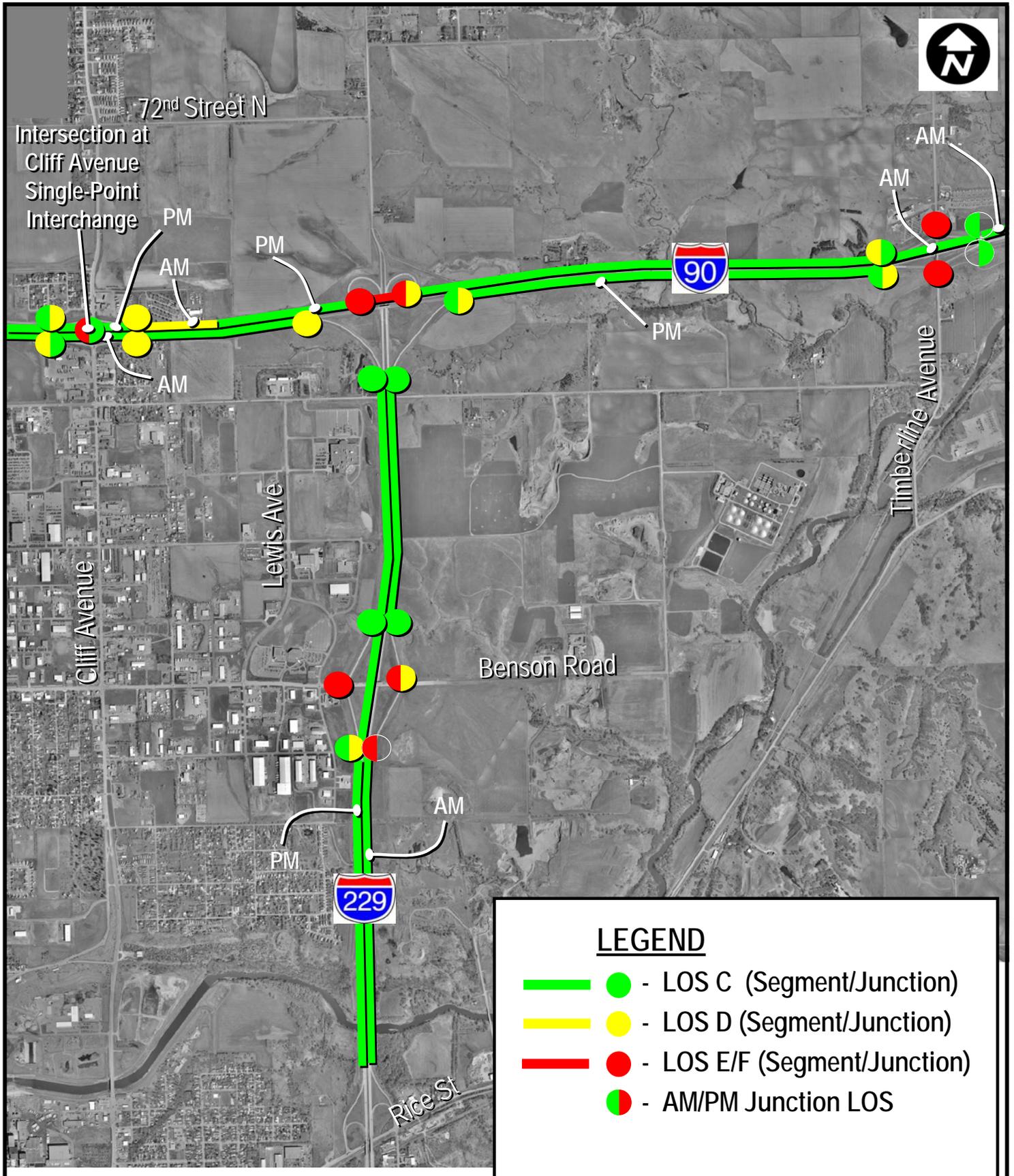


FIGURE 16. I-90/I-229 Traffic Operations Summary, Future No-Build Conditions

2.2.3 2025 Build Scenario Alternatives

A total of five I-90/I-229 Build Scenario alternatives were analyzed for their ability to accommodate the projected traffic growth (Alternative 1 is the No-Build):

- Alternative 2 – Full Cloverleaf Interchange
- Alternative 3 – Lewis Avenue Extension
- Alternative 4 – Full Directional Interchange
- Alternative 5 – Partial Cloverleaf with Fly-over Interchange
- Alternative 6 – Full Cloverleaf Interchange with 60th Street Half-Diamond

These alternatives are detailed in the following subsections.

2.2.3.1 *Alternative 2 – Full Cloverleaf Interchange*

This alternative would include the reconstruction/rehabilitation of the I-90/I-229 interchange to create a full cloverleaf interchange. The existing I-90/I-229 loop ramps require modifications to accommodate new system interchange ramps. Two additional loop ramps will be added to the I-90/I-229 interchange to accommodate flow between eastbound I-90 and 476th Avenue. The I-229/Benson Road interchange will be modified to include two new loop ramps. Figure 17 shows the layout of this alternative. It should be noted that the concept does not eliminate the non-conforming terminus of I-229 at 476th Avenue. Components of this alternative include:

I-90/I-229 Interchange:

- Reconstruct loop ramps in the northwest and northeast quadrants.
- Provide system ramps in the northwest and northeast quadrants to facilitate flow between westbound I-90 and 476th Avenue.
- Construct loop ramps in the southwest and southeast quadrants to facilitate flow between eastbound I-90 and 476th Avenue.
- Provide collector-distributor (C-D) roads along westbound/eastbound I-90. These C-D roads will accommodate all system interchange ramp junctions and remove weaving vehicles from the I-90 mainline.
- Reconstruct I-90 bridges to accommodate C-D road system.

I-90 Mainline:

- The presence of a C-D road system at the I-90 / I-229 interchange will require auxiliary lanes between this interchange and the I-90/Cliff Avenue interchange.

72nd Street/Frontage Road:

- Reconstruct the 72nd Street/476th Avenue intersection to accommodate a fourth intersection leg.



FIGURE 17. Alternative 2 – Full Cloverleaf Interchange

LEGEND

- Improved Roadway Segments
- Bridges
- ✕ Removed Roadway Segments

- Realign the frontage road in the northeast quadrant of the I-90 / I-229 interchange and connect this frontage road to the reconstructed 72nd Street / 476th Avenue intersection.

I-229/Benson Road Interchange:

- Provide loop ramps in the northwest and northeast quadrants of the interchange. The loop in the northwest quadrant will facilitate the westbound Benson Road to southbound I-229 traffic flow. The northbound I-229 to westbound Benson Road traffic flow will be accommodated by the loop ramp in the northeast quadrant of the interchange.
- The diamond ramps in the northwest and northeast quadrants of the interchange will need to be reconstructed to accommodate the new loop ramps.

I-90/Cliff Avenue Interchange:

Slight modifications to the ramps on the east side of this interchange may be required to accommodate auxiliary lanes between this interchange and the I-90/I-229 interchange.

Projected Costs and Right-of-Way Requirements

The projected construction costs for this alternative is approximately \$15 million. This cost does not include costs for rehabilitating existing structures at I-90 / I-229, right-of-way, utility relocations, and/or noise walls. An additional 35 acres of right-of-way is estimated to be required for this alternative.

2.2.3.2 Alternative 3 – Lewis Avenue Extension

This alternative would include the reconstruction/rehabilitation of the I-90/I-229 interchange ramps and structures and the construction of a new fly-over system ramp. This alternative includes a new grade separation of I-90 at Lewis Avenue. The intent of this alternative is to provide a concept that attempts to address access needs in the area more through arterial system improvements and not interstate improvements (other than to better meet current design standards). Figure 18 shows the layout of this alternative. Components of this alternative include:

I-90 / I-229 Interchange:

- Reconstruct loop ramp in the northwest quadrant. Remove loop ramp in the northeast quadrant.
- Provide a fly-over directional ramp to facilitate flow between northbound I-229 and westbound I-90.
- Reconstruct the system ramp in the southeast quadrant to accommodate new fly-over ramp.
- Remove roadway connection between I-229 and 476th Avenue.

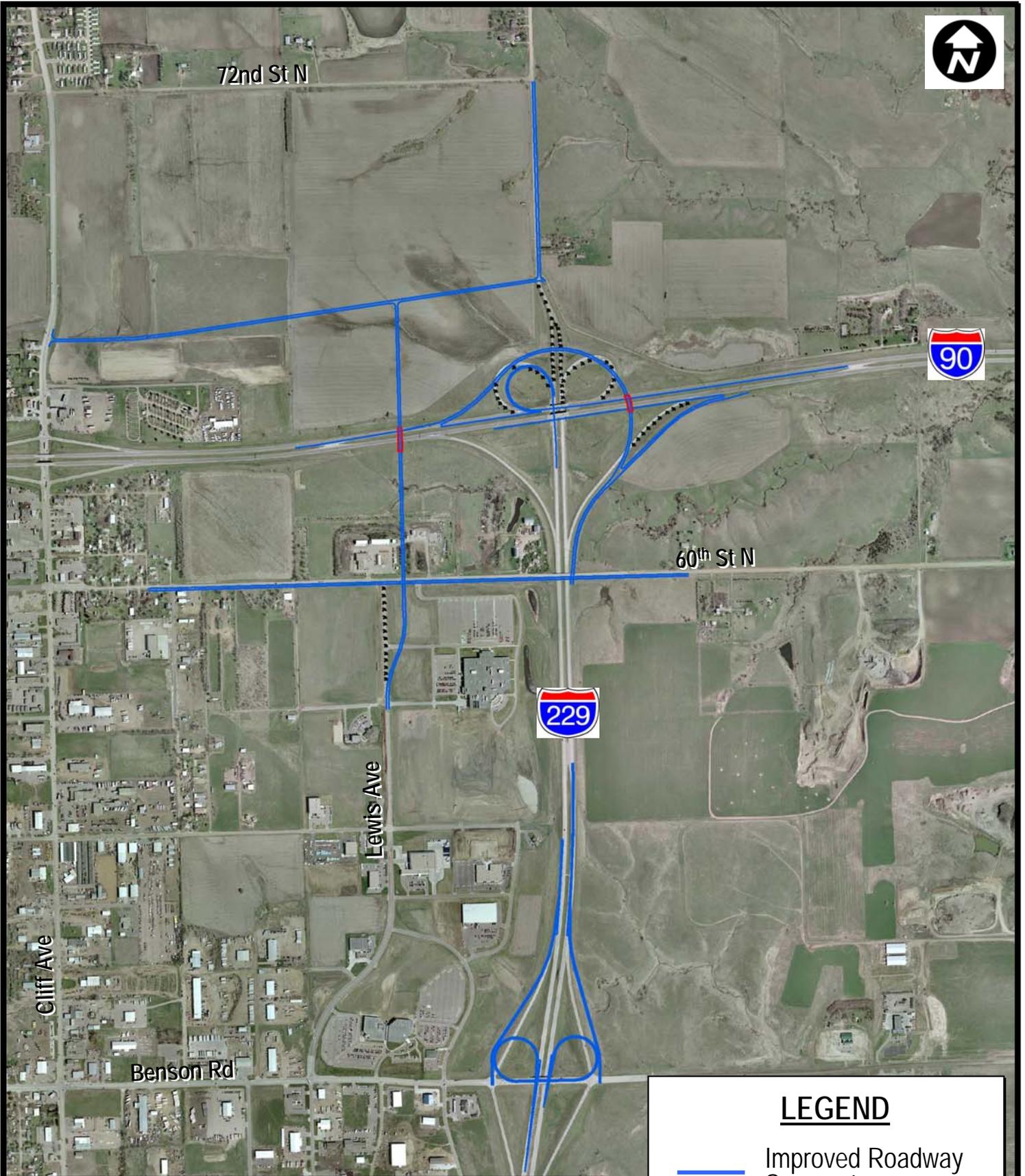


FIGURE 18. Alternative 3 – Lewis Avenue Extension

LEGEND

- Improved Roadway Segments
- Bridges
- ✕ Removed Roadway Segments

Lewis Avenue:

- Extend Lewis Avenue north from 60th Street to 66th Street on a new alignment and construct a new bridge to provide a Lewis Avenue overpass at I-90.
- Realign Lewis Avenue south of 60th Street to minimize impacts to the county maintenance facility located on the north side of 60th Street.

66th Street / Frontage Road:

- Extend 66th Street on new alignment from Cliff Avenue to 476th Avenue.
- Direct access between I-229 and I-90 is not provided between 66th Street or 476th Avenue.
- Maintain frontage road in the northeast quadrant of the I-90 / I-229 interchange.

60th Street:

- The 60th Street bridge over I-229 should be replaced/upgraded.

I-229 / Benson Road Interchange:

- Provide loop ramps in the northwest and northeast quadrants of the interchange. The loop in the northwest quadrant will facilitate the westbound Benson Road to southbound I-229 traffic flow. The northbound I-229 to westbound Benson Road traffic flow will be accommodated by the loop ramp in the northeast quadrant of the interchange.
- The diamond ramps in the northwest and northeast quadrants of the interchange will need to be reconstructed to accommodate the new loop ramps.

I-90 / Cliff Avenue Interchange:

If auxiliary lanes are needed between this interchange and the I-90 / I-229 interchange, then modifications to the ramps on the east side of the interchange would be required.

Projected Costs and Right-of-Way Requirements

The projected construction costs for this alternative is approximately \$14 million. This cost does not include costs for rehabilitating existing structures at I-90 / I-229, right-of-way, utility relocations, and/or noise walls. An additional 49 acres of right-of-way is estimated to be required for this alternative.

2.2.3.3 Alternative 4 – Full Directional Interchange

This alternative would include the reconstruction/rehabilitation of the I-90 / I-229 interchange ramps and structures to create a fully directional interchange. The existing loop ramps would be replaced by fly-over ramps. This alternative would also include a new diamond interchange at I-229 / 60th Street. Figure 19 shows the layout of this alternative. Components of this alternative include:

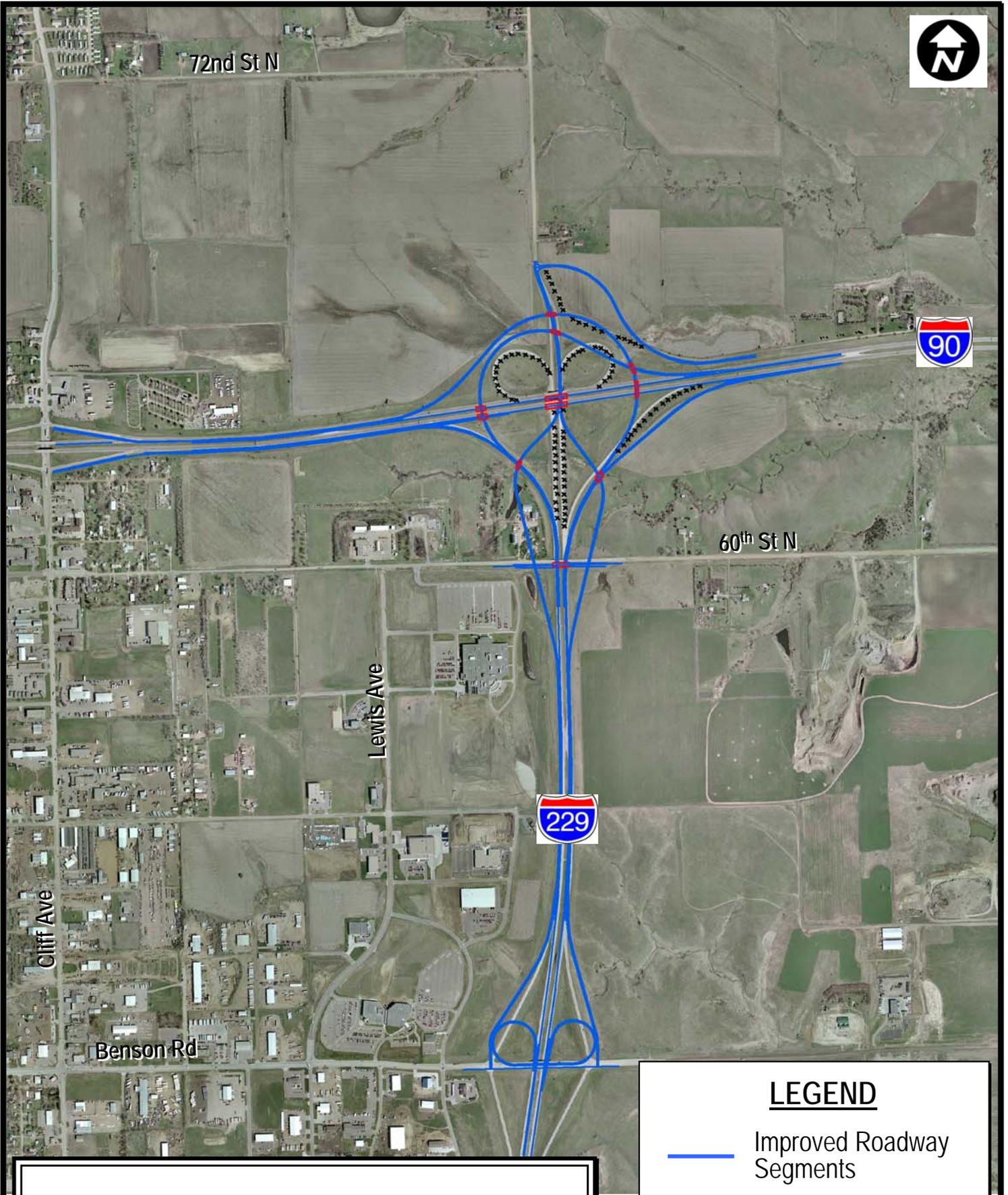


FIGURE 19. Alternative 4 – Full Directional Interchange

LEGEND

- Improved Roadway Segments
- Bridges
- ✕ Removed Roadway Segments

I-90 / I-229 Interchange:

- Remove loop ramps in the northwest and northeast quadrants of this interchange.
- Replace the loop ramp in the northwest quadrant with a fly-over directional ramp that goes over 476th Avenue and under I-90.
- Replace the loop ramp in the northeast quadrant with a fly-over directional ramp that requires structures to carry the ramp over I-90, westbound I-90 to southbound I-229 fly-over ramp, and 476th Avenue.
- Reconstruct the system ramps in the southwest and southeast quadrants to accommodate the new fly-over ramps.
- Remove existing I-229 lanes between 476th Avenue and the system ramps located in the southwest and southeast quadrants.

60th Street Interchange:

- Provide a new diamond interchange at 60th Street and I-229.
 - The ramps in the southwest and southeast quadrants of this interchange will connect directly to I-229.
 - The ramps in the northwest and northeast quadrants will not connect to I-229, however, they will connect to 476th Avenue.
- The ramps in the northwest and northeast quadrants will require structures in order to go over/under the I-90 / I-229 system ramps in the southwest and southeast quadrants of that interchange.
- The 60th Street bridge structure will need to be reconstructed to accommodate the required turn lanes along 60th Street.

I-229 / Benson Road Interchange:

- Provide loop ramps in the northwest and northeast quadrants of the interchange. The loop in the northwest quadrant will facilitate the westbound Benson Road to southbound I-229 traffic flow. The northbound I-229 to westbound Benson Road traffic flow will be accommodated by the loop ramp in the northeast quadrant of the interchange.
- The diamond ramps in the northwest and northeast quadrants of the interchange will need to be reconstructed to accommodate the new loop ramps.

I-90 / Cliff Avenue Interchange:

If auxiliary lanes are needed between this interchange and the I-90 / I-229 interchange, then modifications to the ramps on the east side of the interchange would be required.

Projected Costs and Right-of-Way Requirements

The projected construction costs for this alternative is approximately \$22 million. This cost does not include costs for rehabilitating existing structures at I-90 / I-229, right-of-way, utility

relocations, and/or noise walls. An additional 44 acres of right-of-way is estimated to be required for this alternative.

2.2.3.4 Alternative 5 – Partial Cloverleaf with Fly-Over Interchange

This alternative would include the reconstruction/rehabilitation of the I-90 / I-229 interchange ramps and structures. The existing loop ramps in the northeast quadrant of this interchange would be replaced by fly-over ramp. This alternative would also include a new diamond interchange at I-229 / 60th Street. Figure 20 shows the layout of this alternative. Components of this alternative include:

I-90 / I-229 Interchange:

- Remove loop ramp in the northeast quadrant of this interchange.
- Replace the loop ramp in the northeast quadrant with a fly-over directional ramp that requires structures to carry the ramp over I-90 and 476th Avenue.
- Reconstruct the system ramp in the southeast quadrant to accommodate new fly-over ramp.
- Remove roadway connection between I-229 and 476th Avenue.

60th Street Interchange:

- Provide a new diamond interchange at 60th Street and I-229.
 - The ramps in the southwest and southeast quadrants of this interchange will connect directly to I-229.
 - The ramps in the northwest and northeast quadrants will not connect to I-229, however, they will connect to 476th Avenue.
- The ramps in the northwest and northeast quadrants will require structures in order to go over/under the I-90/I-229 system ramps and I-229 in the southwest and southeast quadrants of that interchange.
- The 60th Street bridge structure will need to be reconstructed to accommodate the required turn lanes along 60th Street.

I-229 / Benson Road Interchange:

- Provide loop ramps in the northwest and northeast quadrants of the interchange. The loop in the northwest quadrant will facilitate the westbound Benson Road to southbound I-229 traffic flow. The northbound I-229 to westbound Benson Road traffic flow will be accommodated by the loop ramp in the northeast quadrant of the interchange.
- The diamond ramps in the northwest and northeast quadrants of the interchange will need to be reconstructed to accommodate the new loop ramps.

I-90 / Cliff Avenue Interchange:

- If auxiliary lanes are needed between this interchange and the I-90/I-229 interchange, then modifications to the ramps on the east side of the interchange would be required.

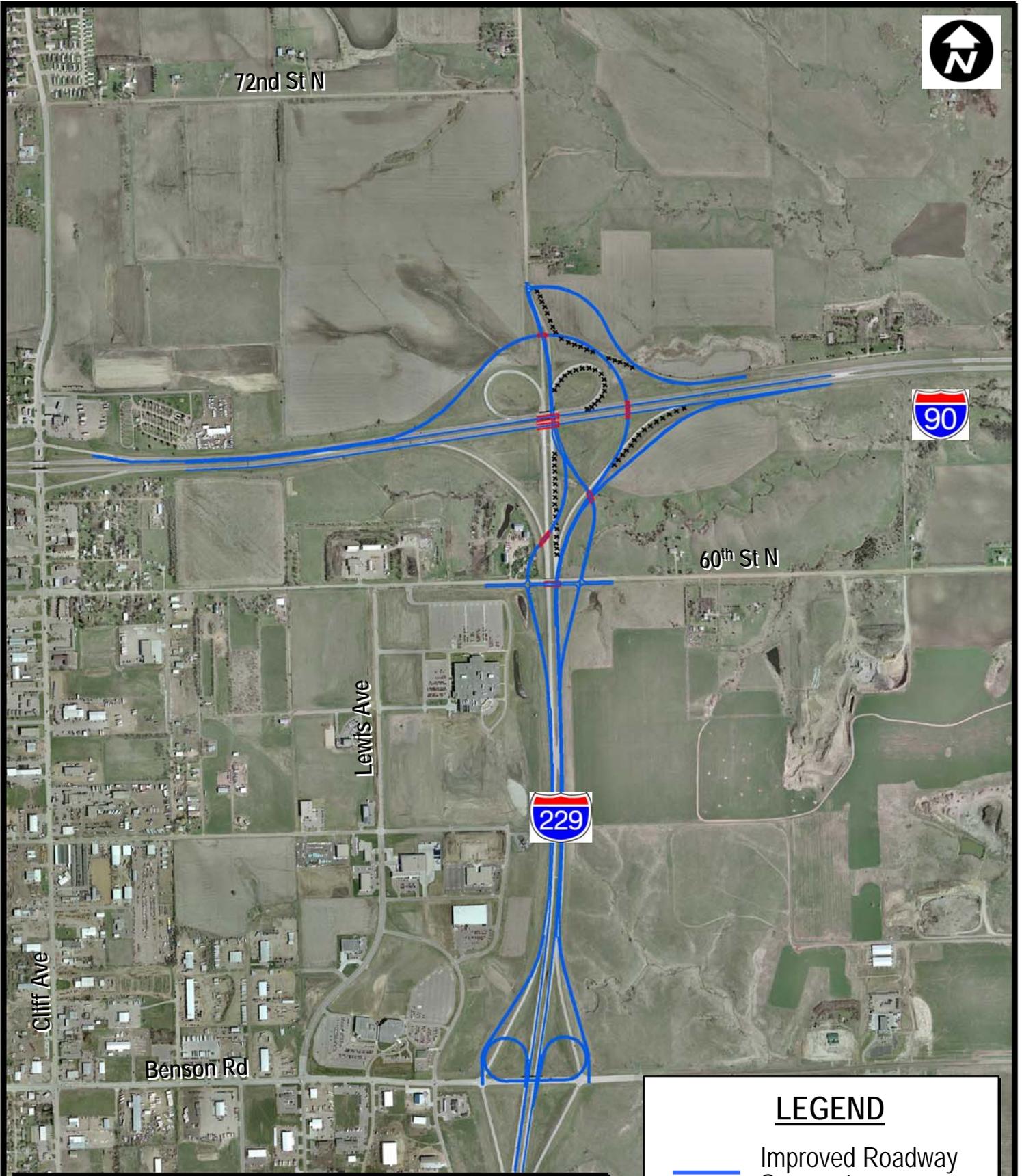


FIGURE 20. Alternative 5 - Partial Cloverleaf with Flyover Interchange

LEGEND

- Improved Roadway Segments
- Bridges
- X Removed Roadway Segments

Projected Costs and Right-of-Way Requirements

The projected construction costs for this alternative is approximately \$17 million. This cost does not include costs for rehabilitating existing structures at I-90 / I-229, right-of-way, utility relocations, and/or noise walls. An additional 44 acres of right-of-way is estimated to be required for this alternative.

2.2.3.5 Alternative 6 – Full Cloverleaf Interchange with 60th Street Half Diamond

This alternative would include the reconstruction/rehabilitation of the I-90/I-229 interchange to create a full cloverleaf interchange. The existing I-90/I-229 loop ramps require modifications to accommodate new system interchange ramps. Two additional loop ramps will be added to the I-90/I-229 interchange to accommodate flow between eastbound I-90 and 476th Avenue. This alternative would also include a new half-diamond interchange at I-229 / 60th Street. Figure 21 shows the layout of this alternative. Components of this alternative include:

I-90 / I-229 Interchange:

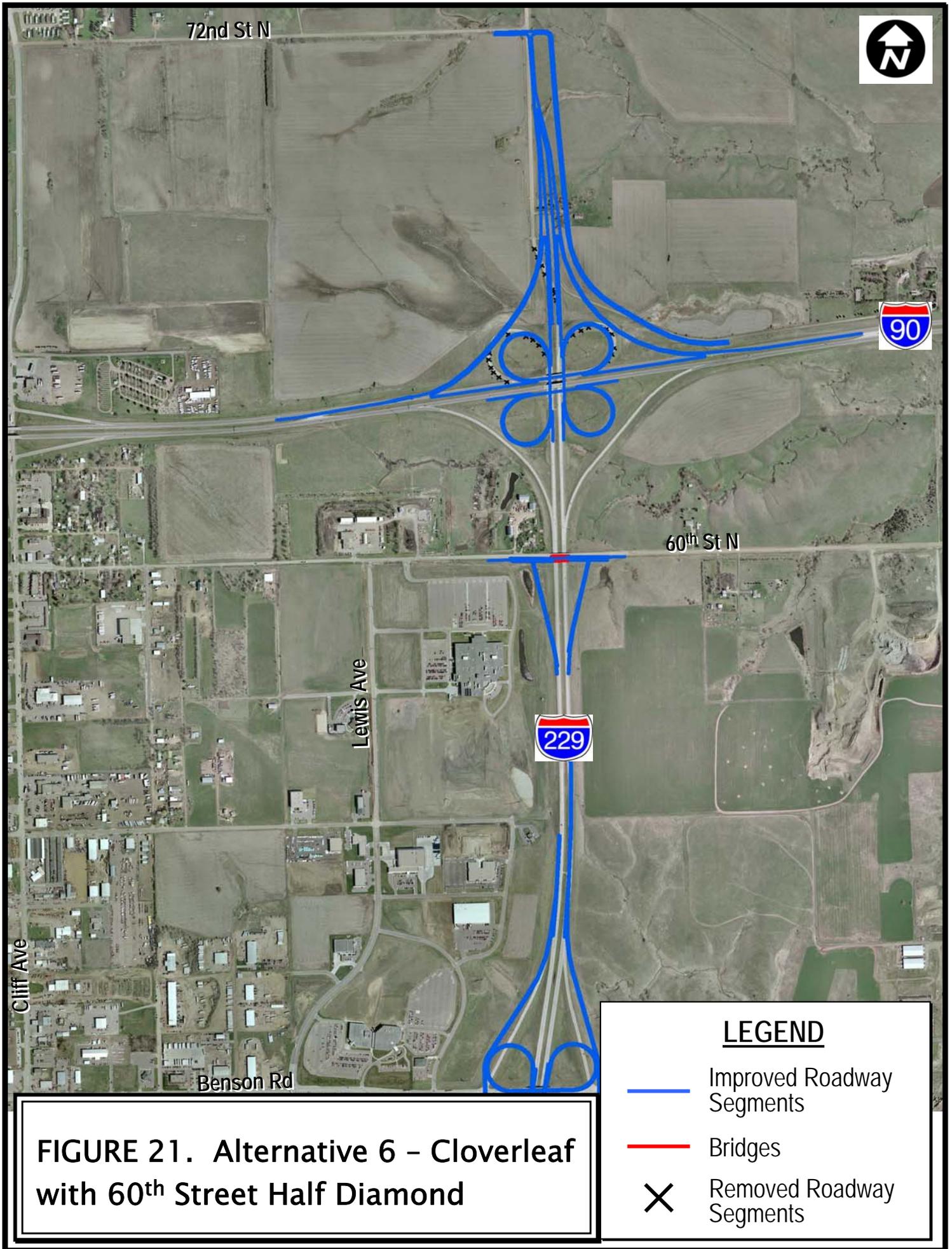
- Reconstruct loop ramps in the northwest and northeast quadrants.
- Provide system ramps in the northwest and northeast quadrants to facilitate flow between westbound I-90 and 476th Avenue.
- Construct loop ramps in the southwest and southeast quadrants to facilitate flow between eastbound I-90 and 476th Avenue.
- Provide collector-distributor (C-D) roads along westbound/eastbound I-90. These C-D roads will accommodate all system interchange ramp junctions and remove weaving vehicles from the I-90 mainline.
- Reconstruct I-90 bridges to accommodate C-D road system.

I-90 Mainline:

- The presence of a C-D road system at the I-90 / I-229 interchange will require auxiliary lanes between this interchange and the I-90/Cliff Avenue interchange.

60th Street Interchange:

- Provide a new half-diamond interchange at 60th Street and I-229. The ramps will be located in the southwest and southeast quadrants and will connect directly to I-229.
- The 60th Street interchange is located in close proximity to the I-90/I-229 system interchange. The system interchange essentially serves as the terminus for I-229.
- The 60th Street bridge structure will need to be reconstructed to accommodate the required turn lanes along 60th Street.



72nd St N



60th St N



Lewis Ave

Cliff Ave

Benson Rd

LEGEND

- Improved Roadway Segments
- Bridges
- ✕ Removed Roadway Segments

FIGURE 21. Alternative 6 - Cloverleaf with 60th Street Half Diamond

72nd Street/Frontage Road:

- Reconstruct the 72nd Street/476th Avenue intersection to accommodate a fourth intersection leg.
- Realign the frontage road in the northeast quadrant of the I-90 / I-229 interchange and connect this frontage road to the reconstructed 72nd Street / 476th Avenue intersection.

I-229/Benson Road Interchange:

- Provide loop ramps in the northwest and northeast quadrants of the interchange. The loop in the northwest quadrant will facilitate the westbound Benson Road to southbound I-229 traffic flow. The northbound I-229 to westbound Benson Road traffic flow will be accommodated by the loop ramp in the northeast quadrant of the interchange.
- The diamond ramps in the northwest and northeast quadrants of the interchange will need to be reconstructed to accommodate the new loop ramps.

I-90/Cliff Avenue Interchange:

Slight modifications to the ramps on the east side of this interchange may be required to accommodate auxiliary lanes between this interchange and the I-90/I-229 interchange.

Projected Costs and Right-of-Way Requirements

The projected construction costs for this alternative is approximately \$20 million. This cost does not include costs for rehabilitating existing structures at I-90 / I-229, right-of-way, utility relocations, and/or noise walls. An additional 41 acres of right-of-way is estimated to be required for this alternative.

2.2.4 2025 Build Scenario Analysis Results

The results of the freeway traffic operations analyses for 2025 Build conditions are provided in the following tables and figure:

- Basic freeway segment analyses are summarized in Tables 13 through 16.
- Ramp junction analyses are summarized in Tables 17 through 21.
- Weaving analyses are summarized in Tables 22 and 23.
- Intersection operation analyses are summarized in Tables 24 through 27.
- The results of all of these analyses are shown graphically in Figures 22 through 26.

TABLE 13: BASIC FREEWAY ANALYSIS –FULL CLOVERLEAF INTERCHANGE ALTERNATIVE (2025)

Basic Freeway Segment	Number of Lanes	AM Peak		PM Peak	
		Density	LOS	Density	LOS
Eastbound					
I-90 west of Cliff Ave off-ramp	2	22.2	C	16.8	B
I-90 east of Cliff Ave off-ramp	2	17.6	B	13.9	B
I-90 east of Cliff Ave on-ramp	2	21.6	C	22.8	C
<i>with auxiliary lane</i>	3	14.4	B	15.2	B
I-90 east of off-ramp to SB I-229	2	10.8	A	13.3	B
I-90 east of loop on-ramp from SB I-229	3	7.8	A	9.4	A
I-90 east of loop off-ramp to NB I-229	2	10.8	A	12.4	B
I-90 east of on-ramp from NB I-229	2	16.2	B	21.7	C
<i>with auxiliary lane</i>	3	10.8	A	14.4	B
I-90 east of Timberline Ave off-ramp	2	8.6	A	14.9	B
I-90 east of Timberline Ave on-ramp	2	9.9	A	17.7	B
Westbound					
I-90 east of Timberline Ave off-ramp	2	22.6	C	14.5	B
I-90 west of Timberline Ave off-ramp	2	19.0	C	12.5	B
I-90 west of Timberline Ave on-ramp	2	23.9	C	19.6	C
<i>with auxiliary lane</i>	3	15.7	B	13.1	B
I-90 west of off-ramp to NB I-229	2	24.2	C	19.5	C
<i>with C-D road for all WB ramps</i>	2	13.5	B	12.4	B
I-90 west of loop on-ramp from NB I-229 ^a	3	23.1	C	19.1	C
I-90 west of loop off-ramp to SB I-229 ^a	2	24.2	C	21.6	C
I-90 west of on-ramp from SB I-229	2	26.7	D	22.8	C
<i>with auxiliary lane</i>	3	17.5	B	15.2	B
I-90 west of Cliff Ave off-ramp	2	18.5	C	18.0	C
I-90 west of Cliff Ave on-ramp	2	21.8	C	23.4	C
Northbound					
I-229 north of Rice St on-ramp	3	24.6	C	15.2	B
I-229 north of Benson Ave off-ramp	3	20.8	C	14.3	B
I-229 north of Benson Ave loop off-ramp	2	17.9	B	18.0	C
I-229 north of Benson Ave on-ramp	2	19.9	C	22.6	C
I-229 north of off-ramp to EB I-90	2	13.6	B	12.6	B
I-229 north of loop on-ramp from EB I-90	3	9.4	A	8.9	A
I-229 north of loop off-ramp to WB I-90	2	3.3	A	4.0	A
I-229 north of on-ramp from WB I-90	2	3.8	A	4.9	A

TABLE 13: BASIC FREEWAY ANALYSIS – FULL CLOVERLEAF INTERCHANGE ALTERNATIVE (2025) – CONT.

Basic Freeway Segment	Number Of Lanes	AM Peak		PM Peak	
		Density	LOS	Density	LOS
<i>Southbound</i>					
I-229 north of off-ramp to WB I-90	2	5.6	A	4.8	A
I-229 south of off-ramp to WB I-90	2	3.2	A	3.5	A
I-229 south of loop on-ramp from WB I-90	3	9.3	A	7.1	A
I-229 south of loop off-ramp to EB I-90	2	13.4	B	10.1	A
I-229 south of on-ramp from EB I-90	2	24.9	C	20.2	C
I-229 south of Benson Ave off-ramp	2	21.3	C	18.8	C
I-229 south of Benson Ave loop on-ramp	3	14.3	B	13.4	B
I-229 south of Benson Ave on-ramp	3	15.8	B	21.1	C

Notes: Density in passenger cars per mile per lane (pc/mi/lane) is the basic freeway level of service criteria

a – This segment does not exist under the C-D road alternative.

See Figure 22 for graphical representation of LOS.

TABLE 14: BASIC FREEWAY ANALYSIS – LEWIS AVENUE EXTENSION ALTERNATIVE (2025)

Basic Freeway Segment	Number of Lanes	AM Peak		PM Peak	
		Density	LOS	Density	LOS
<i>Eastbound</i>					
I-90 west of Cliff Ave off-ramp	2	22.0	C	17.4	B
I-90 east of Cliff Ave off-ramp	2	17.4	B	13.9	B
I-90 east of Cliff Ave on-ramp	2	21.4	C	22.8	C
<i>with auxiliary lane</i>	3	14.2	B	15.2	B
I-90 east of off-ramp to SB I-229	2	6.8	A	8.6	B
I-90 east of on-ramp from NB I-229	2	16.6	B	22.5	C
<i>with auxiliary lane</i>	3	11.0	B	14.9	B
I-90 east of Timberline Ave off-ramp	2	8.6	A	14.9	B
I-90 east of Timberline Ave on-ramp	2	9.9	A	17.7	B
<i>Westbound</i>					
I-90 east of Timberline Ave off-ramp	2	22.6	C	14.5	B
I-90 west of Timberline Ave off-ramp	2	18.6	C	12.1	B
I-90 west of Timberline Ave on-ramp	2	24.4	C	20.0	C
<i>with auxiliary lane</i>	3	16.0	B	13.3	B
I-90 west of off-ramp to SB I-229	2	14.4	B	13.7	B
I-90 west of on-ramp from NB I-229	2	25.2	C	22.4	C
<i>with auxiliary lane</i>	3	16.6	B	14.9	B
I-90 west of Cliff Ave off-ramp	2	17.2	B	17.6	B
I-90 west of Cliff Ave on-ramp	2	21.1	C	22.9	C
<i>Northbound</i>					
I-229 north of Rice St on-ramp	3	24.6	C	14.8	B
I-229 north of Benson Ave off-ramp	3	20.8	C	13.9	B
I-229 north of Benson Ave loop off-ramp	2	17.0	B	16.1	B
I-229 north of Benson Ave on-ramp	2	18.7	C	20.3	C
<i>Southbound</i>					
I-229 south of loop on-ramp from WB I-90	2	11.1	B	7.4	A
I-229 south of on-ramp from EB I-90	2	23.0	C	18.0	C
I-229 south of Benson Ave off-ramp	2	19.4	C	16.4	B
I-229 south of Benson Ave loop on-ramp	3	13.1	B	11.8	B
I-229 south of Benson Ave on-ramp	3	15.2	B	20.4	C

Note: Density in passenger cars per mile per lane (pc/mi/lane) is the basic freeway level of service criteria

See Figure 23 for graphical representation of LOS.

TABLE 15: BASIC FREEWAY ANALYSIS – FULL DIRECTIONAL AND THE PARTIAL CLOVERLEAF WITH FLY-OVER INTERCHANGE ALTERNATIVES (2025)

Basic Freeway Segment	Number of Lanes	AM Peak		PM Peak	
		Density	LOS	Density	LOS
<i>Eastbound</i>					
I-90 west of Cliff Ave off-ramp	2	21.1	C	15.6	B
I-90 east of Cliff Ave off-ramp	2	16.5	B	12.1	B
I-90 east of Cliff Ave on-ramp	2	20.7	C	21.4	C
<i>with auxiliary lane</i>	3	13.8	B	14.2	B
I-90 east of off-ramp to SB I-229	2	6.8	A	8.6	A
I-90 east of on-ramp from NB I-229	2	16.6	B	22.5	C
<i>with auxiliary lane</i>	3	11.0	B	14.9	B
I-90 east of Timberline Ave off-ramp	2	8.6	A	14.9	B
I-90 east of Timberline Ave on-ramp	2	9.9	A	17.7	B
<i>Westbound</i>					
I-90 east of Timberline Ave off-ramp	2	22.6	C	14.5	B
I-90 west of Timberline Ave off-ramp	2	18.6	C	12.1	B
I-90 west of Timberline Ave on-ramp	2	24.4	C	20.0	C
<i>with auxiliary lane</i>	3	16.0	B	13.3	B
I-90 west of off-ramp to SB I-229	2	14.4	B	13.7	B
I-90 west of on-ramp from NB I-229	2	24.2	C	23.1	C
<i>with auxiliary lane</i>	3	16.0	B	15.3	B
I-90 west of Cliff Ave off-ramp	2	16.1	B	18.0	C
I-90 west of Cliff Ave on-ramp	2	20.0	C	23.4	C
<i>Northbound</i>					
I-229 north of Rice St on-ramp	3	25.5	C	16.5	B
I-229 north of Benson Ave off-ramp	3	21.8	C	15.8	B
I-229 north of Benson Ave loop off-ramp	2	24.2	C	22.0	C
I-229 north of Benson Ave on-ramp	2	26.2	D	26.4	D
<i>with auxiliary lane</i>	3	17.1	B	17.1	B
I-229 north of 60 th St off-ramp	2	17.8	B	21.0	C
<i>Southbound</i>					
I-229 south of loop on-ramp from WB I-90 ^a	2	11.2	B	7.5	A
I-229 south of on-ramp from EB I-90	2	22.3	C	16.5	B
I-229 south of 60 th St on-ramp	2	27.6	D	24.4	C
<i>with auxiliary lane</i>	3	17.9	B	15.9	B
I-229 south of Benson Ave off-ramp	2	23.8	C	22.8	C
I-229 south of Benson Ave loop on-ramp	3	15.8	B	15.7	B
I-229 south of Benson Ave on-ramp	3	16.9	B	21.7	C

Notes: Density in passenger cars per mile per lane (pc/mi/lane) is the basic freeway level of service criteria

a – This result is only for the Partial Cloverleaf with Fly-Over Interchange alternative.

See Figures 24 and 25 for graphical representation of LOS.

TABLE 16: BASIC FREEWAY ANALYSIS –FULL CLOVERLEAF INTERCHANGE WITH 60TH STREET HALF DIAMOND ALTERNATIVE (2025)

Basic Freeway Segment	Number of Lanes	AM Peak		PM Peak	
		Density	LOS	Density	LOS
Eastbound					
I-90 west of Cliff Ave off-ramp	2	22.2	C	16.8	B
I-90 east of Cliff Ave off-ramp	2	17.6	B	13.9	B
I-90 east of Cliff Ave on-ramp	2	21.6	C	22.4	C
<i>with auxiliary lane</i>	3	14.4	B	14.9	B
I-90 east of off-ramp to SB I-229	2	10.8	A	13.3	B
I-90 east of loop on-ramp from SB I-229	3	7.8	A	9.4	A
I-90 east of loop off-ramp to NB I-229	2	10.8	A	12.4	B
I-90 east of on-ramp from NB I-229	2	16.2	B	21.7	C
<i>with auxiliary lane</i>	3	10.8	A	14.4	B
I-90 east of Timberline Ave off-ramp	2	8.6	A	14.9	B
I-90 east of Timberline Ave on-ramp	2	9.9	A	17.7	B
Westbound					
I-90 east of Timberline Ave off-ramp	2	22.6	C	14.5	B
I-90 west of Timberline Ave off-ramp	2	19.0	C	12.5	B
I-90 west of Timberline Ave on-ramp	2	23.9	C	19.6	C
<i>with auxiliary lane</i>	3	15.7	B	13.1	B
I-90 west of off-ramp to NB I-229	2	24.2	C	19.5	C
<i>with C-D road for all WB ramps</i>	2	13.5	B	12.4	B
I-90 west of loop on-ramp from NB I-229 ^a	3	23.1	C	19.1	C
I-90 west of loop off-ramp to SB I-229 ^a	2	24.2	C	21.6	C
I-90 west of on-ramp from SB I-229	2	26.7	D	22.8	C
<i>with auxiliary lane</i>	3	17.5	B	15.2	B
I-90 west of Cliff Ave off-ramp	2	18.5	C	18.0	C
I-90 west of Cliff Ave on-ramp	2	21.8	C	23.4	C
Northbound					
I-229 north of Rice St on-ramp	3	25.6	C	15.8	B
I-229 north of Benson Ave off-ramp	3	22.0	C	15.0	B
I-229 north of Benson Ave loop off-ramp	2	24.4	C	20.9	C
I-229 north of Benson Ave on-ramp	2	26.5	D	25.7	C
<i>with auxiliary lane</i>	3	17.2	B	16.7	B
I-229 north of 60 th St off-ramp	2	19.4	C	22.1	C
I-229 north of off-ramp to EB I-90	2	13.1	B	12.2	B
I-229 north of loop on-ramp from EB I-90	3	9.1	A	8.6	A
I-229 north of loop off-ramp to WB I-90	2	2.8	A	3.5	A
I-229 north of on-ramp from WB I-90	2	3.3	A	4.4	A

TABLE 16: BASIC FREEWAY ANALYSIS – FULL CLOVERLEAF INTERCHANGE WITH 60TH STREET HALF DIAMOND ALTERNATIVE (2025) – CONT.

Basic Freeway Segment	Number Of Lanes	AM Peak		PM Peak	
		Density	LOS	Density	LOS
<i>Southbound</i>					
I-229 north of off-ramp to WB I-90	2	5.1	A	4.4	A
I-229 south of off-ramp to WB I-90	2	2.8	A	3.1	A
I-229 south of loop on-ramp from WB I-90	3	9.0	A	6.8	A
I-229 south of loop off-ramp to EB I-90	2	13.0	B	9.6	A
I-229 south of on-ramp from EB I-90	2	24.4	C	19.4	C
I-229 south of 60 th St on-ramp <i>with auxiliary lane</i>	2	27.4	D	26.0	C
	3	17.7	B	16.9	B
I-229 south of Benson Ave off-ramp	2	23.6	C	24.1	C
I-229 south of Benson Ave loop on-ramp	3	15.7	B	16.5	B
I-229 south of Benson Ave on-ramp	3	16.7	B	22.5	C

Notes: Density in passenger cars per mile per lane (pc/mi/lane) is the basic freeway level of service criteria

a – This segment does not exist under the C-D road alternative.

See Figure 26 for graphical representation of LOS.

SECTION TWO

Supporting Traffic Evaluations

TABLE 17: RAMP JUNCTION OPERATIONS ANALYSIS – FULL CLOVERLEAF INTERCHANGE ALTERNATIVE (2025)

Ramp Junction	Number ^a of Lanes	AM Peak		PM Peak	
		Density ^d	LOS	Density ^d	LOS
Eastbound					
Cliff Ave off-ramp	2 / 1	27.3	C	20.9	C
Cliff Ave on-ramp	2 / 1	26.1	C	27.3	C
<i>with auxiliary lane (lane add)</i>	2 / 1	24.6	C	25.7	C
I-90 EB to I-229 SB off-ramp	2 / 1	25.7	C	27.1	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	18.2	B	18.6	B
I-229 SB to I-90 EB loop on-ramp (lane add) ^b	2 / 1	14.6	B	17.1	B
I-90 EB to I-229 NB loop off-ramp (lane drop) ^b	3 / 1	9.2	A	11.3	B
I-229 NB to I-90 EB on-ramp	2 / 1	21.1	C	26.8	C
<i>with auxiliary lane (lane add)</i>	2 / 1	18.3	B	23.9	C
Timberline Ave off-ramp	2 / 1	20.1	C	26.8	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	13.8	B	17.6	B
Timberline Ave on-ramp	2 / 1	14.7	B	23.2	C
Westbound					
Timberline Ave off-ramp	2 / 1	27.7	C	18.1	B
Timberline Ave on-ramp	2 / 1	29.1	D	24.8	C
<i>with auxiliary lane (lane add)</i>	2 / 1	26.3	C	22.0	C
I-90 WB to I-229 NB off-ramp	2 / 1	29.1	D	24.2	C
<i>with auxiliary lane (lane drop) and C-D road</i>	3 / 1	20.2	C	16.4	B
I-229 NB to I-90 WB loop-on-ramp (lane add) ^{b, e}	2 / 1	38.0	F	31.8	D
I-90 WB to I-229 SB loop off-ramp (lane drop) ^{b, e}	3 / 1	39.0	F	32.1	D
I-229 SB to I-90 WB on-ramp	2 / 1	31.3	D	27.8	C
<i>with auxiliary lane (lane add) and C-D road</i>	2 / 1	27.8	C	24.4	C
Cliff Ave off-ramp	2 / 1	31.1	D	27.1	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	20.3	C	17.2	B
Cliff Ave on-ramp	2 / 1	27.3	C	28.8	D
Northbound					
Benson Rd off-ramp	3 / 1	29.1	D	18.1	B
Benson Rd loop off-ramp (lane drop)	3 / 1	24.2	C	15.2	B
Benson Rd on-ramp	2 / 1	23.2	C	25.8	C

TABLE 17: RAMP JUNCTION OPERATIONS ANALYSIS – FULL CLOVERLEAF INTERCHANGE ALTERNATIVE (2025) – CONT.

Ramp Junction	Number ^a of Lanes	AM Peak		PM Peak	
		Density ^d	LOS	Density ^d	LOS
I-229 NB to I-90 EB off-ramp	2 / 1	22.1	C	25.0	C
I-90 EB to I-229 NB loop on-ramp (<i>lane add</i>) ^b	2 / 1	16.5	B	15.6	B
I-229 NB to I-90 WB loop off-ramp (<i>lane drop</i>) ^b	3 / 1	14.1	B	14.0	B
I-90 WB to NB I-229 on-ramp	2 / 1	7.5	A	8.6	A
<i>Southbound</i>					
I-229 SB to I-90 WB off-ramp	2 / 1	6.6	A	5.8	A
I-90 WB to I-229 SB loop on-ramp (<i>lane add</i>) ^b	2 / 1	15.8	B	12.7	B
I-229 SB to I-90 EB loop off-ramp (<i>lane drop</i>) ^b	3 / 1	15.4	B	11.7	B
I-90 EB to I-229 SB on-ramp	2 / 1	27.7	C	23.2	C
Benson Rd off-ramp	2 / 1	27.6	C	22.6	C
Benson Rd loop on-ramp (<i>lane add</i>)	2 / 1	24.1	C	22.6	C
Benson Rd on-ramp	3 / 1	18.9	B	26.7	C

Notes:

a – 2 / 1 = number of freeway lanes / number of ramp lanes

b – Ramp junction is part of a weave section; ramp junction analysis results are approximate.

c – Ramp junction is classified as a major diverge junction; ramp junction analysis results are approximate.

d – Density in passenger cars per mile per lane (pc/mi/lane) is the ramp junction level of service criteria.

e – The lane configuration for this ramp junction under the C-D roadway alternative cannot be analyzed using HCM methodologies.

See Figure 22 for graphical representation of LOS.

TABLE 18: RAMP JUNCTION OPERATIONS ANALYSIS – LEWIS AVENUE EXTENSION ALTERNATIVE (2025)

Ramp Junction	Number ^a of Lanes	AM Peak		PM Peak	
		Density ^d	LOS	Density ^d	LOS
Eastbound					
Cliff Ave off-ramp	2 / 1	27.0	C	21.6	C
Cliff Ave on-ramp	2 / 1	25.9	C	27.3	C
<i>with auxiliary lane (lane add)</i>	2 / 1	24.3	C	25.7	C
I-90 EB to I-229 SB off-ramp	2 / 1	25.4	C	27.1	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	18.2	B	18.8	B
I-229 NB to I-90 EB on-ramp	2 / 1	21.5	C	27.6	C
<i>with auxiliary lane (lane add)</i>	2 / 1	19.9	B	26.0	C
Timberline Ave off-ramp	2 / 1	20.6	C	27.7	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	14.3	B	18.4	B
Timberline Ave on-ramp	2 / 1	14.7	B	23.2	C
Westbound					
Timberline Ave off-ramp	2 / 1	27.7	C	18.1	B
Timberline Ave on-ramp	2 / 1	29.5	D	25.2	C
<i>with auxiliary lane (lane add)</i>	2 / 1	27.9	C	23.6	C
I-90 WB to I-229 SB off-ramp	2 / 1	27.8	C	22.9	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	20.3	C	16.4	B
I-229 NB to I-90 WB on-ramp	2 / 1	27.8	C	25.3	C
<i>with auxiliary lane (lane add)</i>	2 / 1	25.9	C	23.4	C
Cliff Ave off-ramp	2 / 1	29.6	D	26.6	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	19.4	B	16.9	B
Cliff Ave on-ramp	2 / 1	26.6	C	28.3	D
Northbound					
Benson Rd off-ramp	3 / 1	29.5	D	17.7	B
Benson Rd loop off-ramp (<i>lane drop</i>)	3 / 1	24.5	C	15.2	B
Benson Rd on-ramp	2 / 1	22.1	C	23.6	C
I-229 NB to I-90 EB off-ramp (<i>lane drop</i>)	2 / 1	18.1	B	19.9	B
Southbound					
I-90 WB to I-229 SB loop on-ramp (<i>lane add</i>)	2 / 1	n/a	n/a	n/a	n/a
I-90 EB to I-229 SB on-ramp	2 / 1	25.9	C	21.0	C
Benson Rd off-ramp	2 / 1	25.6	C	20.2	C
Benson Rd loop on-ramp (<i>lane add</i>)	2 / 1	22.2	C	20.2	C
Benson Rd on-ramp	3 / 1	18.8	B	26.5	C

Notes:

a – 2 / 1 = number of freeway lanes / number of ramp lanes

b – Ramp junction is part of a weave section; ramp junction analysis results are approximate.

c – Ramp junction is classified as a major diverge junction; ramp junction analysis results are approximate.

d – Density in passenger cars per mile per lane (pc/mi/lane) is the ramp junction level of service criteria.

See Figure 23 for graphical representation of LOS.

TABLE 19: RAMP JUNCTION OPERATIONS ANALYSIS – FULL DIRECTIONAL INTERCHANGE ALTERNATIVE (2025)

Ramp Junction	Number ^a of Lanes	AM Peak		PM Peak	
		Density ^d	LOS	Density ^d	LOS
Eastbound					
Cliff Ave off-ramp	2 / 1	26.0	C	19.5	B
Cliff Ave on-ramp	2 / 1	25.2	C	25.7	C
<i>with auxiliary lane (lane add)</i>	2 / 1	23.6	C	24.2	C
I-90 EB to I-229 SB off-ramp	2 / 1	24.7	C	25.4	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	17.5	B	17.3	B
I-229 NB to I-90 EB on-ramp	2 / 1	21.5	C	27.6	C
<i>with auxiliary lane (lane add)</i>	2 / 1	19.9	B	26.0	C
Timberline Ave off-ramp	2 / 1	20.6	C	27.7	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	14.3	B	18.4	B
Timberline Ave on-ramp	2 / 1	14.7	B	23.2	C
Westbound					
Timberline Ave off-ramp	2 / 1	27.7	C	18.1	B
Timberline Ave on-ramp	2 / 1	29.5	D	25.2	C
<i>with auxiliary lane (lane add)</i>	2 / 1	26.7	C	22.3	C
I-90 WB to I-229 SB off-ramp	2 / 1	27.8	C	22.9	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	19.4	B	15.5	B
I-229 NB to I-90 WB on-ramp	2 / 1	27.0	C	25.9	C
<i>with auxiliary lane (lane add)</i>	2 / 1	25.1	C	24.0	C
Cliff Ave off-ramp	2 / 1	28.6	D	27.4	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	18.9	B	17.4	B
Cliff Ave on-ramp	2 / 1	25.4	C	28.8	D
Northbound					
Benson Rd off-ramp	3 / 1	28.2	D	19.3	B
Benson Rd loop off-ramp (<i>lane drop</i>)	3 / 1	23.7	C	16.3	B
Benson Rd on-ramp	2 / 1	29.4	D	29.5	D
<i>with auxiliary lane (lane add)</i>	2 / 1	26.6	C	26.6	C
60 th St off-ramp	2 / 1	28.7	D	28.9	D
<i>with auxiliary lane (lane drop)</i>	3 / 1	19.0	B	18.3	B
I-229 NB to I-90 EB off-ramp (<i>lane drop</i>)	2 / 1	17.1	B	20.6	C

TABLE 19: RAMP JUNCTION OPERATIONS ANALYSIS – FULL DIRECTIONAL INTERCHANGE ALTERNATIVE (2025) – CONT.

Ramp Junction	Number ^a of Lanes	AM Peak		PM Peak	
		Density ^d	LOS	Density ^d	LOS
<i>Southbound</i>					
I-90 WB to I-229 SB loop on-ramp (<i>lane add</i>)	2 / 1	n/a	n/a	n/a	n/a
I-90 EB to I-229 SB on-ramp	2 / 1	25.2	C	19.6	B
60 th St on-ramp	2 / 1	29.0	D	26.0	C
<i>with auxiliary lane (lane add)</i>	2 / 1	27.1	C	24.1	C
Benson Rd off-ramp	2 / 1	30.4	D	27.1	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	18.8	B	16.4	B
Benson Rd loop on-ramp (<i>lane add</i>)	2 / 1	26.4	C	26.1	C
Benson Rd on-ramp	3 / 1	19.6	B	26.2	C

Notes:

a – 2 / 1 = number of freeway lanes / number of ramp lanes

b – Ramp junction is part of a weave section; ramp junction analysis results are approximate.

c – Ramp junction is classified as a major diverge junction; ramp junction analysis results are approximate.

d – Density in passenger cars per mile per lane (pc/mi/lane) is the ramp junction level of service criteria.

See Figure 24 for graphical representation of LOS.

TABLE 20: RAMP JUNCTION OPERATIONS ANALYSIS – PARTIAL CLOVERLEAF WITH FLY-OVER INTERCHANGE ALTERNATIVE (2025)

Ramp Junction	Number ^a of Lanes	AM Peak		PM Peak	
		Density ^d	LOS	Density ^d	LOS
Eastbound					
Cliff Ave off-ramp	2 / 1	26.0	C	19.5	B
Cliff Ave on-ramp	2 / 1	25.2	C	25.7	C
<i>with auxiliary lane (lane add)</i>	2 / 1	23.6	C	24.2	C
I-90 EB to I-229 SB off-ramp	2 / 1	24.7	C	25.4	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	17.5	B	17.3	B
I-229 NB to I-90 EB on-ramp	2 / 1	21.5	C	27.6	C
<i>with auxiliary lane (lane add)</i>	2 / 1	19.9	B	26.0	C
Timberline Ave off-ramp	2 / 1	20.6	C	27.7	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	14.3	B	18.4	B
Timberline Ave on-ramp	2 / 1	14.7	B	23.2	C
Westbound					
Timberline Ave off-ramp	2 / 1	27.7	C	18.1	B
Timberline Ave on-ramp	2 / 1	29.5	D	25.2	C
<i>with auxiliary lane (lane add)</i>	2 / 1	26.7	C	22.3	C
I-90 WB to I-229 SB off-ramp	2 / 1	27.8	C	22.9	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	19.4	B	15.5	B
I-229 NB to I-90 WB on-ramp	2 / 1	27.0	C	25.9	C
<i>with auxiliary lane (lane add)</i>	2 / 1	25.1	C	24.0	C
Cliff Ave off-ramp	2 / 1	28.6	D	27.4	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	18.9	B	17.4	B
Cliff Ave on-ramp	2 / 1	25.4	C	28.8	D
Northbound					
Benson Rd off-ramp	3 / 1	28.2	D	19.3	B
Benson Rd loop off-ramp (<i>lane drop</i>)	3 / 1	23.7	C	16.3	B
Benson Rd on-ramp	2 / 1	29.4	D	29.5	D
<i>with auxiliary lane (lane add)</i>	2 / 1	26.6	C	26.6	C
60 th St off-ramp	2 / 1	28.7	D	28.9	D
<i>with auxiliary lane (lane drop)</i>	3 / 1	19.0	B	18.3	B
I-229 NB to I-90 EB off-ramp (<i>lane drop</i>)	2 / 1	17.1	B	20.6	C

TABLE 20: RAMP JUNCTION OPERATIONS ANALYSIS – PARTIAL CLOVERLEAF WITH FLY-OVER INTERCHANGE ALTERNATIVE (2025) – CONT.

Ramp Junction	Number ^a of Lanes	AM Peak		PM Peak	
		Density ^d	LOS	Density ^d	LOS
<i>Southbound</i>					
I-90 WB to I-229 SB loop on-ramp (<i>lane add</i>)	2 / 1	n/a	n/a	n/a	n/a
I-90 EB to I-229 SB on-ramp	2 / 1	25.2	C	19.6	B
60 th St on-ramp	2 / 1	29.0	D	26.0	C
<i>with auxiliary lane (lane add)</i>	2 / 1	27.1	C	24.1	C
Benson Rd off-ramp	2 / 1	30.4	D	27.1	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	18.8	B	16.4	B
Benson Rd loop on-ramp (<i>lane add</i>)	2 / 1	26.4	C	26.1	C
Benson Rd on-ramp	3 / 1	19.6	B	26.2	C

Notes:

a – 2 / 1 = number of freeway lanes / number of ramp lanes

b – Ramp junction is part of a weave section; ramp junction analysis results are approximate.

c – Ramp junction is classified as a major diverge junction; ramp junction analysis results are approximate.

d – Density in passenger cars per mile per lane (pc/mi/lane) is the ramp junction level of service criteria.

See Figure 25 for graphical representation of LOS.

SECTION TWO

Supporting Traffic Evaluations

TABLE 21: RAMP JUNCTION OPERATIONS ANALYSIS – FULL CLOVERLEAF INTERCHANGE WITH 60TH STREET HALF DIAMOND ALTERNATIVE (2025)

Ramp Junction	Number ^a of Lanes	AM Peak		PM Peak	
		Density ^d	LOS	Density ^d	LOS
Eastbound					
Cliff Ave off-ramp	2 / 1	27.3	C	20.9	C
Cliff Ave on-ramp	2 / 1	26.1	C	26.9	C
<i>with auxiliary lane (lane add)</i>	2 / 1	24.6	C	25.3	C
I-90 EB to I-229 SB off-ramp	2 / 1	25.7	C	26.6	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	18.2	B	18.2	B
I-229 SB to I-90 EB loop on-ramp (lane add) ^b	2 / 1	14.6	B	17.1	B
I-90 EB to I-229 NB loop off-ramp (lane drop) ^b	3 / 1	9.2	A	11.3	B
I-229 NB to I-90 EB on-ramp	2 / 1	21.1	C	26.8	C
<i>with auxiliary lane (lane add)</i>	2 / 1	18.3	B	23.9	C
Timberline Ave off-ramp	2 / 1	20.1	C	26.8	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	13.8	B	17.6	B
Timberline Ave on-ramp	2 / 1	14.7	B	23.2	C
Westbound					
Timberline Ave off-ramp	2 / 1	27.7	C	18.1	B
Timberline Ave on-ramp	2 / 1	29.1	D	24.8	C
<i>with auxiliary lane (lane add)</i>	2 / 1	26.3	C	22.0	C
I-90 WB to I-229 NB off-ramp	2 / 1	29.1	D	24.2	C
<i>with auxiliary lane (lane drop) and C-D road</i>	3 / 1	20.2	C	16.4	B
I-229 NB to I-90 WB loop-on-ramp (lane add) ^{b, e}	2 / 1	38.0	F	31.8	D
I-90 WB to I-229 SB loop off-ramp (lane drop) ^{b, e}	3 / 1	39.0	F	32.1	D
I-229 SB to I-90 WB on-ramp	2 / 1	31.3	D	27.8	C
<i>with auxiliary lane (lane add) and C-D road</i>	2 / 1	27.8	C	24.4	C
Cliff Ave off-ramp	2 / 1	31.1	D	27.1	C
<i>with auxiliary lane (lane drop)</i>	3 / 1	20.3	C	17.2	B
Cliff Ave on-ramp	2 / 1	27.3	C	28.8	D
Northbound					
Benson Rd off-ramp	3 / 1	28.3	D	18.6	B
Benson Rd loop off-ramp (lane drop)	3 / 1	23.8	C	15.5	B
Benson Rd on-ramp	2 / 1	29.6	D	28.8	D
<i>with auxiliary lane (lane add)</i>	2 / 1	26.8	C	26.0	C

TABLE 21: RAMP JUNCTION OPERATIONS ANALYSIS – FULL CLOVERLEAF INTERCHANGE WITH 60TH STREET HALF DIAMOND ALTERNATIVE (2025) – CONT.

Ramp Junction	Number ^a of Lanes	AM Peak		PM Peak	
		Density ^d	LOS	Density ^d	LOS
60 th St off-ramp	2 / 1	29.0	D	28.2	D
<i>with auxiliary lane (lane drop)</i>	3 / 1	18.7	B	17.4	B
I-229 NB to I-90 EB off-ramp	2 / 1	21.6	C	24.5	C
I-90 EB to I-229 NB loop on-ramp (<i>lane add</i>) ^b	2 / 1	16.0	B	15.2	B
I-229 NB to I-90 WB loop off-ramp (<i>lane drop</i>) ^b	3 / 1	13.8	B	13.6	B
I-90 WB to NB I-229 on-ramp	2 / 1	7.0	A	8.1	A
<i>Southbound</i>					
I-229 SB to I-90 WB off-ramp	2 / 1	6.1	A	5.4	A
I-90 WB to I-229 SB loop on-ramp (<i>lane add</i>) ^b	2 / 1	15.4	B	12.2	B
I-229 SB to I-90 EB loop off-ramp (<i>lane drop</i>) ^b	3 / 1	14.9	B	11.2	B
I-90 EB to I-229 SB on-ramp	2 / 1	27.2	C	22.4	C
60 th St on-ramp	2 / 1	28.9	D	27.0	C
<i>with auxiliary lane (lane add)</i>	2 / 1	27.6	C	25.7	C
Benson Rd off-ramp	2 / 1	30.1	D	28.8	D
<i>with auxiliary lane (lane drop)</i>	3 / 1	18.6	B	17.4	B
Benson Rd loop on-ramp (<i>lane add</i>)	2 / 1	26.1	C	27.4	C
Benson Rd on-ramp	3 / 1	19.4	B	27.0	C

Notes:

- a – 2 / 1 = number of freeway lanes / number of ramp lanes
- b – Ramp junction is part of a weave section; ramp junction analysis results are approximate.
- c – Ramp junction is classified as a major diverge junction; ramp junction analysis results are approximate.
- d – Density in passenger cars per mile per lane (pc/mi/lane) is the ramp junction level of service criteria.
- e – The lane configuration for this ramp junction under the C-D roadway alternative cannot be analyzed using HCM methodologies.

See Figure 26 for graphical representation of LOS.

TABLE 22. WEAVING SECTION ANALYSIS – FULL CLOVERLEAF INTERCHANGE ALTERNATIVE (2025)

Weave Section	Peak Hour	Density ^a	Speed ^b	LOS
Eastbound I-90	AM	7.9	58/68	A
	PM	9.9	55/65	A
Westbound I-90 ^c	AM	53.1	24/42	F
	PM	39.3	26/47	E
Northbound I-229	AM	18.8	29/52	B
	PM	17.4	30/53	B
Southbound I-229	AM	18.8	29/52	B
	PM	12.1	34/59	B

Notes:

- a – Density in passenger cars per mile per lane (pc/mi/ln) is the basic freeway LOS criteria.
- b – Free flow speed is assumed to be 70 mph and the values shown in the table is the speeds for “weave / non-weave” vehicles.
- c – A C-D road system for westbound I-90 would remove the weaving segment from I-90 mainline.
See Figure 22 for graphical representation of LOS.

TABLE 23. WEAVING SECTION ANALYSIS – FULL CLOVERLEAF INTERCHANGE WITH 60TH STREET HALF DIAMOND ALTERNATIVE (2025)

Weave Section	Peak Hour	Density ^a	Speed ^b	LOS
Eastbound I-90	AM	7.9	58/68	A
	PM	9.9	55/65	A
Westbound I-90 ^c	AM	53.1	24/42	F
	PM	39.3	26/47	E
Northbound I-229	AM	18.5	29/52	B
	PM	17.1	30/53	B
Southbound I-229	AM	18.5	29/52	B
	PM	11.8	34/59	B

Notes:

- a – Density in passenger cars per mile per lane (pc/mi/ln) is the basic freeway LOS criteria.
- b – Free flow speed is assumed to be 70 mph and the values shown in the table is the speeds for “weave / non-weave” vehicles.
- c – A C-D road system for westbound I-90 would remove the weaving segment from I-90 mainline.
See Figure 26 for graphical representation of LOS.

TABLE 24: INTERSECTION OPERATIONS ANALYSIS – FULL CLOVERLEAF INTERCHANGE ALTERNATIVE (2025)

Intersection	Peak Period	Intersection Approach				Overall
		Eastbound	Westbound	Northbound	Southbound	
		Delay / LOS	Delay / LOS	Delay / LOS	Delay / LOS	Delay / LOS
Cliff Ave @ I-90 Ramps	AM	27.4 / C	45.7 / D	27.2 / C	32.3 / D	34.5 / C
	PM	28.3 / C	29.8 / C	18.3 / B	25.4 / C	22.2 / C
Timberline Ave@ I-90 EB Ramp ^a	AM	* / F	--	n/a	n/a	n/a
	PM	* / F	--	n/a	n/a	n/a
Timberline Ave@ I-90 WB Ramp ^a	AM	--	* / F	n/a	n/a	n/a
	PM	--	* / F	n/a	n/a	n/a
Benson Rd @ I-229 NB Ramp	AM	10.7 / B	9.8 / A	6.5 / A	--	8.9 / A
	PM	17.1 / B	2.9 / A	9.7 / A	--	11.7 / B
Benson Rd @ I-229 SB Ramp	AM	2.8 / A	18.8 / B	--	30.8 / C	17.0 / B
	PM	3.8 / A	2.5 / A	--	12.6 / B	3.9 / A

Notes:

a – Assumed to remain an unsignalized intersection.

Control delay in (seconds/vehicle) is the intersection level of service criteria.

I-90/Cliff Avenue interchange assumed to be a single-point urban interchange.

See Figure 22 for graphical representation of LOS.

TABLE 25: INTERSECTION OPERATIONS ANALYSIS – LEWIS AVENUE EXTENSION ALTERNATIVE (2025)

Intersection	Peak Period	Intersection Approach				Overall
		Eastbound	Westbound	Northbound	Southbound	
		Delay / LOS	Delay / LOS	Delay / LOS	Delay / LOS	Delay / LOS
Cliff Ave @ I-90 Ramps	AM	27.4 / C	45.5 / D	27.8 / C	31.2 / C	34.0 / C
	PM	29.0 / C	29.8 / C	18.3 / B	25.4 / C	22.4 / C
Timberline Ave@ I-90 EB Ramp ^a	AM	* / F	--	n/a	n/a	n/a
	PM	* / F	--	n/a	n/a	n/a
Timberline Ave@ I-90 WB Ramp ^a	AM	--	* / F	n/a	n/a	n/a
	PM	--	* / F	n/a	n/a	n/a
Benson Rd @ I-229 NB Ramp	AM	10.6 / B	10.1 / B	6.8 / A	--	9.1 / A
	PM	5.3 / A	13.0 / B	6.8 / A	--	8.0 / A
Benson Rd @ I-229 SB Ramp	AM	2.5 / A	33.8 / C	--	31.7 / C	26.6 / C
	PM	7.3 / A	2.1 / A	--	10.6 / B	6.1 / A
Lewis Ave @ 60 th St	AM	27.2 / C	26.8 / C	25.0 / C	17.3 / B	24.7 / C
	PM	35.8 / D	51.9 / D	26.8 / C	60.9 / E	46.1 / D
Lewis Ave @ 66 th St	AM	n/a	n/a	39.1 / E	--	n/a
	PM	n/a	n/a	71.9 / F	--	n/a

Notes:

a – Assumed to remain an unsignalized intersection.

Control delay in (sec/vehicle) is the intersection level of service criteria.

I-90/Cliff Avenue interchange assumed to be a single-point urban interchange.

See Figure 23 for graphical representation of LOS.

TABLE 26: INTERSECTION OPERATIONS ANALYSIS - FULL DIRECTIONAL AND THE PARTIAL CLOVERLEAF WITH FLY-OVER INTERCHANGE ALTERNATIVES (2025)

Intersection	Peak Period	Intersection Approach				Overall
		Eastbound	Westbound	Northbound	Southbound	Delay / LOS
		Delay / LOS	Delay / LOS	Delay / LOS	Delay / LOS	
Cliff Ave @ I-90 Ramps	AM	27.4 / C	45.7 / D	27.2 / C	32.3 / C	34.5 / C
	PM	29.0 / C	29.8 / C	18.9 / B	25.6 / C	22.8 / C
Timberline Ave @ I-90 EB Ramp ^a	AM	* / F	--	n/a	n/a	n/a
	PM	* / F	--	n/a	n/a	n/a
Timberline Ave @ I-90 WB Ramp ^a	AM	--	* / F	n/a	n/a	n/a
	PM	--	* / F	n/a	n/a	n/a
60 th St @ I-229 NB Ramp	AM	23.5 / C	16.4 / B	35.4 / D	--	24.4 / C
	PM	10.8 / B	34.3 / C	29.1 / C	--	24.6 / C
60 th St @ I-229 SB Ramp	AM	34.5 / C	10.5 / B	--	27.9 / C	24.6 / C
	PM	13.9 / B	16.0 / B	--	30.7 / C	17.0 / B
Benson Rd @ I-229 NB Ramp	AM	15.5 / B	7.3 / A	6.2 / A	--	7.9 / A
	PM	4.8 / A	12.8 / B	11.0 / B	--	8.0 / A
Benson Rd @ I-229 SB Ramp	AM	3.3 / A	8.2 / A	--	22.3 / C	9.2 / A
	PM	2.7 / A	2.9 / A	--	10.0 / B	3.3 / A

Notes:

a – Assumed to remain an unsignalized intersection.

Control delay in (sec/vehicle) is the intersection level of service criteria.

I-90/Cliff Avenue interchange assumed to be a single-point urban interchange.

See Figures 24 and 25 for graphical representation of LOS.

TABLE 27: INTERSECTION OPERATIONS ANALYSIS - FULL CLOVERLEAF INTERCHANGE WITH 60TH STREET HALF DIAMOND ALTERNATIVE (2025)

Intersection	Peak Period	Intersection Approach				Overall
		Eastbound	Westbound	Northbound	Southbound	Delay / LOS
		Delay / LOS	Delay / LOS	Delay / LOS	Delay / LOS	
Cliff Ave @ I-90 Ramps	AM	27.4 / C	45.5 / D	27.8 / C	31.2 / C	34.0 / C
	PM	28.3 / C	29.8 / C	18.1 / B	25.3 / C	22.0 / C
Timberline Ave @ I-90 EB Ramp ^a	AM	* / F	--	n/a	n/a	n/a
	PM	* / F	--	n/a	n/a	n/a
Timberline Ave @ I-90 WB Ramp ^a	AM	--	* / F	n/a	n/a	n/a
	PM	--	* / F	n/a	n/a	n/a
60 th St @ I-229 NB Ramp	AM	19.6 / B	11.8 / B	24.5 / C	--	18.4 / B
	PM	9.2 / A	12.1 / B	15.3 / B	--	11.6 / B
Benson Rd @ I-229 NB Ramp	AM	15.5 / B	7.3 / A	6.2 / A	--	7.9 / A
	PM	6.1 / A	12.7 / B	8.3 / A	--	8.4 / A
Benson Rd @ I-229 SB Ramp	AM	3.3 / A	8.2 / A	--	22.3 / C	9.2 / A
	PM	3.4 / A	3.1 / A	--	12.0 / B	4.0 / A

Notes:

a – Assumed to remain an unsignalized intersection.

Control delay in (sec/vehicle) is the intersection level of service criteria.

I-90/Cliff Avenue interchange assumed to be a single-point urban interchange.

See Figure 26 for graphical representation of LOS.

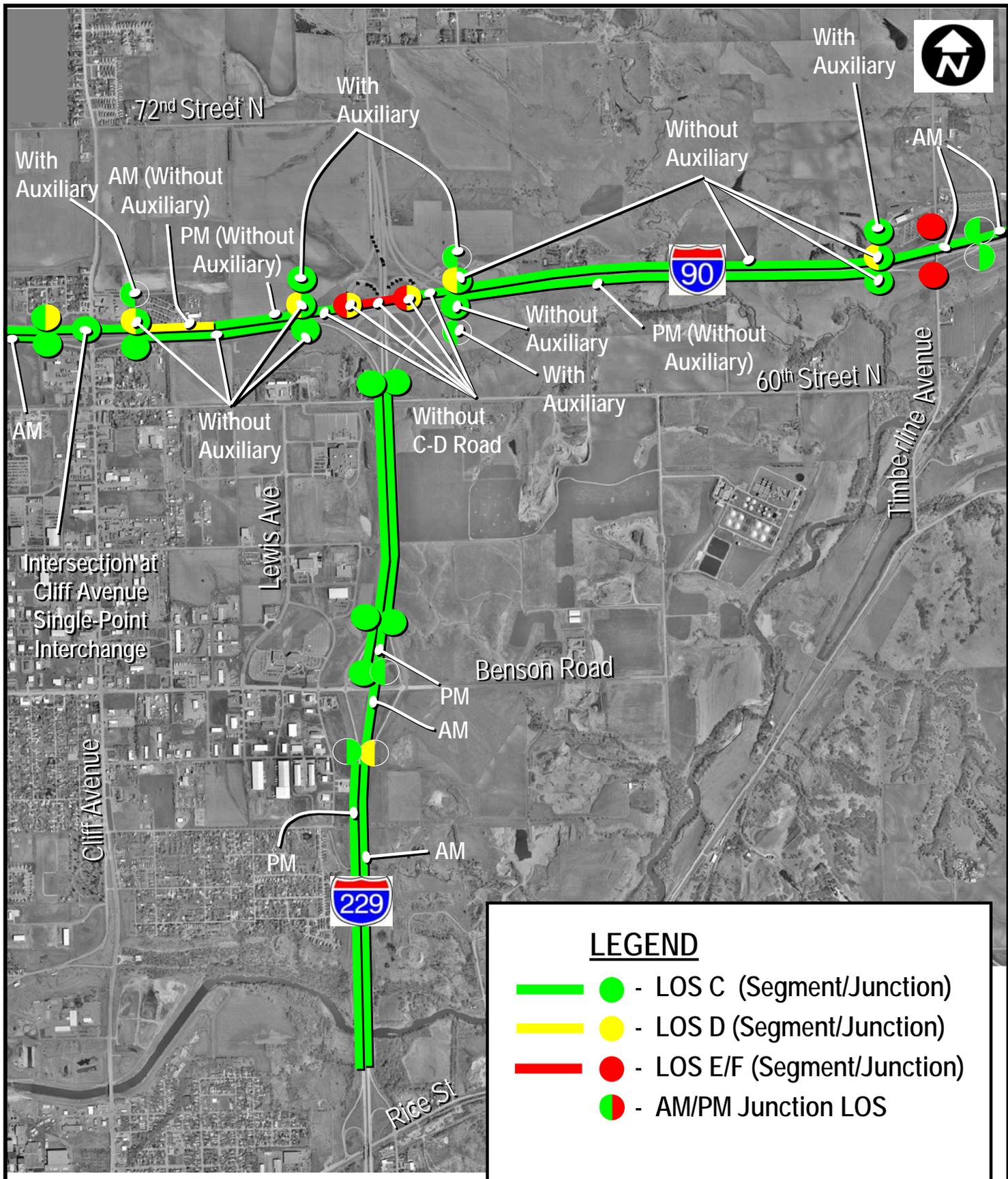


FIGURE 22. I-90/I-229 Traffic Operations Summary, Future Cloverleaf Alternative Conditions

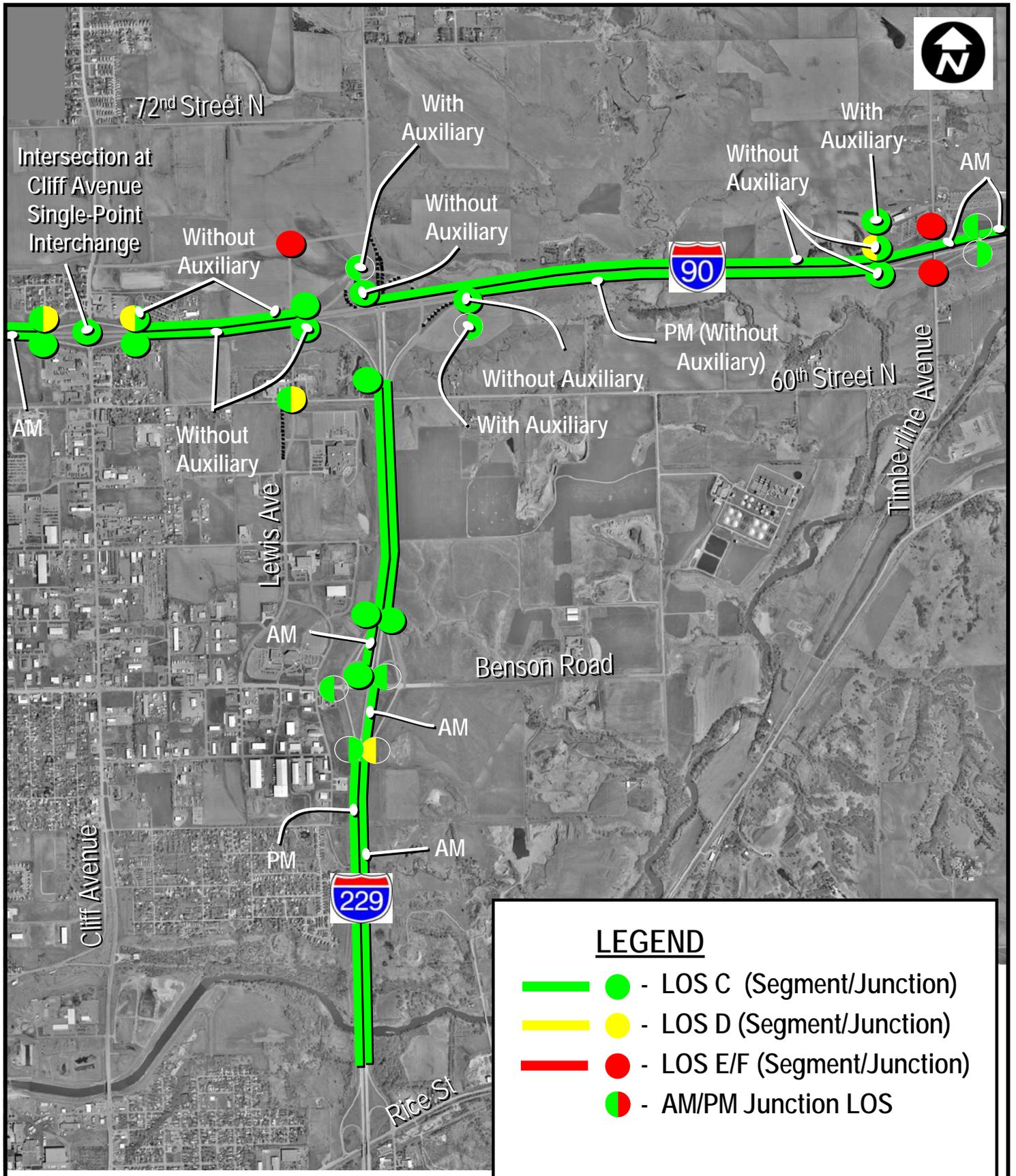


FIGURE 23. I-90/I-229 Traffic Operations Summary, Future Lewis Avenue Extension Alternative Conditions

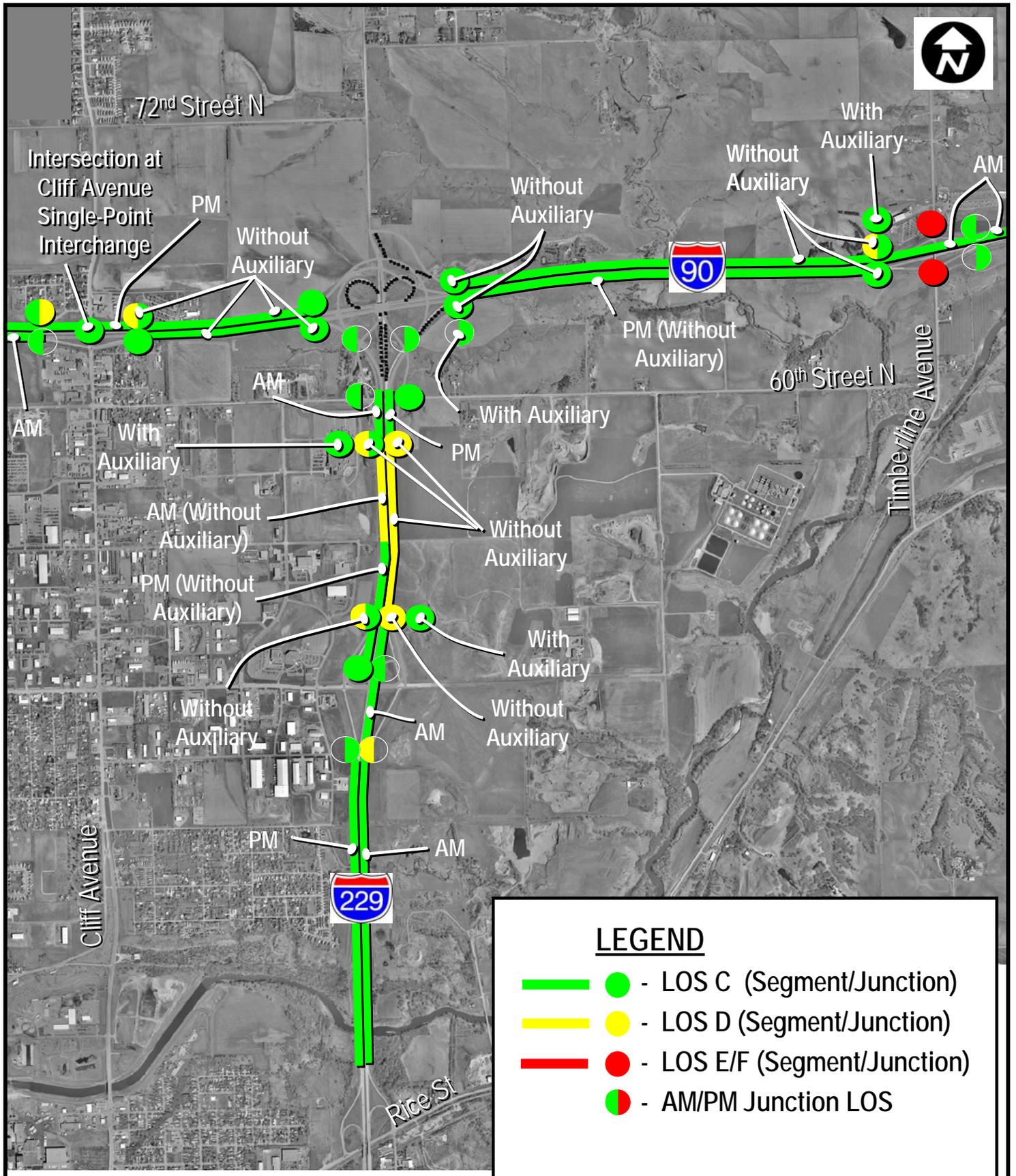


FIGURE 24. I-90/I-229 Traffic Operations Summary, Future Full Directional Interchange Alternative Conditions

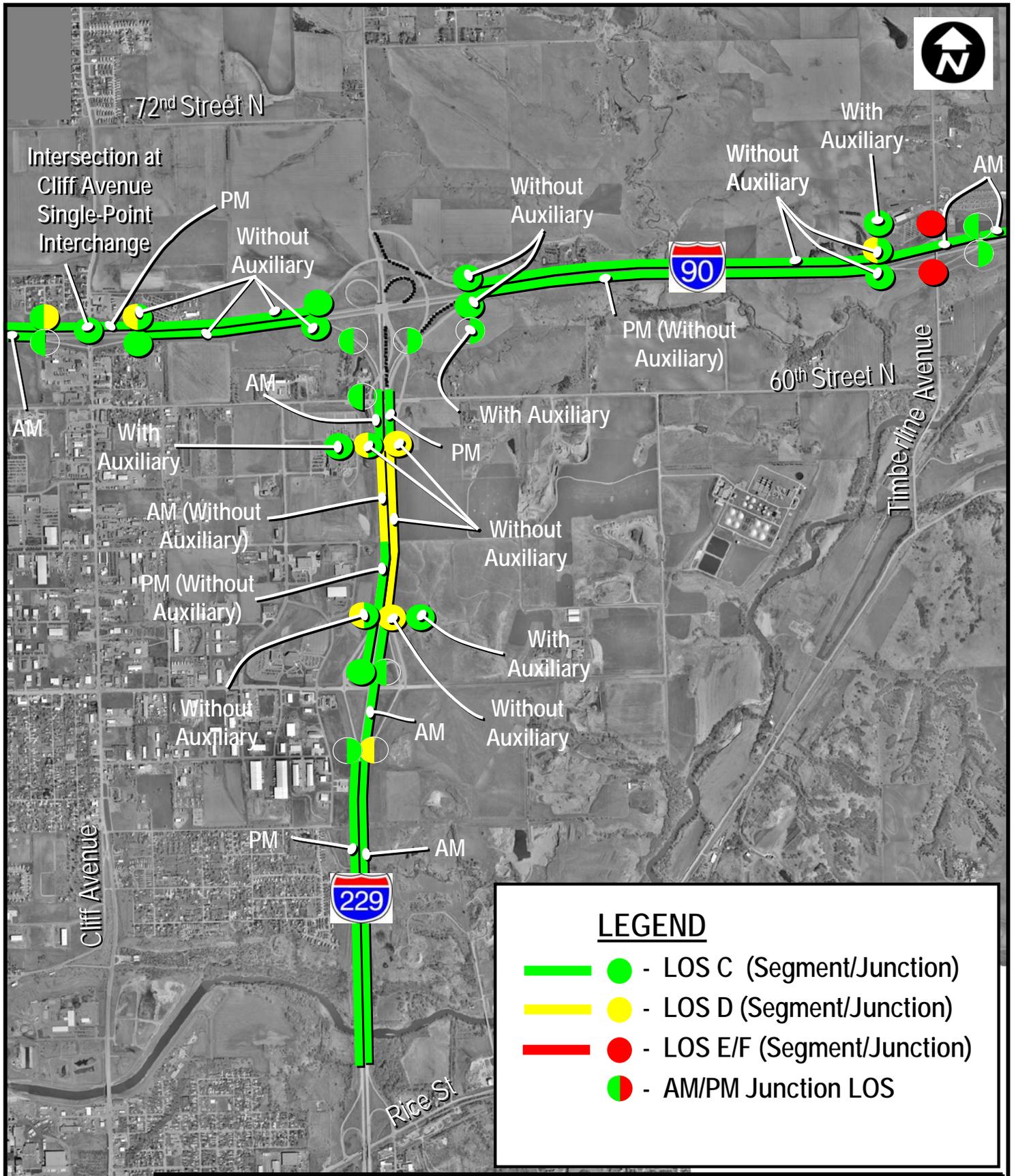


FIGURE 25. I-90/I-229 Traffic Operations Summary, Future Partial Cloverleaf with Fly-Over Interchange Alternative Conditions

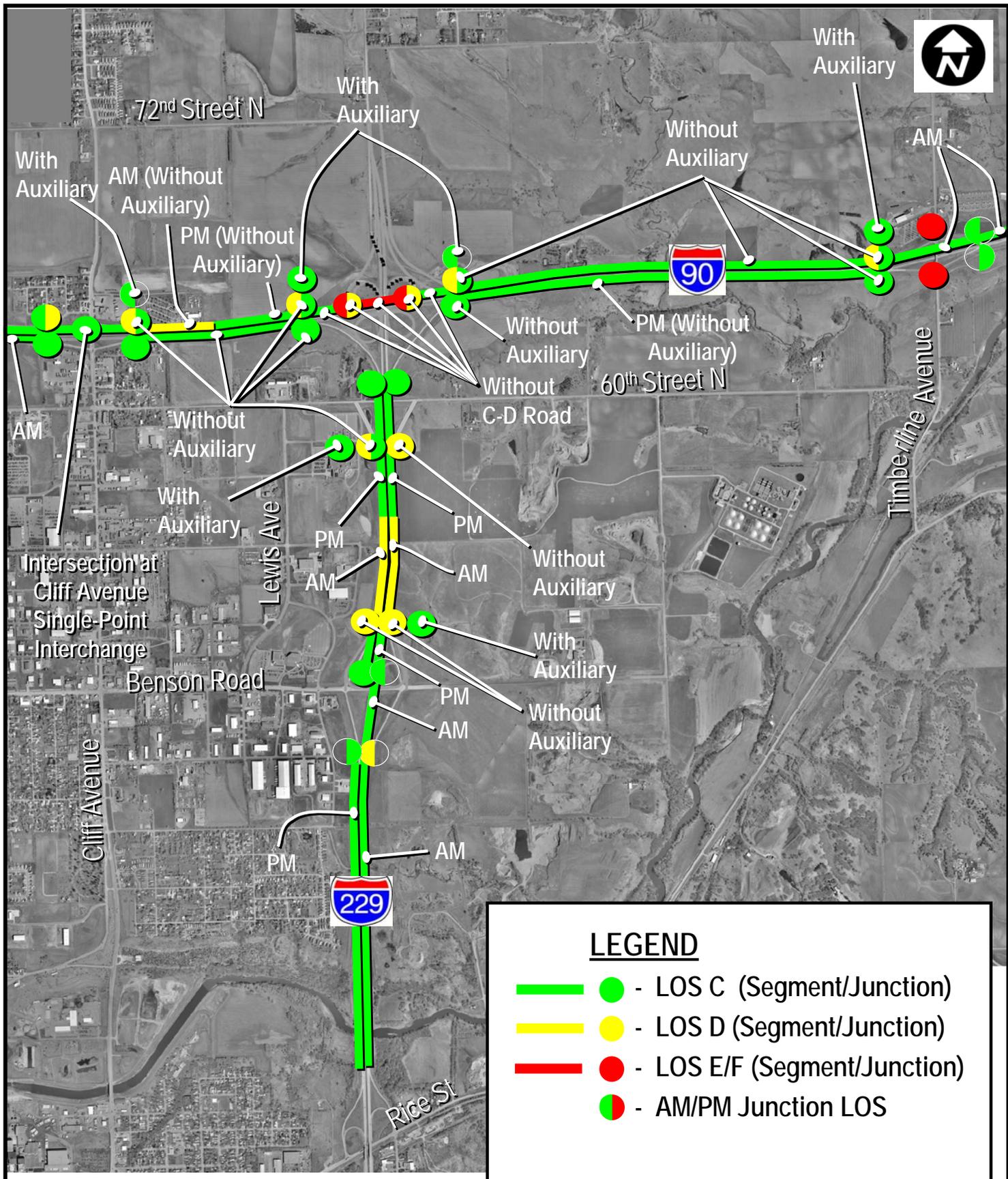


FIGURE 26. I-90/I-229 Traffic Operations Summary, Future Cloverleaf - 60th Half Diamond Alternative Conditions

A summary of the key findings of the traffic operation analyses is provided below:

- The I-90 interchange at Cliff Avenue was assumed to be an improved single point urban interchange for the purposes of this analysis. The I-90/Timberline Avenue interchange lane configuration is assumed to be unchanged for the purposes of this analysis.
- The current four-lane I-90 is projected to result in several ramp junctions operating at or beyond the LOS C/D threshold. The addition of a third “auxiliary” lane between the I-90 interchanges results in significantly improved LOS for freeway operations.
- In some cases, the ramp junction analyses with auxiliary lane do not show a substantial reduction in delay or improvement in the LOS. For this particular lane configuration (i.e., lane addition at an on-ramp) the HCM methodologies underestimate the benefits of an auxiliary lane for ramp junction operations.
- All five of the Build scenarios result in decreased traffic volumes on Cliff Avenue and a reduction in travel delays.
- Traffic volumes on Benson Road decrease under four out of the five Build scenarios with traffic increasing under the Lewis Avenue Extension scenario.
- The new 60th Street interchange ramp terminal intersections are projected to require traffic signalization in order to accommodate the forecasted traffic volumes. The forecasted traffic volumes for 60th Street will require a minimum of four lanes.
- The 60th Street and Lewis Avenue intersection is projected to require traffic signalization in order to accommodate the forecasted traffic volumes. The intersection of 66th Street and Lewis Avenue was analyzed as a stop-controlled intersection.
- The full cloverleaf design for I-90/I-229 results in multiple ramp junctions and weaving sections within a short distance along the mainline freeways. For westbound I-90, all of the ramp junctions are projected to operate at LOS D or worse and the weaving section between the loop ramps at LOS F. All other freeway mainlines at this interchange are projected to LOS C or better for ramp junctions and weaving sections. To address the operation deficiencies along westbound I-90 it is recommended that a collector-distributor (C-D) roadway be constructed along that segment in order to remove most of the merging/diverging and weaving movements from the I-90 mainline. With the C-D roadway in place the LOS for mainline I-90 ramp junctions are projected to improve to LOS C or better.
- The majority of the intersections are projected to operate at LOS C or better. The Timberline Avenue intersections have current lane configurations that will be over capacity by a significant amount for the projected traffic volumes.

3.1 PROJECT PURPOSE

The SDDOT in cooperation with the City of Sioux Falls and the Sioux Falls MPO have initiated an assessment of the infrastructure needs for the I-90/I-229 Interchange. The purpose of the I-90/I-229 Interstate Access Modification Request is to review alternatives that provide additional access to/from I-229 and I-90, while maintaining the desired level of service (LOS). Since this interchange is a junction of two interstates, it is an important feature of the Sioux Falls regional transportation system. For the system to function properly all components need to be operating within design specifications

3.2 FHWA ASSESSMENT REQUIREMENTS

This Interstate Access Modification Request documents the information needed for FHWA and SDDOT staff to make an informed decision regarding the concept of modifying the I-90/I-229 interchange and providing additional access to these interstates. Much of the information presented in this document describes the analysis completed, particularly as it relates to the eight FHWA requirements documented in Section 1.3. This section documents the impacts of improving an interchange relative to each of the requirements. The documentation includes the review of two scenarios:

- **No-Build Scenario:** This condition assumes that no changes to the existing interchange would be made. For the purposes of developing the travel forecasts for this study, the No-Build Scenario assumes complete 2025 land development scenario identified by the Sioux Falls Planning Department.
- **Build Scenario:** This condition assumes that the 2025 land development scenario, a modified/improved I-90/I-229 interchange is provided, and additional access to I-90 and I-229 are provided.

3.2.1 Requirement 1

The existing interchanges and/or local roads and streets in the corridor can neither provide the necessary access nor be improved to satisfactorily accommodate the design-year traffic demands while at the same time providing the access intended by the proposal.

To evaluate the interchange improvement scenarios in relation to Requirement 1, accessibility and 2025 No-Build scenario traffic operations analysis were reviewed and documented in this section.

Study Area Access

The Sioux Falls Planning Department is projecting that northeastern Sioux Falls will experience extensive development (both residential and commercial/industrial in the later part of the current 20 year planning horizon. The I-90/I-229 interchange and the other study area interchanges are expected to be primary regional access points to this developing area. The Cliff Avenue and Benson Road corridors currently experience congestion during peak periods and congestion is projected to worsen.

As shown in Table 28, the growth in housing and employment within the study area are projected to grow at a faster rate than for the entire Sioux Falls region. A significant amount of the projected growth in housing slated for the areas north of the I-90/Cliff Avenue and east of the I-229/Benson Road interchanges. As is documented in the Sioux Falls MPO and City of Sioux Falls land use planning documents, several subareas within the I-90/I-229 study area are anticipated to experience significant growth in employment resulting from commercial and industrial land use development. The projected growth in housing and employment are shown in Figures 27 and 28. Development within this study area has the potential to benefit from an access perspective from additional access proposed in the Build scenarios.

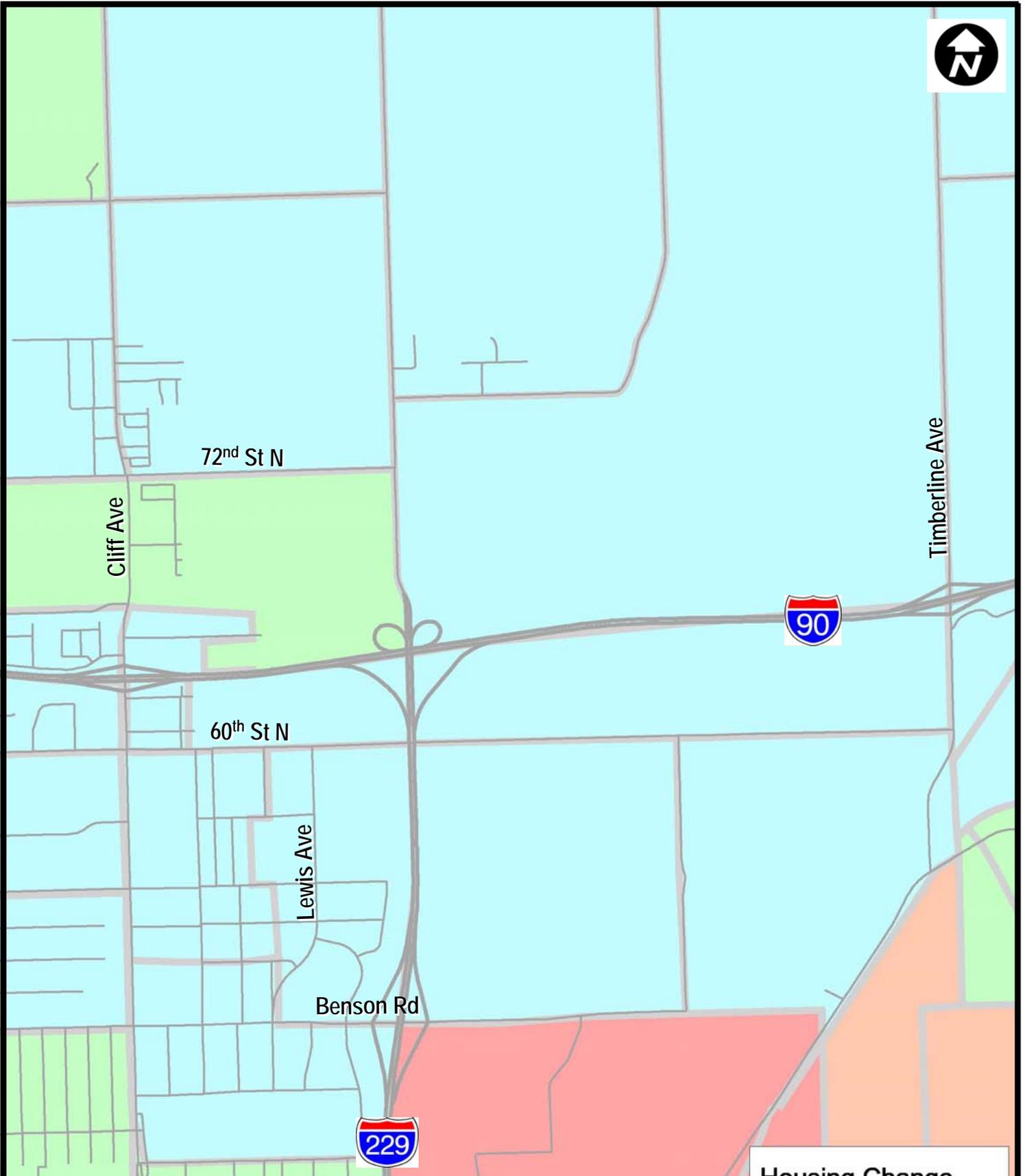
TABLE 28: PROJECTED SOCIOECONOMIC GROWTH, SIOUX FALLS MODEL, 2000 TO 2025

Evaluation Area	2000		2025		Percent Change	
	Dwelling Units	Total Employment	Dwelling Units	Total Employment	Dwelling Units	Total Employment
I-90/I-229 Interchange Study Area	679	14,099	2,628	33,144	287%	135%
Entire Sioux Falls Region	66,279	99,415	134,534	181,161	103%	82%

No-Build 2025 Traffic Operations Results

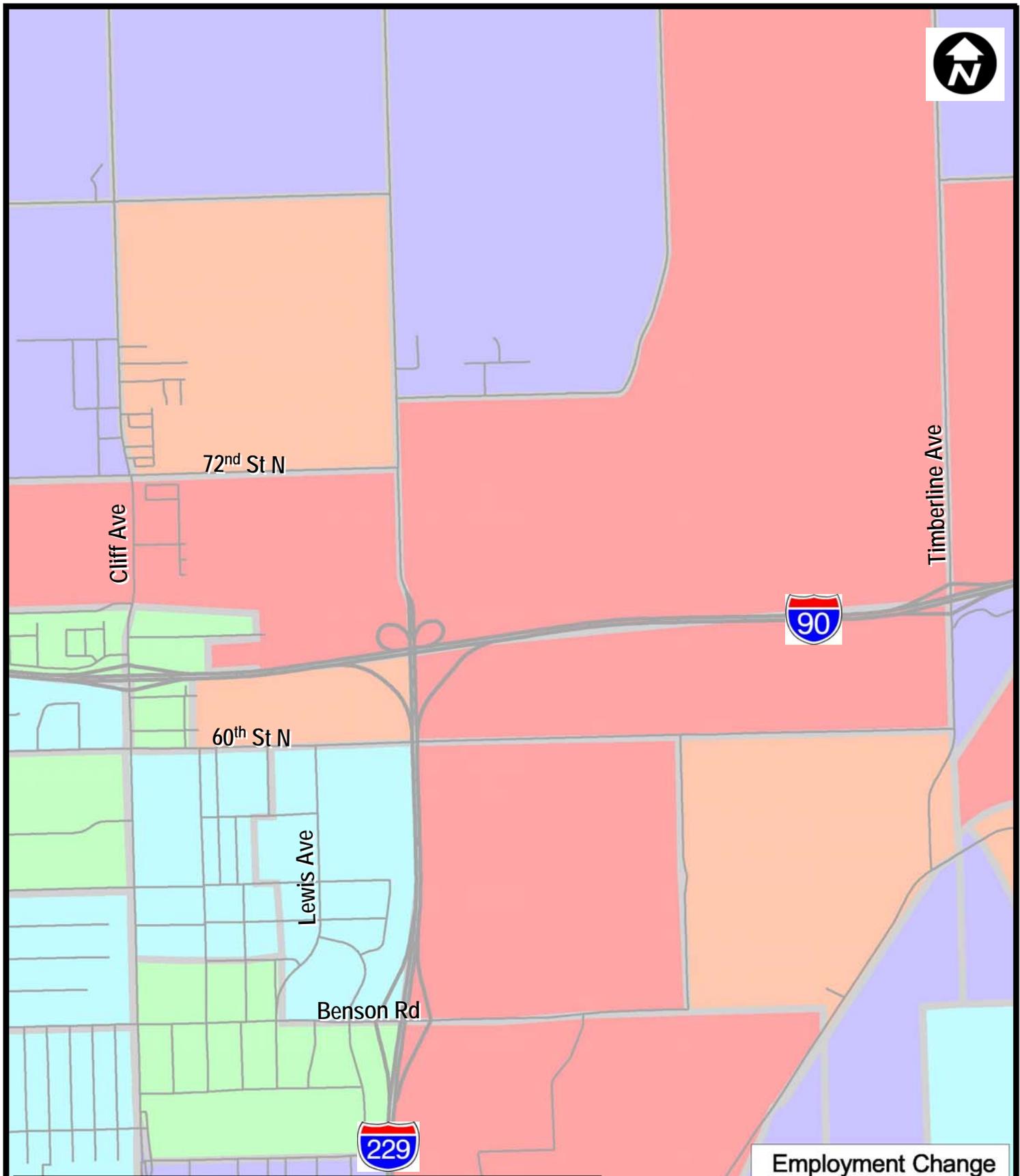
The current year and 2025 horizon year peak period traffic operations analysis associated with this access modification request identified several freeway segments and ramp junctions, and arterial intersection with traffic operations deficiencies. As shown in Figure 16 in Section 2.2.2, the study area intersections associated with all of the study area interchanges are projected to incur significantly more congestion through the planning horizon. Therefore, there is an identified need to increase the capacity of interchanges throughout the study area and/or develop alternatives that provide additional access to the freeways to assure the desired LOS on the freeways and intersections throughout the study area.

The evaluation of the feasibility addressing traffic operations concerns at the I-90/I-229 interchange by improving adjacent interchanges and/or arterial corridors completed for this study included a review of the origins-destinations of vehicle traveling through the interchange area. This evaluation was completed using the regional travel demand model and extracting the trip table for each of the approach links entering the interchange. Through the “selected link” analysis model, origins and destinations of every trip can be mapped and evaluated as to whether the trip could be served through an adjacent interchange or could be diverted to the adjacent arterial system should improvements to those interchanges or arterial routes be made.



**FIGURE 27. Projected Household Growth, 2000 to 2025
I-90/I-229 Study Area**





Employment Change	
	50 or Less
	51 - 200
	201 - 500
	501 - 1000
	1001 or More

**FIGURE 28. Projected Employment Growth, 2000 to 2025
I-90/I-229 Study Area**

Trips were considered candidates for diversion from the system interchange if:

- The trip was forecasted to travel through the I-90/I-229 interchange in the 2025 no-build scenario.
- The trip had either an origin or destination that would use one of the contiguous service interchanges (Timberline Avenue, Benson Road or Cliff Avenue).
- The trip could have reasonably been assigned to a route that did not travel through the I-90/I-229 interchange.

The results of this evaluation are reported by approach in the following bullets.

- *Northbound I-229 Traffic:* It is estimated that approximately three (3) percent of traffic entering the system interchange from the south (or approximately 700 vehicles per day) could be diverted from the interchange if capacity improvements were made to adjacent interchanges and surface streets. There were two general origin-destination patterns for trips that were considered candidates for diversion from the northbound approach of the I-90/I-229 interchange:
 - Trips between Benson Road west of I-229 and the Cliff Avenue corridor north of I-90.
 - Trips between Benson Road east of I-229 and the Brandon area.
- *Eastbound I-90 Traffic:* It is estimated that approximately one (1) percent of traffic entering the system interchange from the west (or approximately 300 vehicles per day) could be diverted from the interchange if capacity improvements were made to adjacent interchanges and surface streets. There were two general origin-destination patterns for trips that were considered candidates for diversion from the eastbound approach of the I-90/I-229 interchange:
 - Trips between the Cliff Avenue corridor north of I-90 and Benson Road west of I-229.
 - Trips between the Cliff Avenue corridor and the Timberline Avenue corridor north of I-90.
- *Westbound I-90 Traffic:* It is estimated that approximately one (1) percent of traffic entering the system interchange from the east (or approximately 400 vehicles per day) could be diverted from the interchange if capacity improvements were made to adjacent interchanges and surface streets. There were two general origin-destination patterns for trips that were considered candidates for diversion from the westbound approach of the I-90/I-229 interchange:
 - Trips between the Brandon area and Benson Road east of I-229.
 - Trips between the Timberline Avenue corridor north of I-90 and the Cliff Avenue corridor.

Through this evaluation, it is concluded that the I-90/I-229 interchange provides unique access within the study area. As such, it is predicted that improvements to adjacent interchanges would

not provide a significant level of traffic diversion from the I-90/I-229 interchange and as a result would not improve the projected traffic operations deficiencies identified for the 2025 no-build conditions.

Based on the results of the selected link analysis, it is unlikely that any improvements made to the immediately adjacent interchanges or to the arterial system that supports the I-90 and I-229 corridors would result in a substantial diversion of traffic from this interchange. This conclusion is the expected result in that the I-90/I-229 interchange is a system interchange that serves longer trips in the region and trips that do or may use the adjacent interchanges must pass through the I-90/I-229 interchange to reach the adjacent interchanges.

In addition to traffic impacts, the geometric design of the existing I-90/I-229 interchange was evaluated as part of the *South Dakota Interstate Corridor Study: Phase I Report*. Several geometric design deficiencies of the I-90/I-229 Interchange were identified:

- Inslope for mainline and ramp junction.
- Superelevation rate for ramp roadway.
- Minimum radius for ramp roadway (i.e., loop ramps).
- Lane width on ramp roadway(s).
- On-ramp taper for ramp junction.

These deficiencies indicate that the I-90/I-229 Interchange has the following geometric design needs:

- The inslope (the slope from the shoulder of the road to the bottom of the ditch) needs to be flattened. For the mainline, the inslope should be no more than 6 horizontal to one vertical (6H:1V) and the inslope of the ramps should not exceed 4H:1V.
- The radius needs to be increased and made consistent throughout the loop ramp(s) in order to meet current design standards. The current design for the loop ramps at this interchange has superelevation rates of eight percent and this is too steep. The superelevation rate needs to be lowered for the loop ramps.
- The transition from the mainline to the interchange ramps needs to be improved. Generally, the ramps need to be lengthened to allow the sharpness of grade changes to be reduced, to allow the flattening of the grade on the ramps, and to allow the tapering of lanes to occur over a longer area.
- The lane widths of the ramp roadways need to be widened to satisfy current design standards.

3.2.2 Requirement 2

All reasonable alternatives for design options, location and transportation system management type improvements (such as ramp metering, mass transit, and HOV facilities) have been assessed and provided for if currently justified, or provisions are included for accommodating such facilities if a future need is identified.

The documentation included in the review of Requirement 2 contains a review of the alternatives assessment. Typically, alternative access modification concepts are developed which address the identified needs of a study area. In most access modification concept studies, the needs are based on upon identified access needs and/or traffic operations needs.

- In the case of the I-90/I-229 study area, the project need has been demonstrated from a traffic operations perspective. Peak hour traffic operations for 2025 under both the No-Build and Build scenarios include freeway facilities and intersections that are predicted to operate at LOS D or worse.
- The I-90/I-229 study area would benefit from improved system connectivity. To effectively improve study area access, the selected interchange concept should provide full connections to study area interstates.
- The I-90/I-229 study area is an important growth area for the City of Sioux Falls. Improved access levels and connectivity is important in supporting this growth.

Alternatives Assessment

Initially, five build alternatives were identified and evaluated in regard to their ability to satisfy the project's purpose and need. The range of alternatives considered for this evaluation included:

- Continued use of the existing interchange without any major redesign or capacity improvements (No Build).
- Identify and evaluate potential improvements for existing interchange(s) and/or identify potential for new access on I-229 (build). The range of Build alternatives considered include the following:
 - A full cloverleaf interchange at I-90/I-229.
 - Lewis Avenue extension across I-90 and an improved I-90/I-229 interchange.
 - Full directional interchange at I-90/I-229 and new access at I-229/60th Street.
 - An improved I-90/I-229 interchange and new access at I-229/60th Street.
 - A full cloverleaf interchange at I-90/I-229 and a half diamond at I-229/60th Street.

All of the above Build alternatives include improvements for the I-229/Benson Road interchange.

Multimodal options in this portion of the Sioux Falls metropolitan area would not likely address, to any significant extent, the traffic operations needs of the I-90 and I-229 corridors. Within the

Sioux Falls metropolitan area, transit use accounts for less than one percent of all work trips (US Census Bureau, Summary Tape File 3, 2000). The need for transportation system management type improvements were assessed and it was determined that these types of improvements would not be adequate. Thus, the alternatives evaluated have focused on the study area roadway system.

No-Build Alternative

The inability of the existing configuration and traffic control to address future traffic operations requires action to improve the operation of the interchange. The No-Build alternative is not a viable option.

Full Cloverleaf Interchange Alternative

The first Build alternative (Alternative 2) evaluated was a full cloverleaf interchange at I-90/I-229 with capacity improvements at the I-229/Benson Road interchange. This alternative is shown in Figure 17. This alternative provides full access to/from I-229, north of I-90. Other characteristics of this interchange alternative include:

- All of the on-ramps and off-ramps for this interchange will consist of single lane ramps at the ramp junctions.
- Auxiliary lanes will be required east and west of the I-90/I-229 interchange to achieve a LOS C or better.
- For westbound I-90 a C-D roadway will be required to achieve an acceptable LOS for the mainline I-90 ramp junctions. This C-D roadway will remove much of the merging/diverging and weaving movements from the freeway mainline.
- The addition of directional ramps in the northwest and northeast quadrants of the I-90/I-229 interchange will require some right-of-way (ROW) and also a shift in the horizontal alignment for 476th Avenue.
- At the modified I-229/Benson Road interchange the third lane should be continued north to the two new loop ramps.

The results of the year 2025 traffic operations analysis for the full cloverleaf interchange alternative, documented in Figure 22 in Section 2.2.4, are:

- Overall operations for freeway facilities are predicted to be generally acceptable for the full cloverleaf interchange configuration. The exceptions include the ramp junctions and weaving sections along westbound I-90. Auxiliary lanes on I-90 between the I-229 interchange and the Cliff Avenue and Timberline Avenue interchanges are needed to achieve an acceptable LOS.
- A C-D roadway along westbound I-90 through this interchange should provide acceptable LOS for mainline I-90.
- Overall, traffic volumes are reduced to some degree in the Cliff Avenue, Benson Road, and Timberline Avenue corridors and travel delays are also reduced.

Lewis Avenue Extension Alternative

This alternative (Alternative 3) does not provide additional access to either I-90 or I-229. Instead this alternative provides an arterial grade separated overcrossing at I-90/Lewis Avenue. This alternative also includes modifications at the I-90/I-229 interchange that include providing a fly-over ramp for the northbound I-229 to westbound I-90 movement and removes the connection between I-229 and 476th Avenue. This interchange alternative is shown in Figure 18. Other characteristics of this interchange alternative include:

- All of the on-ramps and off-ramps for this interchange will consist of single lane ramps at the ramp junctions.
- Auxiliary lanes will be required east and west of the I-90/I-229 interchange to achieve a LOS C or better.
- The northbound I-229 to westbound I-90 fly-over ramp eliminates the weaving segment on westbound I-90.
- This alternative includes a new east-west roadway (66th Street) between Cliff Avenue and 476th Avenue.
- The daily forecasts for year 2025 for 60th Street and 66th Street are 25,000 and 10,000 vehicles per day, respectively. A minimum of four lanes will be required for 60th Street and two lanes will be sufficient for 66th Street.
- The intersection of 60th Street/Lewis Avenue will require traffic signal control. Stop-sign control should be adequate for the intersection of 66th Street/Lewis Avenue, but traffic volumes would need to be monitored to determine if a traffic signal would be warranted at a later date.
- A slight horizontal alignment to the east for Lewis Avenue will allow this alternative to miss the Minnehaha County maintenance facility located at 60th Street and Lewis Avenue.
- The realignment of the ramps in the southeast quadrant of the I-90/I-229 interchange will require ROW.
- At the modified I-229/Benson Road interchange the third lane should be continued north to the two new loop ramps.

The results of the year 2025 traffic operations analysis for the Lewis Avenue extension alternative, documented in Figure 23 in Section 2.2.4, include:

- Overall operations for freeway facilities are predicted to be generally acceptable for this alternative. Auxiliary lanes on I-90 between the I-229 interchange and the Cliff Avenue and Timberline Avenue interchanges are needed to achieve an acceptable LOS.
- Operations at the intersections are predicted to be generally acceptable for this scenario.
- Overall, traffic volumes are reduced to some degree in the Cliff Avenue and Timberline Avenue corridors. Traffic volumes for the Benson Road corridor, west of I-229, are projected to increase somewhat with this alternative.

Full Directional Interchange Alternative

A third alternative (Alternative 4) for the I-90/I-229 interchange is a full directional interchange that replaces the existing loop ramps with fly-over ramps. This alternative also includes a new diamond interchange at I-229/60th Street, as shown in Figure 19. Other characteristics of this interchange alternative include:

- All of the on-ramps and off-ramps for this interchange will consist of single lane ramps at the ramp junctions.
- Auxiliary lanes will be required east and west of the I-90/I-229 interchange to achieve a LOS C or better. Auxiliary lanes will also be required between the Benson Road and the 60th Street interchanges in order to achieve an acceptable LOS.
- The directional fly-over ramps at the I-90/I-229 interchange eliminate the weaving segment on westbound I-90.
- This alternative removes the I-229 connection to 476th Avenue. The new 60th Street interchange provides connectivity to 476th Avenue.
- The daily forecasts for year 2025 for 60th Street is 30,000 vehicles per day. A four-lane arterial design should be sufficient to accommodate these volumes.
- The I-90/I-229 fly-over ramps will require ROW in three out of the four quadrants. The local roadway located in the northeast quadrant of this interchange will have to be moved to accommodate the new northbound I-229 to westbound I-90 fly-over ramp.
- Additional ROW will also be required for the new I-229/60th Street interchange.
- The spacing between consecutive on-ramps or off-ramps between the I-90/I-229 and I-229/60th Street interchanges meet design standards.
- Traffic signal control is required for the new 60th Street ramp terminal intersections.
- At the modified I-229/Benson Road interchange the third lane should be continued north to the two new loop ramps.

The results of the year 2025 traffic operations analysis for the full directional interchange alternative, documented in Figure 24 in Section 2.2.4, are:

- Overall operations for freeway facilities are predicted to be generally acceptable for this alternative. Auxiliary lanes on I-90 between the I-229 interchange and the Cliff Avenue and Timberline Avenue interchanges are needed to achieve an acceptable LOS.
- Auxiliary lanes are also needed along I-229 between the Benson Road and 60th Street interchanges to achieve an acceptable LOS.
- Overall operations at the 60th Street signalized intersections are predicted to be LOS C or better for this alternative.
- Overall, traffic volumes are reduced to some degree in the Cliff Avenue, Benson Road, and Timberline Avenue corridors and travel delays are also reduced.

Partial Cloverleaf with Fly-Over Interchange Alternative

The fourth alternative (Alternative 5) for the I-90/I-229 interchange maintains the loop ramp for the I-90 westbound to I-229 southbound movement, but replaces the other loop ramp with a directional fly-over ramp. This alternative also includes a new diamond interchange at I-229/60th Street, as shown in Figure 20. Other characteristics of this interchange alternative include:

- All of the on-ramps and off-ramps for this interchange will consist of single lane ramps at the ramp junctions.
- Auxiliary lanes will be required east and west of the I-90/I-229 interchange to achieve a LOS C or better. Auxiliary lanes will also be required between the Benson Road and the 60th Street interchanges in order to achieve an acceptable LOS.
- The directional fly-over ramp at the I-90/I-229 interchange eliminates the weaving segment on westbound I-90.
- This alternative removes the I-229 connection to 476th Avenue. The new 60th Street interchange provides connectivity to 476th Avenue.
- The I-90/I-229 fly-over ramps will require ROW in three out of the four quadrants. The local roadway located in the northeast quadrant of this interchange will have to be moved to accommodate the new northbound I-229 to westbound I-90 fly-over ramp.
- Additional ROW will also be required for the new I-229/60th Street interchange.
- The spacing between consecutive on-ramps or off-ramps between the I-90/I-229 and I-229/60th Street interchanges meet design standards.
- Traffic signal control is required for the new 60th Street ramp terminal intersections.
- At the modified I-229/Benson Road interchange the third lane should be continued north to the two new loop ramps.

The results of the year 2025 traffic operations analysis for the full directional interchange alternative, documented in Figure 25 in Section 2.2.4, are:

- Overall operations for freeway facilities are predicted to be generally acceptable for this alternative. Auxiliary lanes on I-90 between the I-229 interchange and the Cliff Avenue and Timberline Avenue interchanges are needed to achieve an acceptable LOS.
- Auxiliary lanes are also needed along I-229 between the Benson Road and 60th Street interchanges to achieve an acceptable LOS.
- Overall operations at the 60th Street signalized intersections are predicted to be LOS C or better for this alternative.
- Overall, traffic volumes are reduced to some degree in the Cliff Avenue, Benson Road, and Timberline Avenue corridors and travel delays are also reduced.

Full Cloverleaf Interchange with 60th Street Half Diamond Alternative

The fifth Build alternative (Alternative 6) evaluated was a full cloverleaf interchange at I-90/I-229 with a half diamond provided at I-229/60th Street. This alternative also includes capacity improvements at the I-229/Benson Road interchange. This alternative is shown in Figure 21. This alternative provides full access to/from I-229, north of I-90. Other characteristics of this interchange alternative include:

- All of the on-ramps and off-ramps for this interchange will consist of single lane ramps at the ramp junctions.
- Auxiliary lanes will be required east and west of the I-90/I-229 interchange to achieve a LOS C or better. Auxiliary lanes will also be required between the Benson Road and the 60th Street interchanges in order to achieve an acceptable LOS.
- For westbound I-90 a C-D roadway will be required to achieve an acceptable LOS for the mainline I-90 ramp junctions. This C-D roadway will remove much of the merging/diverging and weaving movements from the freeway mainline.
- The addition of directional ramps in the northwest and northeast quadrants of the I-90/I-229 interchange will require right-of-way (ROW) and also a shift in the horizontal alignment for 476th Avenue.
- Additional ROW will also be required for the new I-229/60th Street interchange.
- The spacing between consecutive on-ramps or off-ramps between the I-90/I-229 and I-229/60th Street and I-229/Benson Road interchanges meet design standards.
- Traffic signal control is required for the new 60th Street northbound ramp terminal intersection. The new 60th Street southbound on-ramp intersection will require traffic control.
- At the modified I-229/Benson Road interchange the third lane should be continued north to the two new loop ramps.

The results of the year 2025 traffic operations analysis for the full cloverleaf interchange alternative, documented in Figure 26 in Section 2.2.4, are:

- Overall operations for freeway facilities are predicted to be generally acceptable for the full cloverleaf interchange configuration. The exceptions include the ramp junctions and weaving sections along westbound I-90. Auxiliary lanes on I-90 between the I-229 interchange and the Cliff Avenue and Timberline Avenue interchanges are needed to achieve an acceptable LOS.
- A C-D roadway along westbound I-90 through this interchange should provide acceptable LOS for mainline I-90.
- Auxiliary lanes are also needed along I-229 between the Benson Road and 60th Street interchanges to achieve an acceptable LOS.
- Overall operations at the 60th Street intersections are predicted to be LOS C or better for this alternative.

- Overall, traffic volumes are reduced to some degree in the Cliff Avenue, Benson Road, and Timberline Avenue corridors and travel delays are also reduced.

3.2.3 Requirement 3

The proposed access point does not have a significant adverse impact on the safety and operation of the Interstate facility based on an analysis of current and future traffic. The operational analysis for existing conditions shall, particularly in urbanized areas, include an analysis of sections of Interstate to and including at least the first adjacent existing or proposed interchange on either side. Crossroads and other roads and streets shall be included in the analysis to the extent necessary to assure their ability to collect and distribute traffic to and from the interchange with new or revised access points.

The documentation included in reference to Requirement 3 contains a review of study area crash history and a review of I-90/I-229 Build Scenario traffic operations.

Safety

Safety along I-90, I-229 and at the study area interchanges was evaluated through review and summary of recent crash data from the corridor. Crash data for a three-year period (2001-2003) was obtained from the SDDOT. To refine the crash review, the study area was divided into freeway segments and interchange areas for which the crash data was summarized.

Freeway Segments:

The number of crashes and the crash rate [crashes per 100 million vehicle miles traveled (VMT)] for the I-90 and I-229 segments are provided below:

- I-90, I-29 to Cliff Avenue: 40 crashes [90 crashes per 100 million VMT.]
- I-90, Cliff Avenue to I-229: 5 crashes [52 crashes per 100 million VMT]
- I-90, I-229 to Timberline Avenue: 52 crashes [184 crashes per 100 million VMT]
- I-90, Timberline Avenue to Brandon: 89 crashes [157 crashes per 100 million VMT]
- I-229, Rice Street to Benson Road: 12 crashes [64 crashes per 100 million VMT.]
- I-229, Benson Road to I-90: 8 crashes [99 crashes per 100 million VMT.]

The segments with the highest crash rates are the I-90 segments east of I-229. The severity of the crashes along these segments was also reviewed and is summarized below:

- 175 Property damage only crashes (85%).
- 30 Injury-only collisions (14%)
- 1 Fatal collision (1%). The fatal crash involved an overturn vehicle that left the roadway.

The most frequent crash types, by number of reported crashes, include:

- 125 animal collisions (61%)
- 30 vehicle collisions involving fixed objects (15%)
- 18 crashes involving an overturned vehicle (9%)
- 10 rear-end crashes (5%)
- 8 sideswipe crashes involving vehicles traveling in same direction (4%)

The majority of the crashes along these freeway segments are of the type (e.g., animal, fixed object, overturn) not typically associated with traffic congestion. The I-90 segments located on either side of the Timberline Avenue interchange have the highest occurrence of crashes (e.g., rear-end and sideswipes) typically associated with traffic congestion. A majority of the collisions involving animals occurred along the I-90 segments. The I-90 segments east of I-229 experience a fair amount of out of control crashes accounting for 15 out of the 18 overturned crashes and 12 out of the 30 fixed object collisions.

I-90/I-229 Interchange area:

The crash data obtained from SDDOT for this time period also included those crashes that occurred in the vicinity of this interchange area. Data for the interchange areas were collected and evaluated because it is reasonable to assume similar conditions at a new interchange. A total of 33 crashes occurred within the I-90/I-229 interchange area over the three year time period. The most frequent crash types on the ramps, by number of reported crashes, include:

- 13 single vehicle collisions involving a fixed object
- 7 animal collisions
- 4 rear-end crashes
- 4 sideswipe crashes involving vehicles traveling in the same direction

The fixed object crashes may suggest either a design deficiency with the ramp design or vehicle speed/driver error could be the cause of these crashes. The *South Dakota Interstate Corridor Study: Phase I Report* found a number of out of control vehicle crashes for this interchange. The study further indicated that many of these out of control crashes involved vehicles on the ramps and that they often occurred during inclement weather conditions. The study suggested there may be a correlation between these crashes and the existing superelevation and the radius of the ramps.

The severity of the crashes for this area was also reviewed and is summarized below:

- 26 Property damage only crashes (79%)
- 7 Injury-only crash (21%)
- 0 Fatal crash (0%)

Other Study Area Interchanges:

The number of crashes for each of the study area interchanges is provided below:

- I-90/Cliff Avenue: 44 crashes
- I-90/Timberline Avenue: 16 crashes
- I-229/Benson Road: 23 crashes

The most frequent crash types on the ramps, by number of reported crashes, include:

- 19 single vehicles collisions involving a fixed object
- 19 rear-end crashes
- 16 collisions involving a left-turning vehicle
- 10 animal collisions
- 8 sideswipe crashes involving vehicles traveling in the same direction

The Cliff Avenue intersections had the highest number of left-turn and rear-end collisions. Left-turn crashes are typically associated with a failure to yield condition.

The severity of the crashes for this area was also reviewed and is summarized below:

- 63 Property damage only crashes (76%)
- 19 Injury-only crash (23%)
- 1 Fatal crash (1%). The fatal crash occurred on Timberline Avenue and it involved a left-turning vehicle.

Previous Analysis of Study Area Interchanges:

The *South Dakota Interstate Corridor Study: Phase I Report* developed crash rates for all interchanges in South Dakota. The ranking and crash rates (that takes into consideration the crash severity) for the I-90/I-229 study area interchanges are provided below:

- I-90 / I-229: #10, (2.13 Weighted Accidents/MEV)
- I-90/Cliff Avenue: #16 (1.73 Weighted Accidents/MEV)
- I-90/Timberline Avenue: #26, (1.26 Weighted Accidents/MEV)
- I-229/Benson Road: #55 (0.43 Weighted Accidents/MEV)

The statewide average from this study was 1.23 weighted accidents/MEV.

Improvement to the existing interchange at I-90/I-229 should have a positive impact on driver safety. The addition of a new interchange has both positive and negative safety factors to consider. Providing alternate access routes could potentially help driver safety at existing interchanges (e.g., I-90/Cliff Avenue and I-229/Benson Road) by reducing projected traffic

growth at those locations. The addition of another interchange to the study area would introduce another service interchange (and additional intersections) to the study area, which typically exhibit higher crash propensities than mainline freeway segments.

Build Scenario Traffic Operations

As documented in Figures 16, 22, 23, 24, 25 and 26, traffic operations along the mainline are not significantly different between the 2025 No-Build and 2025 Build Scenarios. In both conditions, all basic freeway segments are predicted to be LOS C or better. Under both conditions, there are several ramp junctions and some intersections that are projected to LOS D or worse during the peak hours. The operation of these basic freeway segments and ramp junctions would improve under the Build Scenarios with the implementation of auxiliary lanes and/or C-D roads.

3.2.4 Requirement 4

The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" for special purpose access for transit vehicles, for HOVs, or into park and ride lots may be considered on a case-by-case basis. The proposed access will be designed to meet or exceed current standards for Federal-aid projects on the Interstate System.

The modified interchange(s) will connect to public roads on all approaches. The proposed interchange modifications will provide a full access interchange. The new interchange at I-229 and 60th Street provides full access for north/south travel (Alternatives 4 and 5). Partial access at the new I-229/60th Street interchange is provided in Alternative 6. The new I-229/60th Street interchange is located within close proximity to the I-90/I-229 system interchange that essentially serves as the terminus for I-229. Alternative 6 is presented as a unique case with special circumstances that need to be considered, including:

- The separation between a northbound on-ramp to I-229 from 60th Street or a southbound off-ramp from I-229 to 60th Street and the I-90/I-229 system interchange is limited. Including the north ramps would have little of no positive impact on I-90/I-229 operations.
- Benson Road is anticipated to experience tremendous traffic growth by 2025. The vast majority of the new traffic will have origins/destination to the south. Providing the southern oriented ramps at 60th Street would aid in reducing the burden on Benson Road/I-229. Including the northern-oriented ramps would have only a minor positive impact to the Benson Road operations, and the positive impact on Benson Road of providing the ramps would not likely offset the negative impacts to the I-90/I-229 system interchange operations.
- The cost of the full-cloverleaf interchange is lower than the other interchange reconstruction alternatives. Including the I-229/60th Street half diamond improves the effectiveness of the lower cost alternative while still being lower than other selected reconstruction alternatives.

The interchange concepts were developed to conform to SDDOT and American Association of State Highway & Transportation Officials (AASHTO) design standards for Federal-aid projects on the Interstate system.

3.2.5 Requirement 5

The proposal considers and is consistent with local and regional land use and transportation plans. Prior to final approval, all requests for new or revised access must be consistent with the metropolitan and/or statewide transportation plan, as appropriate, the applicable provisions of 23 CFR part 450 and the transportation conformity requirements of 40 CFR parts 51 and 93.

The proposed interchange improvement is consistent with local land use and transportation plans.

3.2.6 Requirement 6

In areas where the potential exists for future multiple interchange additions, all requests for new or revised access are supported by a comprehensive Interstate network study with recommendations that address all proposed and desired access within the context of a long-term plan.

There are no plans for additional interchanges along this portion of I-90. The South Dakota Interstate Corridor Study (completed in February 2001) did not identify any potential future interchange additions along this segment of Interstate I-90.

3.2.7 Requirement 7

The request for a new or revised access generated by new or expanded development demonstrates appropriate coordination between the development and related or otherwise required transportation system improvements.

The coordination between the interchange concept(s), planned development, and related transportation system improvements has been documented throughout this report. The interchange is being reconstructed to improve geometric design and traffic operation of the I-90/I-229 interchange and to improve traffic operations at other interchanges within the study area. The improved interchange access modifications would also accommodate the projected land use development adjacent to the study area.

3.2.8 Requirement 8

The request for new or revised access contains information relative to the planning requirements and the status of the environmental processing of the proposal.

As stated in Section 1.1.1, an EA is currently being completed for proposed improvements to the I-90/I-229 interchange. A full NEPA review of the interchange concept location will be included in the EA.

The I-90 Interstate Access Modification Request was completed to address the eight requirements documented as FHWA policy on additional interchanges to the Interstate system (Federal Register, Volume 63, Number 28, February 11, 1998). The document was developed through first establishing an appropriate study area. The study area extended from west of the I-90/Cliff Avenue Interchange to east of the I-90/Timberline Avenue Interchange. The study area also extended south of the I-229/Benson Road Interchange. The next step was collecting the appropriate traffic volume, crash, and land use/development data. Based on the data collected, including the updated Sioux Falls regional travel demand model, horizon year 2025 daily and peak hour traffic forecasts for Build and No-Build Scenarios were prepared. Current and future year traffic operations and safety assessments were completed along study area roadway links.

The results of the Interstate Access Modification Request are that:

- In the case of the I-90/I-229 study area, the project need has been demonstrated from a traffic operations perspective. No-Build scenario peak hour traffic operations through the planning horizon of 2025 include freeway facility and intersections predicted to operate at LOS D or worse.
- The I-90/I-229 interchange will serve as an important connection to a significant City of Sioux Falls growth corridor along I-90 between Cliff Avenue and Timberline Avenue. This development is likely to occur at some level with or without interchange modifications. If the No-build alternative is selected, traffic operations along these corridors will become congested during peak periods.
- A total of five Build project alternatives were evaluated as part of this analysis. Each of these alternatives improves the overall traffic operations in the study area.
- Consideration should be given to auxiliary lanes on I-90 between the I-90/I-229 interchange and Cliff Avenue and Timberline Avenue interchanges in order to maintain acceptable freeway ramp junction operations. The implementation of auxiliary lanes should not be implemented until such time that traffic volumes warrant their construction.

Coordination of the Interstate Access Modification Request with the on-going EA was to determine, prior to officially carrying the I-90/I-229 interchange concepts forward as action alternatives, that no fatal flaws to the concept exist. Fatal flaws would include:

- Not providing full access at the interchange.
- Creating a condition where mainline traffic operations are negatively impacted and the negative effects cannot be mitigated.
- Creating a condition where mainline/interchange safety is impaired and cannot be mitigated.
- The interchange concept/location is in conflict with or is inconsistent with local/regional plans.
- Adding the interchange creates potential unmitigable environmental consequences.

Based on the analyses conducted and should the argument for considering the I-229/60th Street half-diamond be accepted, no fatal flaws exist to the interchange improvement alternatives.