

I-29/I-94 Microsimulation Analysis Report

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I hereby certify that this report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of North Dakota.

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Introduction

Between Kansas City and Canada, 5 of the 10 most significant freight bottlenecks on I-29 occur in Fargo according to bottleneck data on the Federal Highway Administration webpage. A major challenge in maintaining efficient operations along I-29 and I-94 is keeping operations at the I-29/I-94 interchange at an acceptable level. Currently, each interstate carries between 70,000 and 80,000 vehicles per day at their junction. The cloverleaf design makes for challenging merging and diverging movements during peak hours and the southbound I-29 to eastbound I-94 flyover movement regularly sees backups that stretch beyond 13th Avenue. According to the Fargo-Moorhead Metro COG travel demand model, this interchange is expected to serve 182,000 vehicles per day by 2045, making already problematic operations significantly worse.

The North Dakota Department of Transportation is in the process of completing an environmental document to reconfigure the I-94 flyover connection point with the northbound-eastbound ramp and eastbound through movement. This alternative reconfigures the merge on the tri-level by restriping the existing pavement. The existing structure is wide enough to accommodate two lanes. Instead of merging, two lanes will continue the length of the structure. The area where the NB and SB I-29 exits merge will also be restriped to accommodate the extra lane from the tri-level. The rest of the ramp to I-94 will have additional pavement constructed to add the auxiliary lane and shoulder. The right shoulder along the EB lane will be removed and replaced with an auxiliary lane and a new shoulder. This auxiliary lane will extend from the I-29 exit ramp through the 25th St exit ramp, acting as a dual exit lane that will tie in with the existing pavement. The figures below are from the Draft CATEX document and illustrate the proposed changes.

Figure 1 - Proposed Layout: Tri-Level Restriping

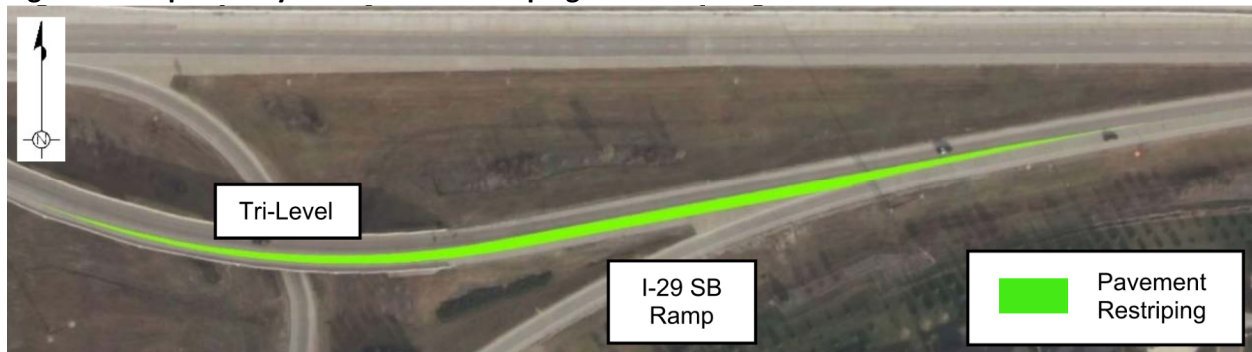


Figure 2 - Proposed Layout: Lane Addition, I-29 Ramp to I-94



Figure 3 - Proposed Layout: Lane Addition, I-94 to 25th St Ramp



Figure 4 - Proposed Layout: Lane Addition, 25th St Ramp



This study report goes through the traffic analysis completed to understand the existing and future operations at the I-29/I-94 interchange and shows the impacts of improving the southbound I-29 to eastbound I-94 movement resultant from the proposed build reconfiguration.

Traffic Data Collection

Various types of transportation data were collected to support traffic model development and calibration, including traffic volume data, observed queueing, traffic speeds, and lane utilization.

StreetLight Insight

Transportation data from StreetLight Insight was used to support traffic modeling that was completed for this project. StreetLight Insight uses anonymized location data from mobile phones to estimate a wide range of data for use in various transportation analyses.

The primary goals for the StreetLight data analyses were to develop reasonable traffic volume assumptions for traffic modeling under existing traffic conditions and to calibrate traffic simulation models to best reflect a real-world condition for each scenario being studied. Two different traffic volume sets were developed for existing traffic conditions – one set to best reflect typical conditions, and another to reflect atypical traffic patterns during the December holiday season. 2045 traffic volume sets were based on existing conditions data, factored up based on forecast 2045 traffic data obtained from the Fargo-Moorhead regional travel demand model

Key data that was obtained from StreetLight Insight includes:

- Traffic volumes between origin-destination pairs
- Travel times and travel speeds

Figures A1 and A2 in Appendix A show the zones used in StreetLight Insight for the origin-destination and travel time analysis.

Hourly Distribution of Study Area Traffic

StreetLight Insight was used to assess how daily traffic volumes are distributed throughout the day under existing traffic conditions. To understand potential traffic impacts from the ongoing COVID-19 pandemic, mid-week data (Tuesday, Wednesday, and Thursday) from 2019, 2020, and the first eight months of 2021 (1/1/2021 through 8/30/2021) were evaluated. Key takeaways from this analysis are:

- The hourly distribution of traffic in the study area is nearly identical in the 2019, 2020, and 2021 datasets. This suggests that while overall traffic volumes may be impacted by COVID-19, the peaking characteristic of traffic is generally unchanged.
- The AM peak hour begins at 7 am, with around seven percent of daily traffic occurring in this hour.
- The PM peak hour begins at 5 pm, with around ten percent of daily traffic occurring in this hour.
- The PM peak is the highest volume hour of the day.
- Hourly distribution data is summarized in **Table 1**.

Table 1. Daily Traffic Distribution (StreetLight Insight)

Time of Day	Percent of Vehicles		
	2019	2020	2021
12am-1am	1%	0%	0%
1am-2am	0%	0%	0%
2am-3am	0%	0%	0%
3am-4am	0%	0%	0%
4am-5am	0%	0%	1%
5am-6am	1%	1%	1%
6am-7am	3%	3%	3%
7am-8am	7%	7%	6%
8am-9am	6%	5%	5%
9am-10am	4%	4%	4%
10am-11am	5%	5%	5%
11am-12pm	6%	6%	6%
12pm-1pm	7%	7%	7%
1pm-2pm	6%	7%	6%
2pm-3pm	6%	7%	7%
3pm-4pm	7%	8%	8%
4pm-5pm	9%	9%	9%
5pm-6pm	10%	10%	10%
6pm-7pm	7%	7%	7%
7pm-8pm	5%	5%	5%
8pm-9pm	4%	4%	4%
9pm-10pm	3%	3%	3%
10pm-11pm	2%	1%	2%
11pm-12am	1%	1%	1%

Monthly Distribution of Study Area Traffic

StreetLight Insight data was also used to quantify month-to-month volume fluctuations in the study area. This analysis also included comparisons between 2019, 2020, and 2021 traffic data to quantify traffic impacts from COVID-19. Key takeaways from this analysis include:

- Traffic volumes were shown to be lower in 2020 and 2021 than volumes in 2019 which suggests that traffic patterns have not yet returned to conditions that were occurring prior to the beginning of the COVID-19 pandemic. Therefore, traffic data from 2020 and 2021 was omitted from the detailed analysis.
- The highest traffic months are June, July, and August; however, AM and PM peak hour volumes are generally lower during these months than they are during the fall.
- The months most representative of the annual average are September and October with both months being around three percent higher than the annual average.
- **Figure 5** shows traffic totals per month in 2019, 2020, and 2021. **Table 2** shows the hourly traffic volume data in 2019. Note that data in **Figure 5** and **Table 2** is the summation of all origin-destination pairs in the project area.
- **Tables A1** and **A2** in **Appendix A** show the 2020 and 2021 detailed traffic distributions.

Figure 5 - Monthly Traffic Distribution (StreetLight Insight)

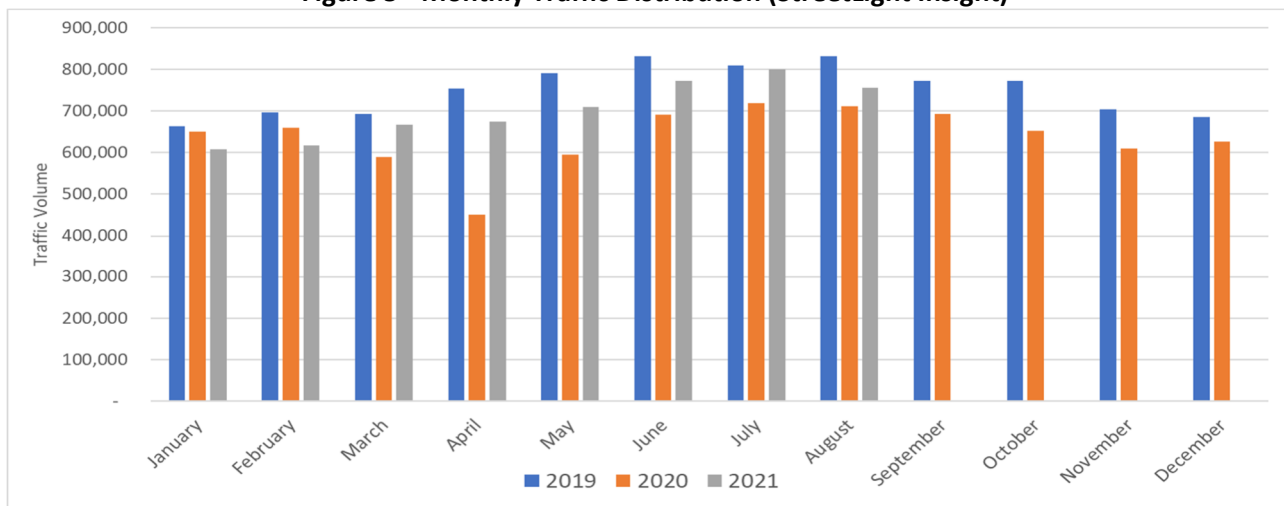


Table 2. 2019 Monthly Traffic Distribution (StreetLight Insight)

Time of Day	2019 Volumes											
	January	February	March	April	May	June	July	August	September	October	November	December
12am-1am	4,402	4,209	4,320	3,834	3,708	4,495	5,052	4,279	3,036	3,388	3,010	3,347
1am-2am	2,757	2,860	2,630	2,114	2,227	2,711	2,738	2,598	2,132	1,790	1,956	2,409
2am-3am	2,147	2,223	1,947	2,060	1,962	2,352	1,689	2,189	1,384	1,206	1,240	1,617
3am-4am	2,210	2,503	2,103	2,004	1,866	2,029	2,050	2,713	1,866	1,919	1,889	1,862
4am-5am	3,434	4,462	3,113	3,355	3,235	3,660	3,162	3,760	3,037	2,761	2,488	2,923
5am-6am	6,886	7,614	6,719	7,928	8,528	9,422	8,312	9,067	8,298	7,956	6,976	6,247
6am-7am	18,082	20,454	18,931	21,263	23,764	25,421	22,625	24,017	21,694	21,270	18,830	16,060
7am-8am	46,690	51,514	50,418	58,049	57,206	54,633	49,341	55,991	59,357	58,855	53,738	45,098
8am-9am	39,210	44,173	41,083	44,268	44,637	42,576	41,132	45,189	45,660	46,223	40,441	39,316
9am-10am	29,162	31,390	30,162	33,405	33,849	35,563	35,276	36,031	32,990	34,972	29,982	28,867
10am-11am	31,670	31,912	31,380	34,812	37,419	40,442	40,816	41,336	34,544	35,446	32,267	33,058
11am-12pm	36,170	38,053	38,111	43,420	44,629	50,208	49,766	49,595	43,456	41,792	38,300	39,242
12pm-1pm	44,157	41,960	44,616	50,778	50,607	59,023	56,758	58,616	48,640	48,299	44,777	46,678
1pm-2pm	42,489	40,560	41,910	46,432	47,305	51,652	54,946	54,521	45,441	46,832	42,601	45,632
2pm-3pm	43,960	42,552	42,294	45,233	48,390	50,740	51,773	52,745	46,252	48,167	41,766	45,020
3pm-4pm	51,566	52,882	50,590	54,271	57,022	56,425	56,545	59,282	56,064	55,775	51,999	51,906
4pm-5pm	62,362	62,342	63,284	68,203	71,395	73,727	69,327	71,525	72,505	72,746	67,805	62,696
5pm-6pm	69,766	68,980	70,312	73,859	76,592	76,752	72,603	80,691	78,321	78,659	71,416	68,098
6pm-7pm	41,944	47,797	47,659	49,853	55,030	56,423	53,415	55,905	54,382	56,048	50,511	46,488
7pm-8pm	29,889	34,325	36,593	38,901	41,872	44,083	43,173	42,995	42,418	39,183	36,509	35,085
8pm-9pm	22,927	26,681	26,601	30,268	35,180	35,805	35,112	34,794	33,082	30,353	29,162	26,370
9pm-10pm	16,914	19,670	20,764	21,564	24,050	27,384	26,688	23,840	20,557	20,502	19,080	19,547
10pm-11pm	9,418	12,038	10,623	12,297	12,958	16,444	16,022	13,073	11,707	11,818	11,660	11,419
11pm-12am	6,046	6,234	7,359	6,554	7,402	9,266	11,017	7,830	6,083	6,777	5,849	5,937

Based on the data described above combined with local understanding of the project area, traffic data for simulation analyses were based on the following data:

- **Typical Conditions:** Based on mid-week September 2019 and October 2019 traffic volumes. These months are generally representative of an average day throughout the year and include school-related traffic from both NDSU and other local schools.
- **Holiday Season:** Based on 2019 traffic data on Fridays between November 29th and December 20th.

Travel Time Data

Travel time data from StreetLight Insight was used to calibrate simulation models. Travel time information was obtained for each movement at the I-29/I-94 Interchange and was collected for typical mid-week 2019 conditions (Tuesday through Thursday in September and October of 2019). StreetLight Insight travel time information for each movement at the interchange is shown in **Table 3**. Discussion related to how this data was used to calibrate simulation models is provided in the *Travel Time Calibration* section of this report.

Table 3. Travel Time (seconds) [StreetLight Insight]

Location	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	Average
EB I-94 to NB I-29	128	120	120	119	141	117	124	128	122	137	127	115	125
EB I-94 to EB I-94	84	89	96	97	94	98	96	95	94	101	99	98	95
EB I-94 to SB I-29	84	87	110	87	102	101	96	103	106	94	100	84	96
SB I-29 to EB I-94	83	92	93	95	97	88	99	95	91	118	112	98	97
SB I-29 to SB I-29	89	93	97	96	101	101	98	98	90	92	92	97	95
SB I-29 to WB I-94	83	82	88	68	78	86	90	95	76	87	88	88	84
WB I-94 to SB I-29	118	113	127	128	116	137	113	116	119	116	123	115	120
WB I-94 to WB I-94	93	93	97	95	99	105	96	95	94	101	102	94	97
WB I-94 to NB I-29	83	79	83	82	85	90	85	88	94	86	85	89	86
NB I-29 to WB I-94	129	129	139	148	137	121	128	136	124	142	147	130	134
NB I-29 to NB I-29	93	99	101	111	112	102	114	111	109	107	105	100	105
NB I-29 to EB I-94	74	75	85	91	82	84	93	92	81	94	85	77	84

Note: Travel times close to the average travel time are shown in green, travel times that are significantly lower are shown in yellow, and travel times significantly higher are shown in red.

Lane Utilization

Based on local understanding of the project area and collaboration with technical stakeholders, it was determined that imbalanced lane utilization on I-29 and I-94 impacts traffic flow on the interstate system. To best incorporate real-world lane utilization data into both simulation models and traffic forecast preparation, lane utilization data was collected using video cameras at the following locations for a 13-hour time period (6 am to 7 pm):

- I-94 east of 25th Street
- I-94 east of 42nd Street
- I-29 south of Main Avenue
- I-29 north of 32nd Avenue

The average lane utilization over the 13-hour timeframes are listed in **Table 4**. This shows how most traffic is using the center and outside travel lanes. In locations where there are three lanes, only between 11% and 23% are utilizing the inside lane.

Table 4. Summary of Lane Utilization Data

Location	WB I-94 at 25th St			EB I-94 at 25th St		
Lane	Outside Lane	Center Lane	Inside Lane	Inside Lane	Center Lane	Outside Lane
Field Collected	34%	44%	22%	23%	42%	36%
Location	WB I-94 at 42nd St			EB I-94 at 42nd St		
Lane	Outside Lane	Center Lane	Inside Lane	Inside Lane	Center Lane	Outside Lane
Field Collected	25%	56%	19%	19%	42%	39%
Location	SB I-29 at Main Ave			NB I-29 at Main Ave		
Lane	Outside Lane	Center Lane	Inside Lane	Inside Lane	Center Lane	Outside Lane
Field Collected	51%	38%	11%	16%	47%	37%
Location	SB I-29 at 32nd Ave			NB I-29 at 32nd Ave		
Lane	Outside Lane	Center Lane	Inside Lane	Inside Lane	Outside Lane	
Field Collected	28%	53%	19%	34%	66%	

The hourly lane utilization data is included in **Appendix A**, with further discussion related to this data found in the *Traffic Projections* section of this report.

Traffic Projections

Traffic conditions in 2045 were estimated using the Fargo-Moorhead regional travel demand model. The travel demand model is the basis for many transportation planning decisions in the area and is a valuable forecasting tool since it's traffic estimates are based on spatially-allocated demographic changes and local trip-making behavior rather than the application of simple annual traffic growth rates. Traffic projections were developed for the following scenarios:

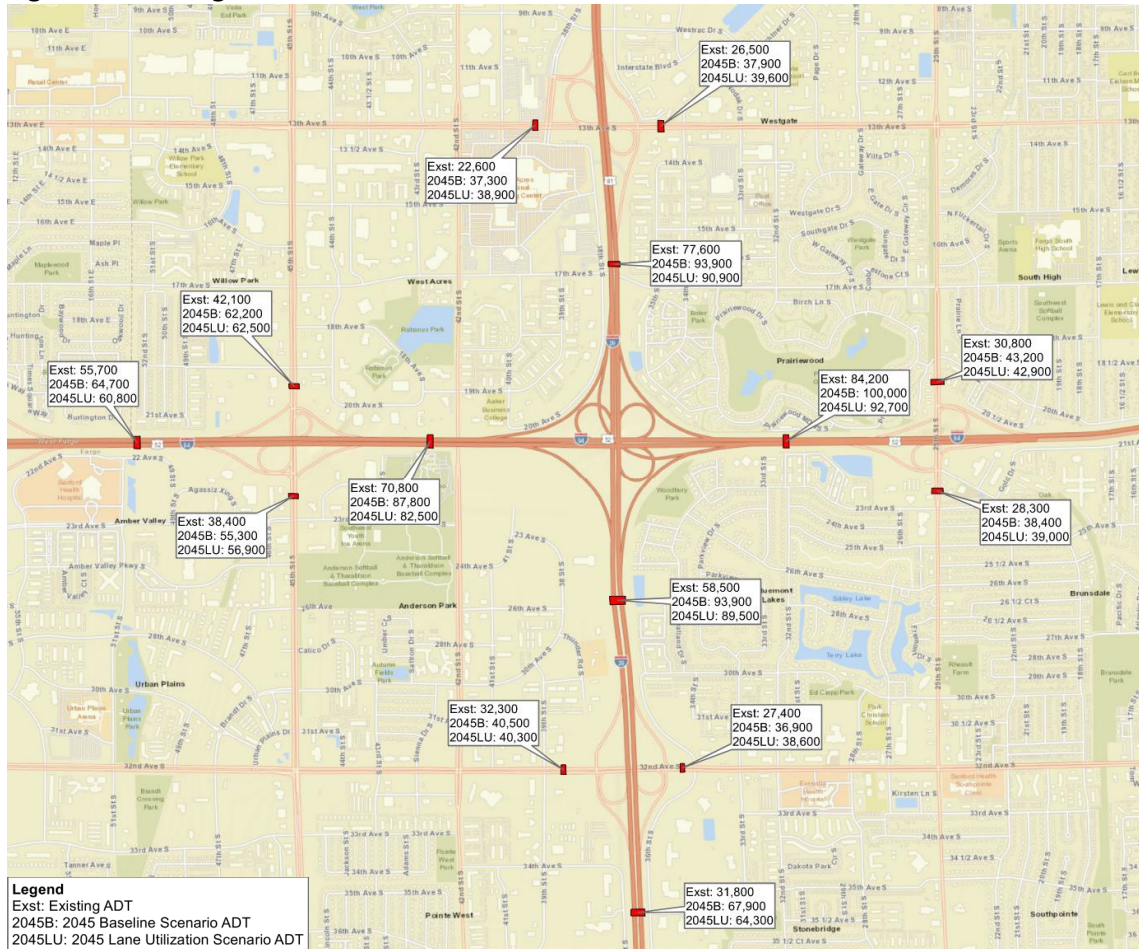
- **2045 Baseline Scenario** – this scenario assumes the implementation of all fiscally-constrained transportation projects that are listed in the current Metropolitan Transportation Plan (MTP)
- **2045 Lane Utilization Scenario** – this scenario uses the same demographic growth assumptions and roadway investment assumptions as the 2045 baseline scenario, in addition to considering traffic operations impacts from imbalanced lane utilization on the Interstate system in Fargo
 - Traffic data collected on both I-94 and I-29 shows that the center lanes are used considerably more than the outer lanes. In the study area, the center lanes carry around 80 percent more traffic than either the outer left or outer right lanes.
 - If certain travel lanes are underutilized, this reduces the effective capacity of the freeway system. *To reflect the actual lane utilization, freeway capacities were reduced by 15 percent in the lane utilization scenario.* As a result of a reduced freeway capacity, the travel demand model will show vehicles diverting from the Interstate system onto other surface streets to optimize travel times between trip start and end points.

Projected 2045 daily traffic volumes under both the 2045 Baseline Scenario and the 2045 Lane Utilization Scenario are shown in **Figure 6** below and **Figure B1 of Appendix B**. Key takeaways include:

- I-94
 - **Baseline Scenario:** By 2045, daily traffic volumes on I-94 are expected to increase by around 20 percent, with a maximum daily volume exceeding 100,000 ADT east of I-29
 - **Lane Utilization Scenario:** When adjusting for lane utilization imbalances, daily 2045 volumes are 6 to 7 percent lower than the 2045 baseline scenario, with a maximum daily volume around 93,000 ADT east of I-29

- I-29
 - **Baseline Scenario:** North of I-94, traffic volumes are expected to increase by around 20 percent, increasing to 94,000 ADT just north of I-94. Traffic is expected to grow more considerably south of I-94, with traffic increasing by around 60 percent to around 94,000 ADT. South of 32nd Avenue, traffic is expected to more than double by 2045, growing to around 68,000 ADT.
 - **Lane Utilization Scenario:** Traffic on I-29 is reduced by 3 to 5 percent in this scenario compared to the baseline scenario, with a maximum 2045 ADT of around 94,000 just north and just south of I-94.

Figure 6 – Existing and Forecasted ADTs



Traffic Model Development

Traffic operations and safety analysis for the study area was completed using the Vissim traffic simulation software. For each scenario being studied, a 13-hour (6:00 AM to 7:00 PM) traffic model was created in Vissim to analyze a typical 12 hour period from 7:00 AM to 7:00 PM with one hour of seeding. The Vissim models include the following interchanges:

- I-29 and I-94
- I-29 at 13th Avenue
- I-29 at 32nd Avenue
- I-94 at 25th Street
- I-94 at 45th Street

The project area is shown in **Figure 7**.

Figure 7 – Project Area



A summary of key data that was used in model development is provided below, with more details presented in the *Data Collection* section of this report:

- **Signal timing data** - Provided by the City of Fargo.
- **Existing hourly traffic volume data** – Obtained from StreetLight data
 - Some adjustments were made based on other volume datasets based on local knowledge and engineering judgement
- **2045 daily traffic projections** – Obtained from the Fargo-Moorhead regional travel demand model
- **NDDOT daily traffic data** – Data from 2020 and 2021 was omitted due to impacts from COVID-19
- **Lane Utilization Data on I-29 and I-94** – Field-collected by Bolton & Menk staff
- **Travel time and speed data** – Obtained from StreetLight data

Model Calibration

The existing Vissim model was calibrated to ensure correct lane utilization, traffic volumes, and travel times. The “Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software” published by the Federal Highway Administration was followed during the calibration process. The data analyzed and modifications to the Vissim model are detailed below.

Lane Utilization Calibration

The field collected lane utilization data was averaged over the 13-hour timeframe to determine the average percent of vehicles utilizing each lane. Data collection points in Vissim were used to determine what percentage of vehicles utilized each lane in the traffic model. Several model iterations were completed by modifying the “lane change distance” of connectors at the exit ramps, as well as by modifying the “link behavior type” for certain lanes along links to more closely match the field collected lane utilization data. The model was calibrated such that the modeled lane utilization was within eight percent of the field collected lane utilization. A calibration target of within ten percent was the goal.

Table C1 in Appendix C shows the modeled lane utilization data and the field collected lane utilization data.

Traffic Volume Calibration

Since StreetLight data was the basis of most input data into simulation models, comparisons to other field-collected traffic data were used to ensure that assumptions within the model reflected realistic volumes.

- Using data from the NDDOT 2019 Traffic Report, 77.1 percent of daily traffic on I-94 is present from 6:00 AM to 7:00 PM and 76.5 percent of daily traffic on I-29 is present from 6:00 AM to 7:00 PM. The standard deviation of the I-94 daily count is 2.7 and the standard deviation of the I-29 daily count is 2.6.
 - It should be noted that this data is averaged over multiple urban locations in North Dakota, and is not specific to the study area for this project
- StreetLight Insight data showed that 88 percent of the traffic volumes in the entire project area are present between 6:00 AM and 7:00 PM. Since the StreetLight Insight data was found to be higher than what is shown in the NDDOT 2019 Traffic Report and would give a more conservative estimate of traffic volumes the 88 percent was used to calibrate the volumes in the Vissim model.
- An acceptable range of daily traffic percentages from 85.3 percent to 90.7 percent was determined based on the standard deviation of the NDDOT traffic data (approximately 2.7) and the average percent of daily traffic volume (88 percent) from StreetLight Insight.

Volumes at each location were calibrated using data collection points in Vissim. The volumes in Vissim were summed at each location for the entire 13-hour period modeled. The 13-hour volume at each location in Vissim was compared to the known traffic counts from the NDDOT Transportation Information Map to ensure each location was between 85.3 percent and 90.7 percent of the daily volumes. **Table C2 in Appendix C** shows the locations calibrated along with the associated volume data. This table shows that all locations except for one were calibrated to be within the 85.3 percent and 90.7 percent range. In order for all of the other locations to be within the acceptable range, northbound I-29 south of 32nd Avenue needed to be above the acceptable volume threshold. This was considered an acceptable deviation for the sake of preserving the overall accuracy of the model.

Travel Time Calibration

The travel time data collected in StreetLight Insight was also used to calibrate the Vissim model. The average travel time throughout the 12-hour model (7:00 AM – 7:00 PM) was compared to the average travel time over the same 12-hour period in StreetLight Insight for each of the movements to ensure the modeled travel times were all within 15 percent of those in StreetLight Insight. Vehicle speed was modified to calibrate the travel time. **Table C3 in Appendix C** shows the results of the travel time calibration. This table shows how all the travel times in the existing Vissim model were found to be within 15 percent of those found in StreetLight except for the southbound I-29 to eastbound I-94

movement. This movement was found to have a much higher average travel time in Vissim than what was shown in StreetLight Insight. The detailed hourly volume from both the Vissim model and from StreetLight Insight for this movement are shown in **Table 5**.

Table 5. Southbound I-29 to Eastbound I-94 Traffic Travel Time Comparison

Option	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
StreetLight Insight	83	92	93	95	97	88	99	95	91	118	112	98
Vissim Model	88	87	88	89	89	90	91	91	93	205	299	146

Table 5 shows how the travel time for this movement in StreetLight Insight only increased by about 30 seconds comparing the 3:00 PM and 4:00 PM hours where in the Vissim model there is nearly a two-minute difference between these two hours. Additionally, in StreetLight Insight the 5:00 PM hour shows a lower travel time than at 4:00 PM, but the Vissim model shows the 5:00 PM travel time being over a minute and a half longer than the 4:00 PM peak hour. Based on local knowledge and observations of the issues at the I-29/I-94 interchange, it was determined that what is shown in Vissim more closely reflects real world conditions. Therefore, the StreetLight Insight data was assumed to be inaccurate for this movement and no changes were made to the model to improve the longer travel time shown in Vissim.

Traffic Analysis

Once the existing Vissim model was calibrated traffic operations for the following scenarios were analyzed:

- **Existing (2019)** – Average mid-week (Tuesday/Wednesday/Thursday) September/October 2019 traffic volumes
- **Friday Holiday (2019)** – Average of Fridays between November 29th and December 20th when the commercial area north of the interchange is the busiest
- **2045 Baseline** – Fargo-Moorhead regional travel demand model assuming the implementation of all fiscally-constrained transportation projects that are listed in the current long range transportation plan
- **2045 Lane Utilization** – Same assumptions as the 2045 baseline scenario, however it also considers traffic operations impacts from imbalanced lane utilization on the Interstate system in Fargo

Existing Conditions/No Build Analysis

Travel Time

Travel time was compared for each hour and each movement at the I-29/I-94 interchange to see which movements showed consistent travel times throughout the day and which do not. **Figures 8 through 11** below show minimum, average, and maximum travel times throughout the 12-hour model for each movement for the existing and 2045 no build scenarios. The detailed travel time data is included in **Appendix D**.

Figure 8 - Existing (2019) Travel Time Reliability

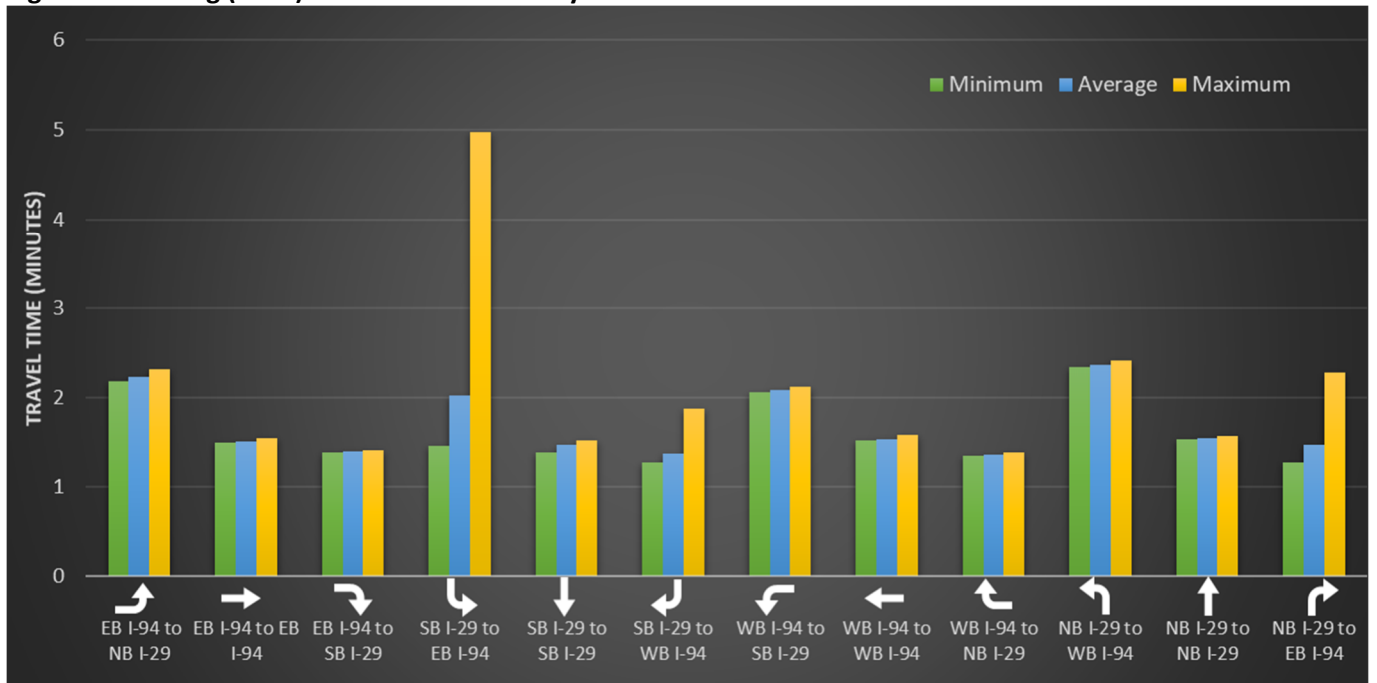


Figure 8 shows how for most movements the minimum, average, and maximum travel times show minimal variation. However, the southbound I-29 to eastbound I-94, southbound I-29 to westbound I-94, and northbound I-29 to eastbound I-94 movements show significant increases in travel time. The southbound I-29 to eastbound I-94 movement shows the greatest variation between travel times with the maximum travel time being three minutes longer than the average travel time. The northbound I-29 to eastbound I-94 movement has a maximum travel time that is about one minute longer than the average travel time and the southbound I-29 to westbound I-94 has a maximum travel time that is about 30 seconds longer than the average travel time.

Figure 9 - Friday Holiday (2019) Travel Time Reliability

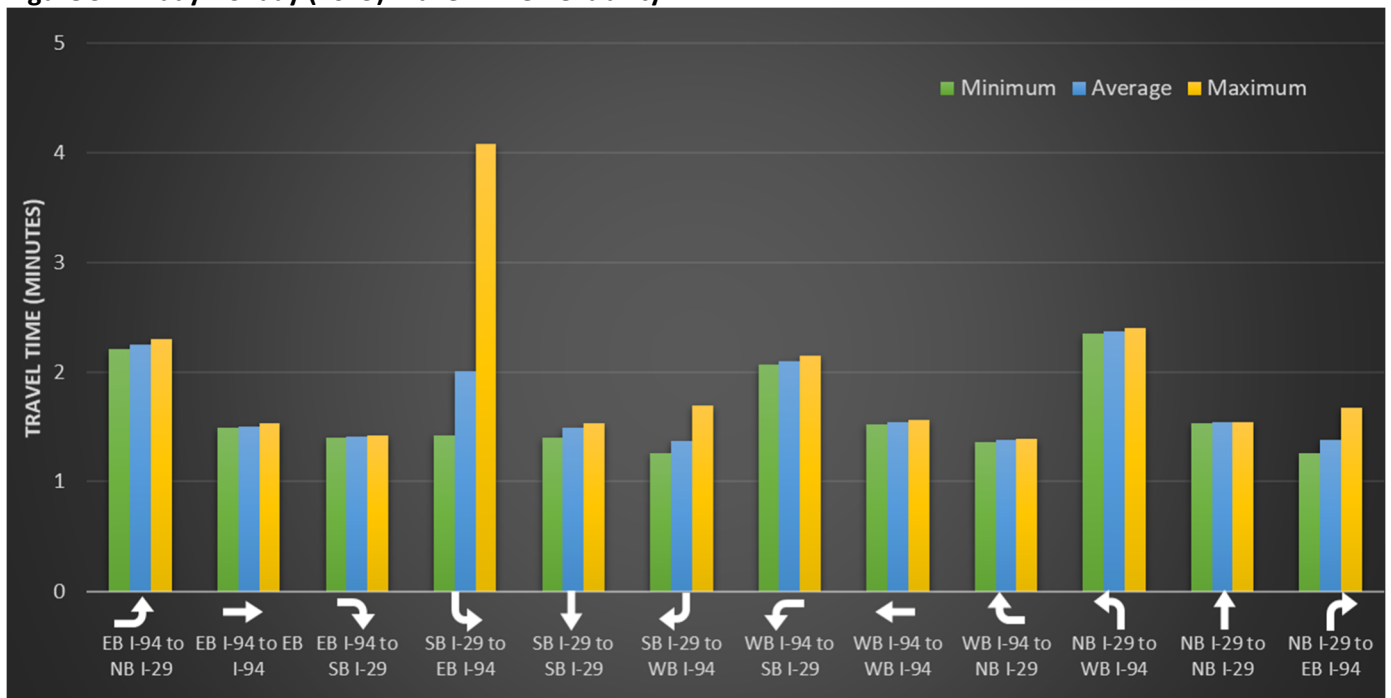


Figure 9 shows how the 2019 Friday Holiday scenario travel time results are very similar to the existing conditions scenario. The southbound I-29 to eastbound I-94 movement shows the greatest variation between travel times, with the maximum being two minutes longer than the average. Both the northbound I-29 to eastbound I-94 movement and the southbound I-29 to westbound I-94 show some variation in travel time indicating that these are not always the most reliable movements.

Figure 10 - 2045 Baseline No Build Travel Time Reliability

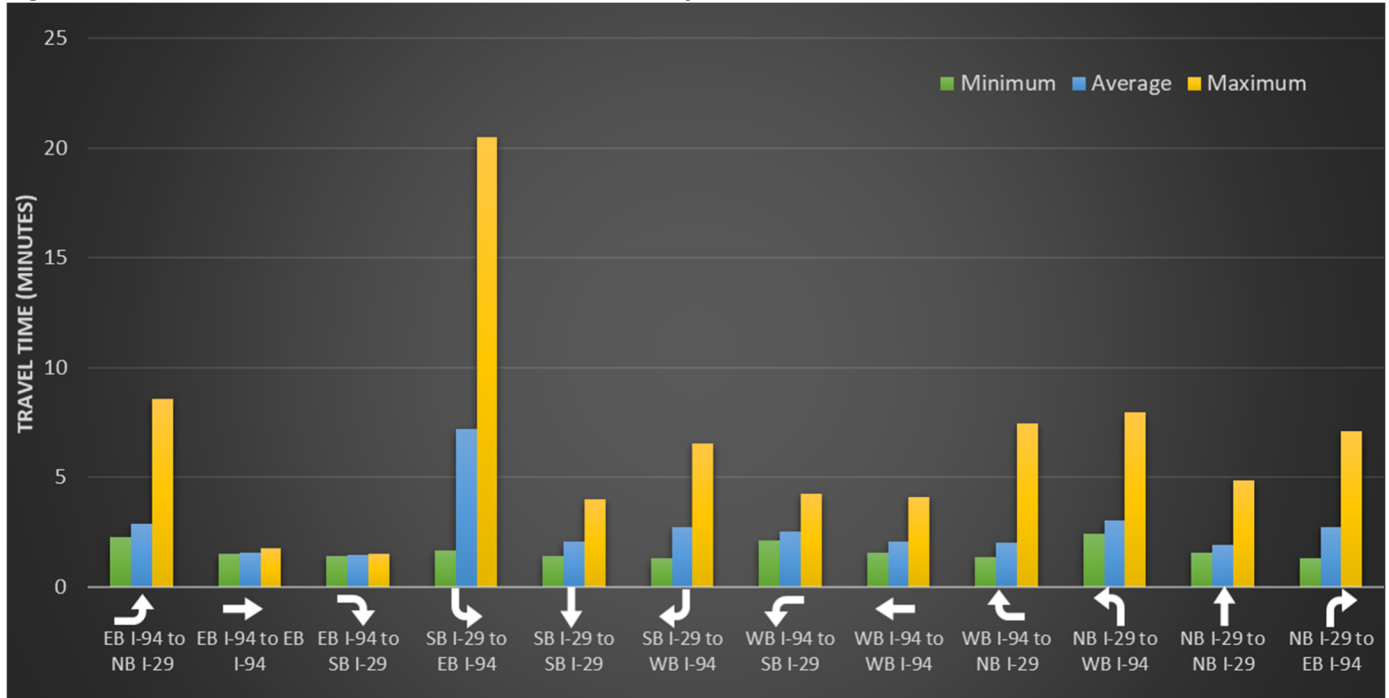
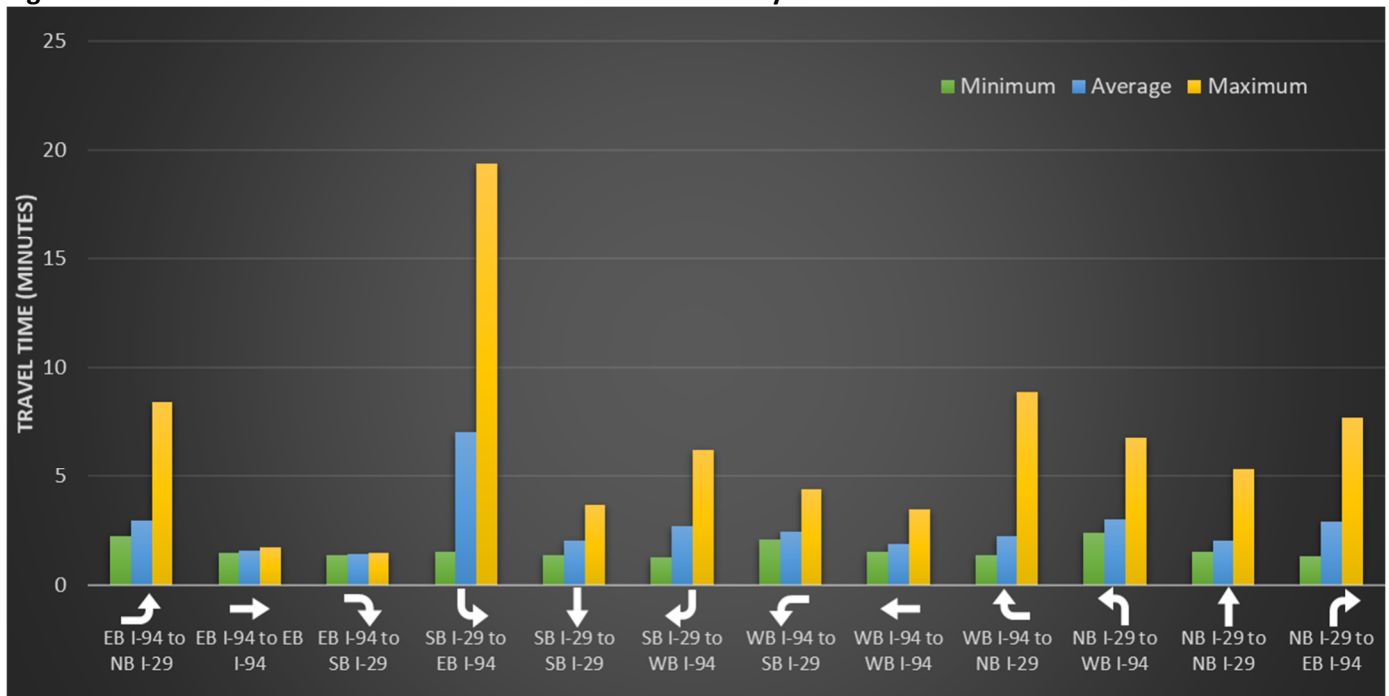


Figure 11 - 2045 Lane Utilization No Build Travel Time Reliability



Figures 10 and 11 shows how with projected 2045 volumes most movements show notable variation between minimum, average, and maximum travel times. There are only two movements (eastbound I-94 to eastbound I-94 and eastbound I-94 to southbound I-29) that show minimal variation between the three travel times. All other movements show a significant difference between the minimum/average and maximum travel times. This indicates that several of the movements at the I-29/I-94 interchange will become congested with an increase in traffic volumes.

Since the southbound I-29 to eastbound I-94 movement showed the greatest variation in travel time, an hourly analysis was completed to see when the longer travel time occurs and how long they would last. Figure 12 below shows the results of this analysis for each existing and no build scenario analyzed.

Figure 12 - SB I-29 to EB I-94 Existing/No Build Condition Travel Time Comparison

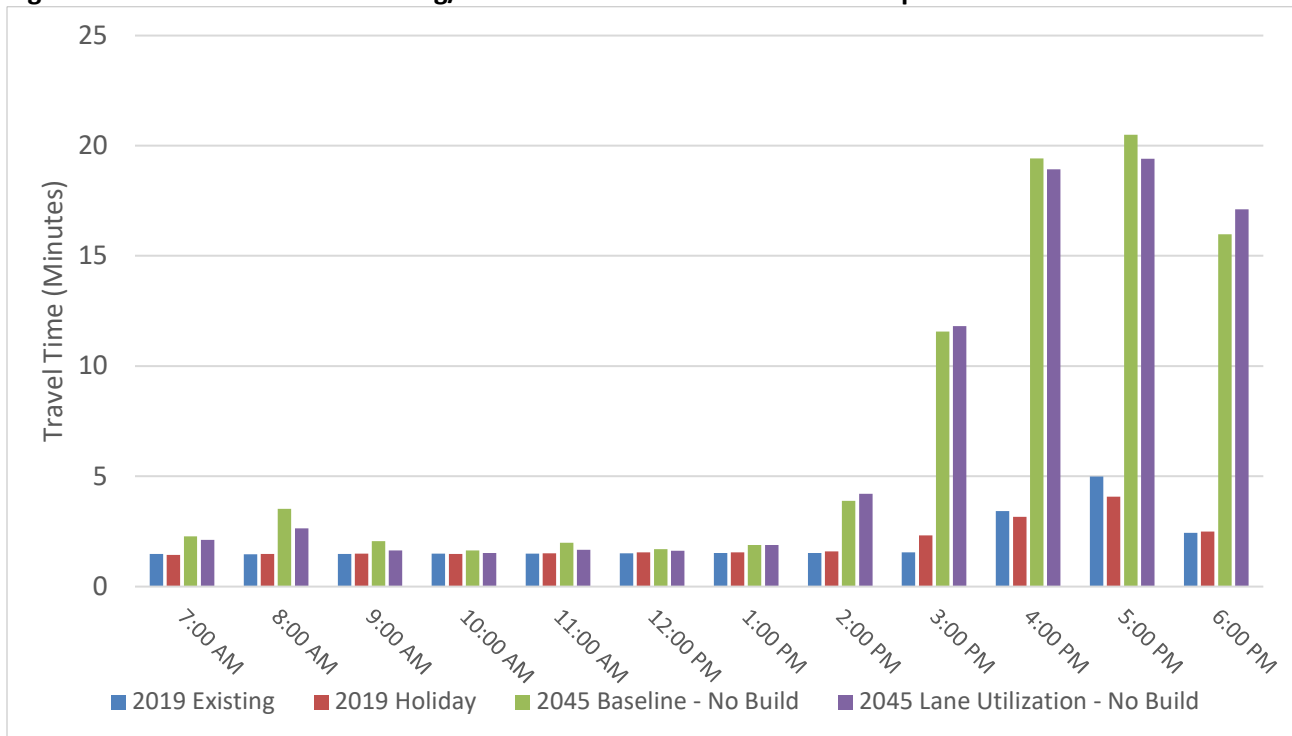


Figure 12 shows that with 2019 volumes the 4:00 PM and 5:00 PM hours see an increase in travel time from about 1.5 minutes for most of the day to about 3-5 minutes. During the 2045 baseline and lane utilization no build scenarios the travel time shows a slight increase during the 7:00 AM, 8:00 AM, and 2:00 PM hours. There is a significant increase in travel time between 3:00 PM and 7:00 PM, showing how with the higher traffic volumes traffic congestion is much worse and last for a longer period of time.

Level of Service

Peak hour level of service was compared for each scenario for all roadway segments at the I-29/I-94 interchange. The level of service (LOS) thresholds based on density according to the Highway Capacity Manual (HCM) for basic freeway, merge and diverge, and freeway weaving segments are shown in Table 6. The density is shown in passenger cars per mile per lane (pc/mi/ln).

Table 6. LOS Criteria
(Exhibits 12-15, 13-6, and 14-3 in the HCM)

LOS	Density (pc/mi/ln)		
	Basic Freeway Segments	Merge and Diverge Segments	Freeway Weaving Segments
A	</= 11	</= 10	</= 10
B	>11-18	>10-20	>10-20
C	>18-26	>20-28	>20-28
D	>26-35	>28-35	>28-35
E	>35-45	>35	>35-43
F	>45 or demand exceeds capacity	demand exceeds capacity	>43 or demand exceeds capacity

The HCM describes the LOS thresholds as follows:

- LOS A: free-flow operations. Vehicles are almost completely unimpeded in their ability to maneuver within the traffic stream.
- LOS B: reasonably free-flow operations. The freedom of vehicles to maneuver within the traffic steam is only slightly restricted.
- LOS C: travel speeds are near the free-flow speed. The freedom of vehicles to maneuver within the traffic steam is noticeably restricted so lane changes require more care and vigilance on the driver.
- LOS D: traffic speeds begin to decline with increasing traffic flow. The freedom of vehicles to maneuver within the traffic steam is seriously limited and drivers experience reduced comfort
- LOS E: the highway is operating near capacity. Operations are highly volatile as there is little room for vehicles to maneuver withing the traffic stream.
- LOS F: traffic flow is unstable. Traffic demand exceeds capacity. Traffic congestion/queuing occurs.

Figures 13 through 16 show the PM peak hour (5:00 – 6:00 PM) level of service by segment throughout the I-29/I-94 interchange for the existing and 2045 no build scenarios. The detailed LOS data is included in **Appendix D**.

Figure 13 - Existing (2019) PM Peak Level of Service

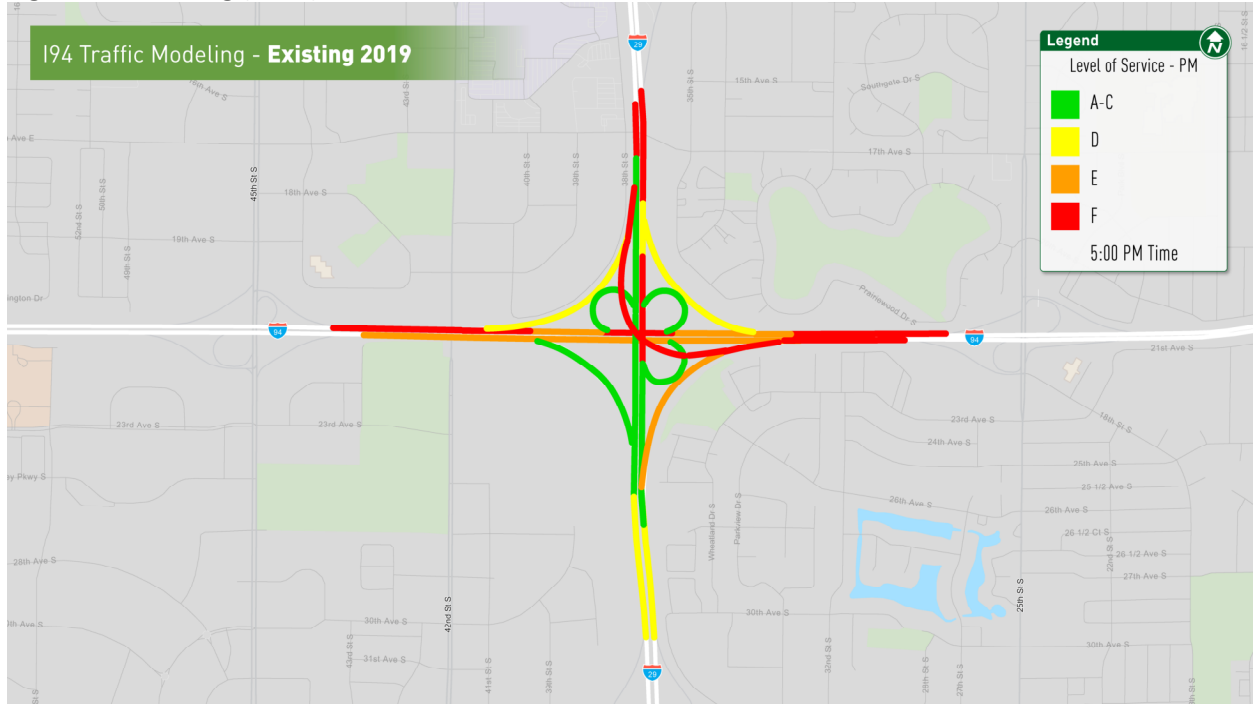


Figure 13 shows failing LOS along the southbound I-29 to eastbound I-94 movement, along westbound I-94, and along NB I-29 north of the interchange.

Figure 14 - Friday Holiday (2019) PM Peak Level of Service

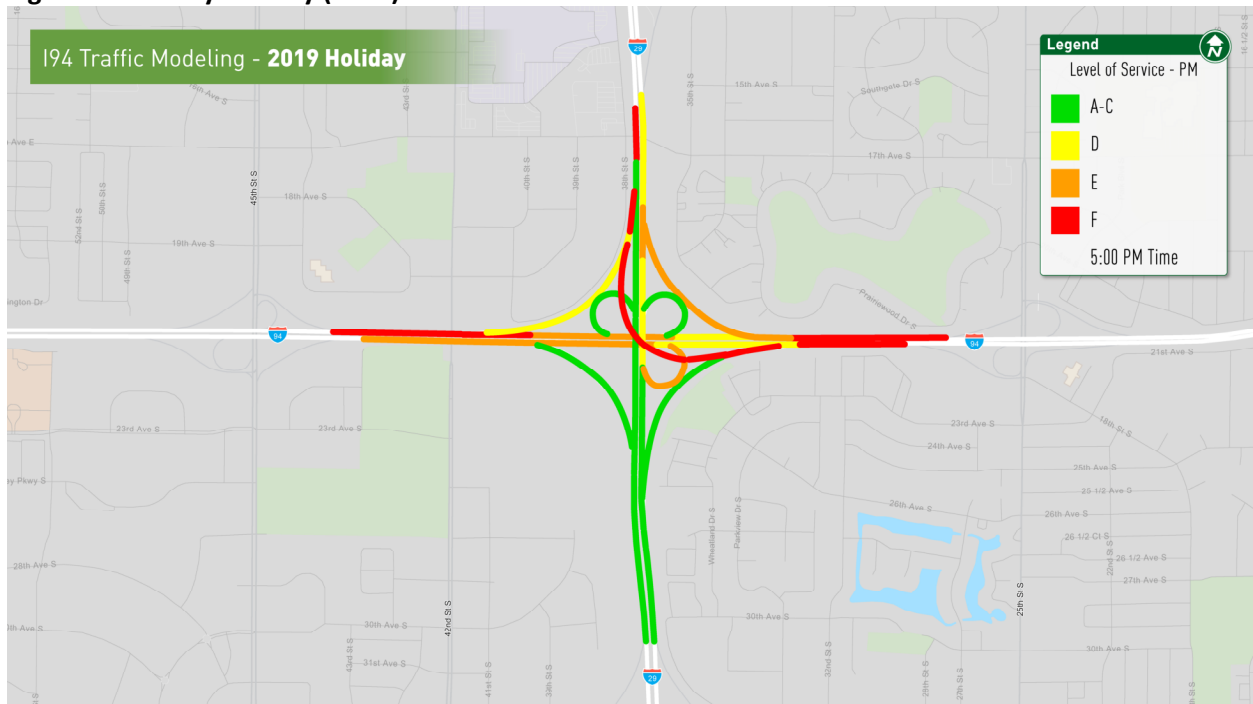


Figure 14 shows failing LOS along the southbound I-29 to eastbound I-94 movement and along westbound I-94.

Figure 15 – 2045 Baseline No Build PM Peak Level of Service

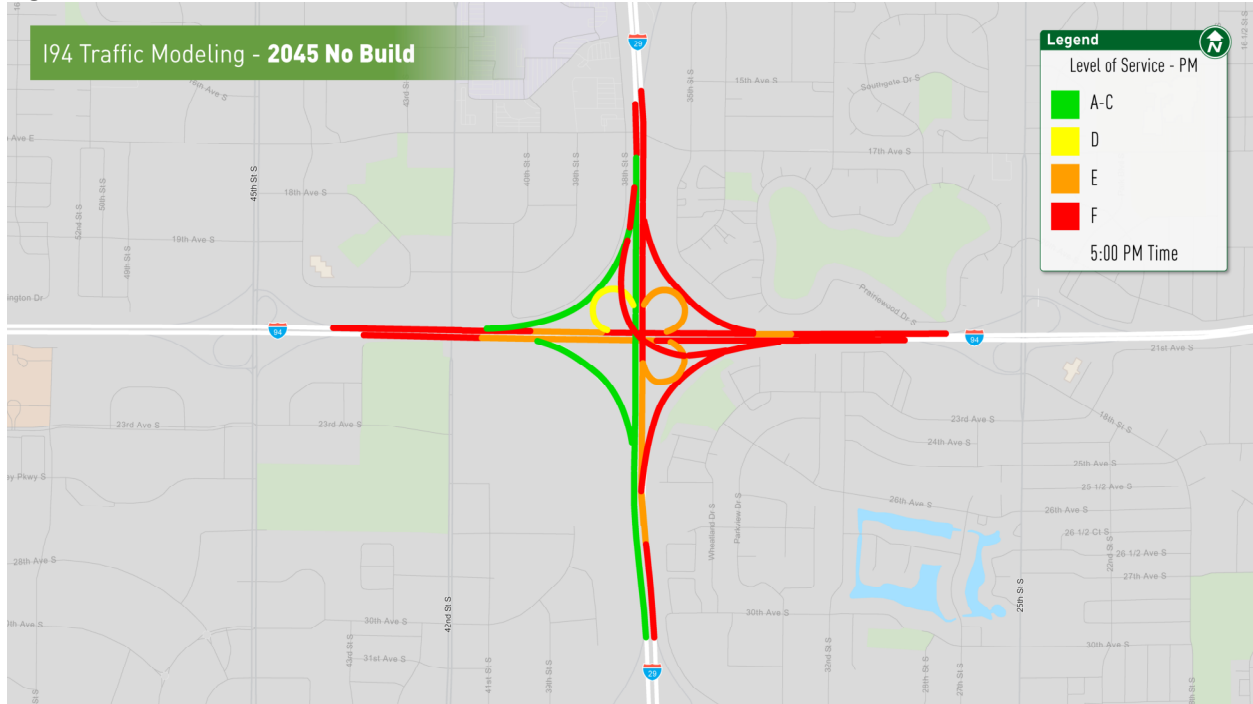


Figure 15 shows failing LOS along the southbound I-29 to eastbound I-94 movement, northbound I-29 to eastbound I-94 movement, along both eastbound and westbound I-94, and along NB I-29.

Figure 16 – 2045 Lane Utilization No Build PM Peak Level of Service

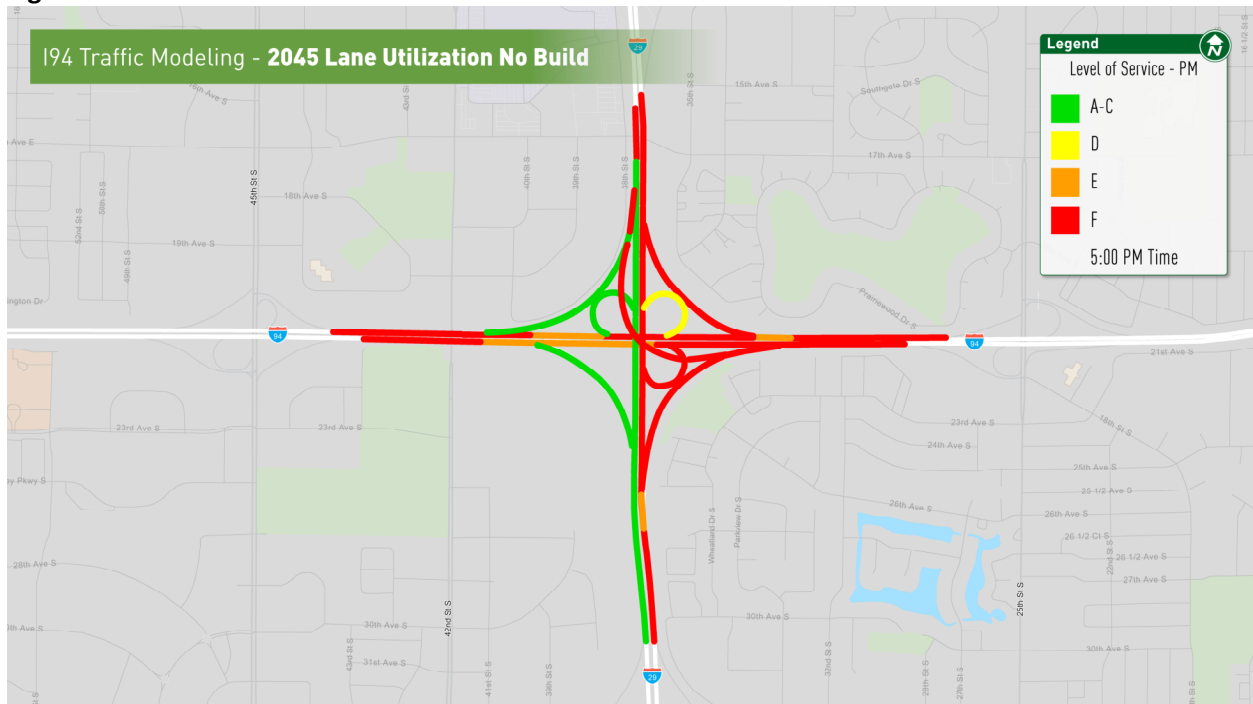


Figure 16 shows failing LOS along the southbound I-29 to eastbound I-94 movement, northbound I-29 to eastbound I-94 movement, along both eastbound and westbound I-94, along northbound I-29, and along the eastbound to northbound loop ramp.

Build Analysis

The build alternative analyzed improved the southbound I-29 to eastbound I-94 movement by making the following changes:

- The two lanes along the southbound to eastbound flyover ramp are maintained for the entire distance
- With two lanes maintained along the flyover ramp, a lane is added along eastbound I-94 between the entrance ramp from northbound/southbound I-29 and the exit ramp to 25th St
- The added outside lane along eastbound I-94 must exit at 25th Street
- The second most outside lane along eastbound I-94 remains the same as today, with traffic in this lane given the choice to either exit at 25th Street or remain on eastbound I-94
- Traffic coming from northbound I-29 destined for eastbound I-94 remains the same as today and must merge with the southbound to eastbound traffic

Travel Time

Travel time was compared for each scenario with the build alternative. **Figures 17 through 20** below show minimum, average, and maximum travel times throughout the 12-hour model for each movement for the build scenarios. The detailed travel time data is included in **Appendix D**.

Figure 17 - 2019 Build Travel Time Reliability

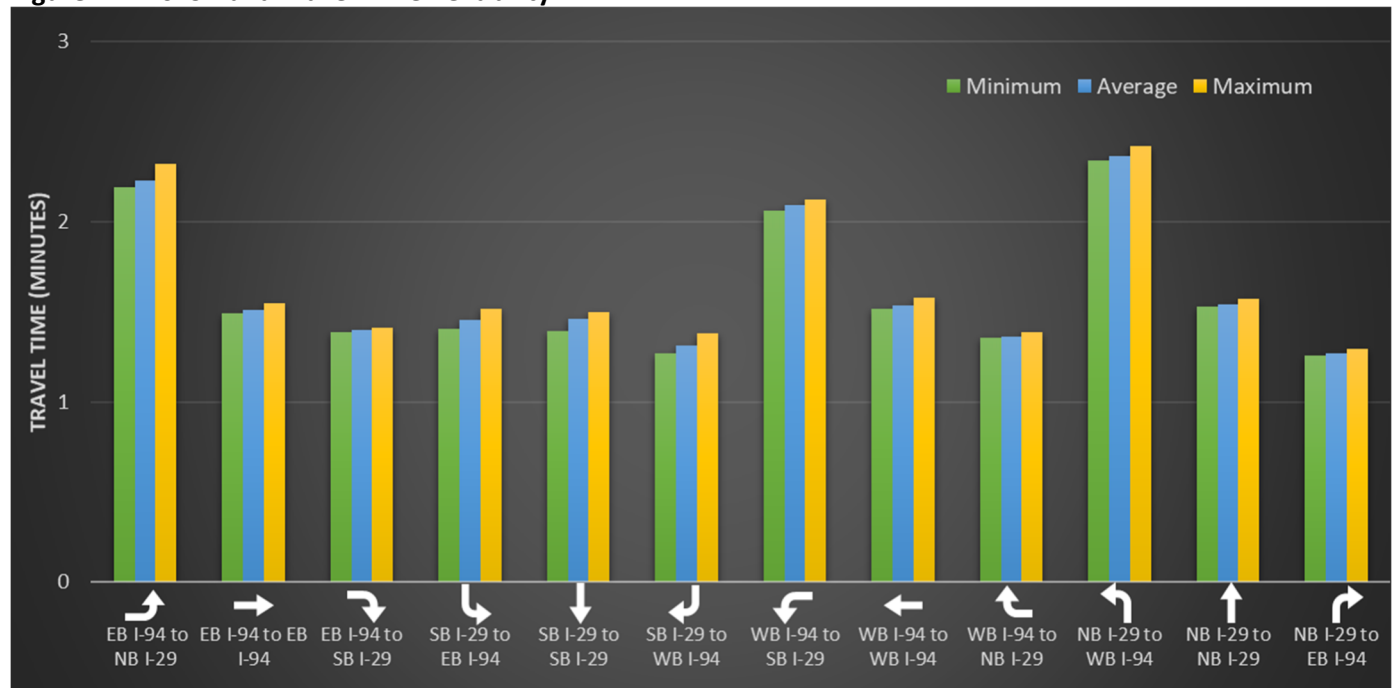
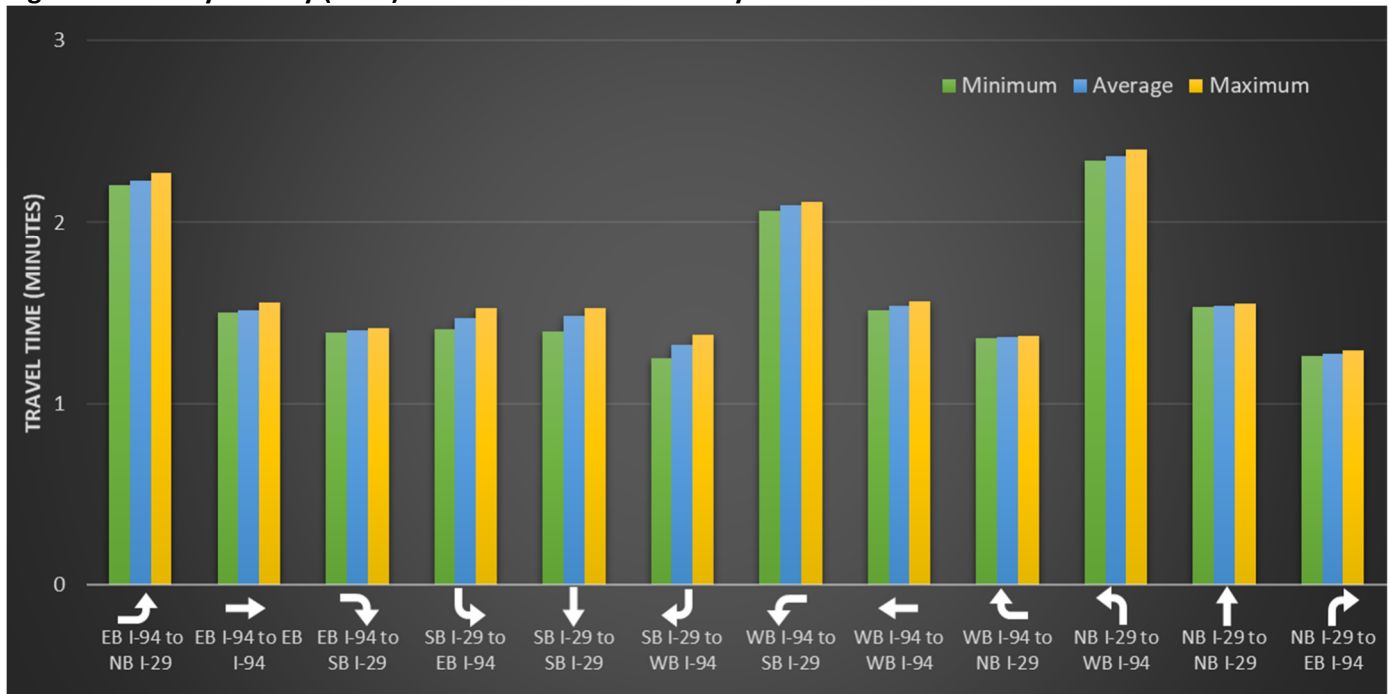


Figure 18 - Friday Holiday (2019) Build Travel Time Reliability



Figures 17 and 18 shows that for all movements the minimum, average, and maximum travel times have minimal variation in travel time. This analysis illustrates how with 2019 volumes the build alternative is anticipated to operate with minimal delay throughout the day. The southbound I-29 to eastbound I-94 movement shows a reduction in the peak travel time from 5 minutes during the 2019 existing condition down to 1.5 minutes with the build alternative.

Figure 19 - 2045 Baseline Build Travel Time Reliability

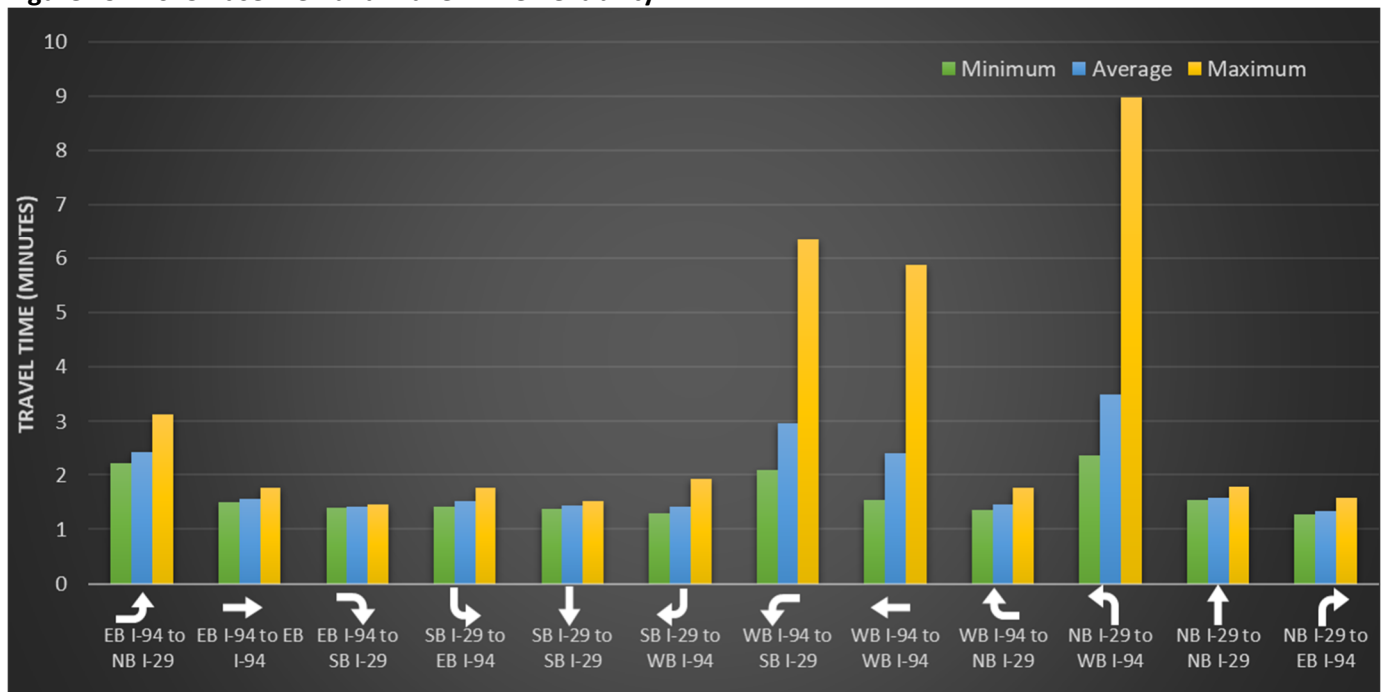
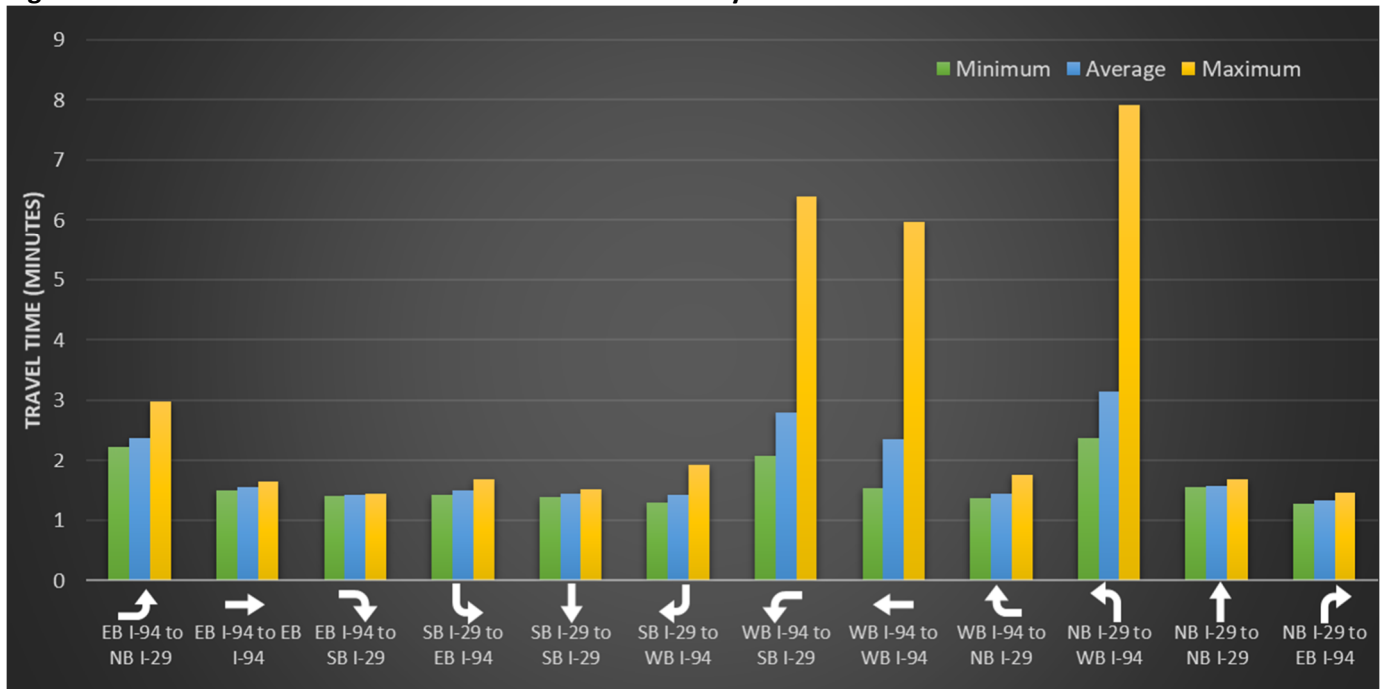


Figure 20 - 2045 Lane Utilization Build Travel Time Reliability



Figures 19 and 20 shows how with 2045 volumes several movements begin to operate poorly as the maximum travel time is much higher than the minimum and average travel time. The westbound I-94 to southbound I-29, westbound I-94 to westbound I-94, and northbound I-29 to westbound I-94 movements show poor operations with significantly longer maximum travel times. These movements operate with a longer travel time due to the congestion surrounding the weave area between the two loop ramps on the north side of the interchange. The southbound I-29 to eastbound I-94 movement still shows minimal variation in travel time with 2045 volumes, indicating that the improvement to this movement is anticipated to continue to operate well with higher volumes in the future.

Level of Service

Figures 21 through 24 show the PM peak hour (5:00 – 6:00 PM) level of service by link throughout the I-29/I-94 interchange for the build scenarios. The detailed LOS data is included in Appendix D.

Figure 21 – 2019 Build PM Peak Level of Service

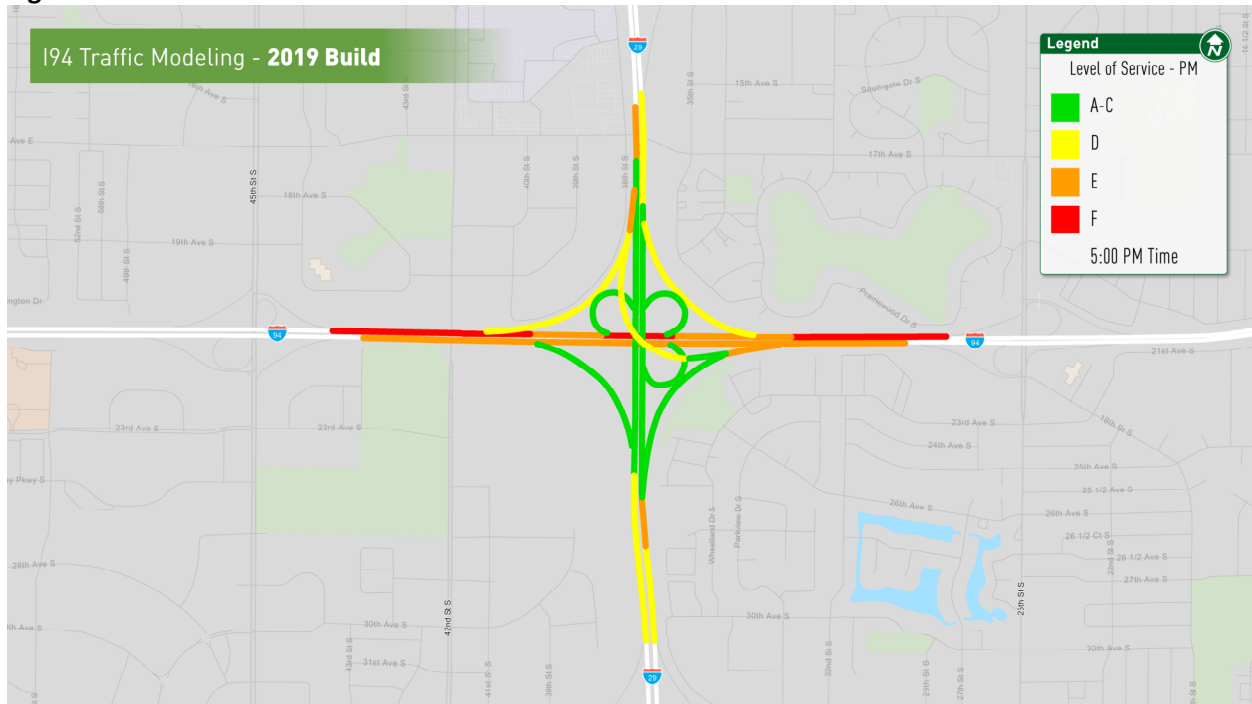


Figure 21 shows failing LOS along westbound I-94 with the build alternative; however, traffic speeds were shown to remain above 40 MPH in the traffic model for traffic along westbound I-94. The level of service improves along the southbound I-29 to eastbound I-94 movement from LOS F to LOS C through E.

Figure 22 – Friday Holiday (2019) Build PM Peak Level of Service

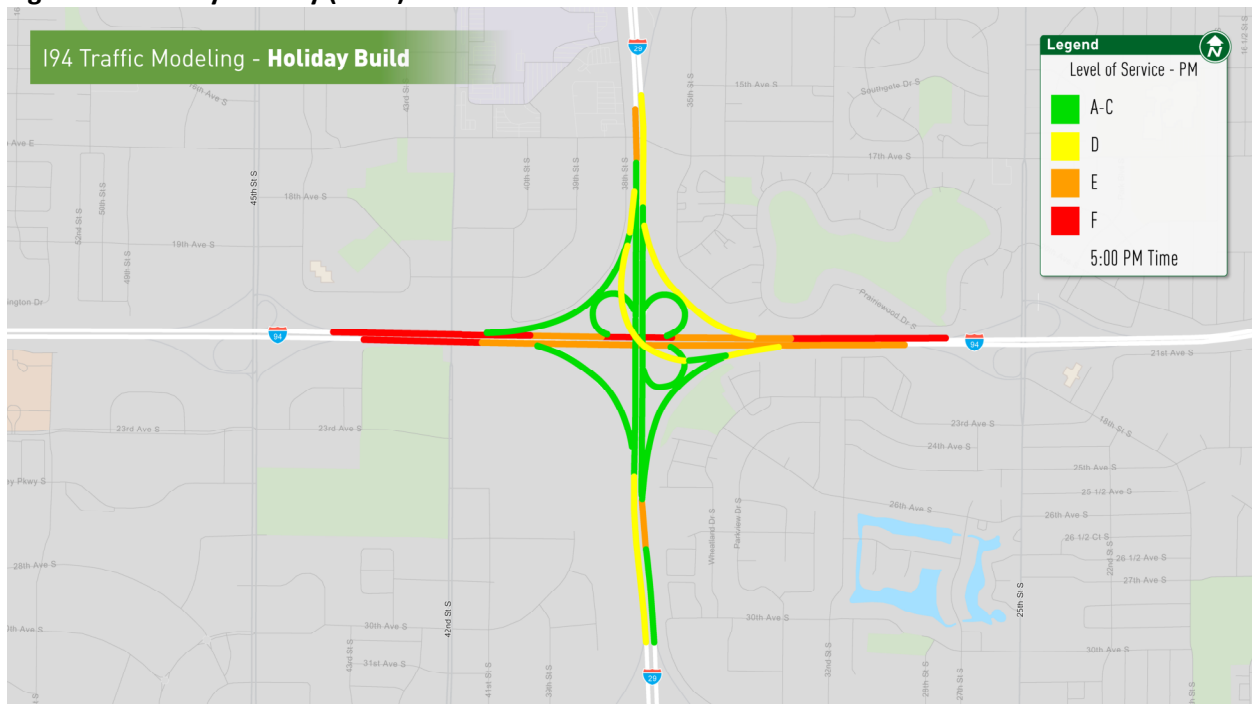


Figure 22 also shows failing LOS along westbound I-94 with the build alternative, but again traffic speeds were shown to remain above 40 MPH along westbound I-94. The level of service improves along the southbound I-29 to eastbound I-94 movement from LOS F to LOS C or D.

Figure 23 – 2045 Baseline Build PM Peak Level of Service

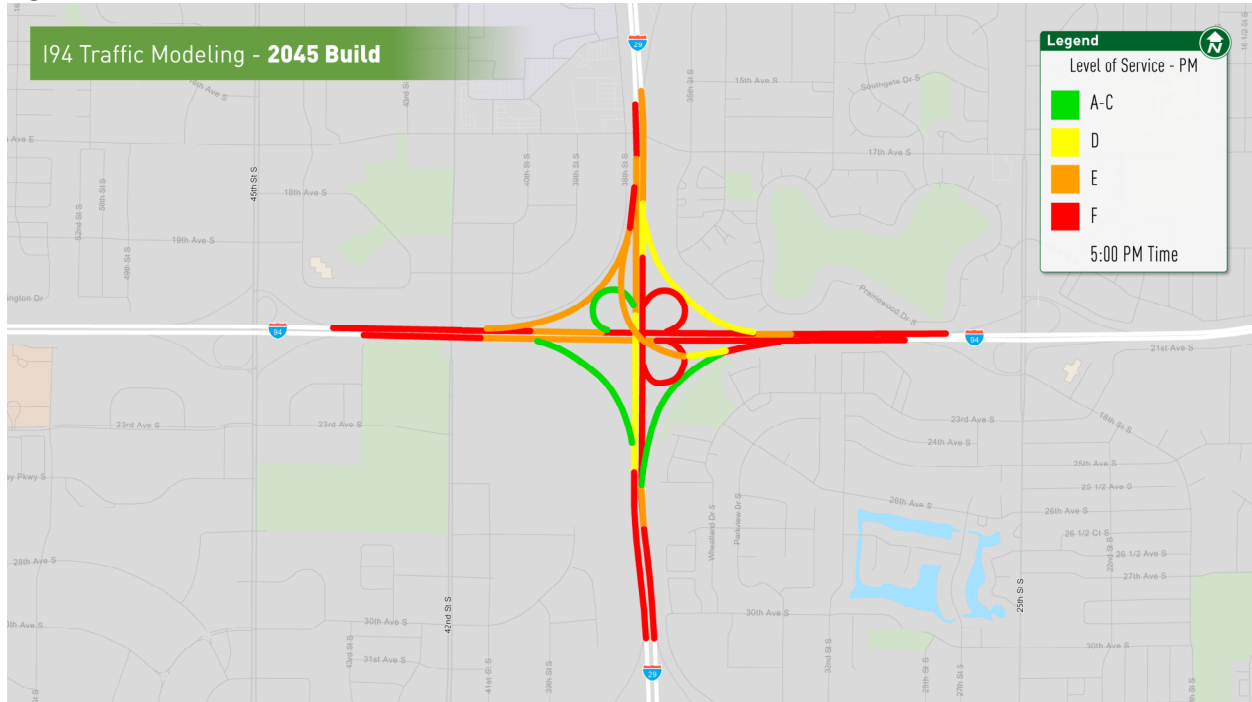


Figure 23 shows failing LOS along both eastbound and westbound I-94, along northbound and southbound I-29 south of the interchange, along southbound I-29 north of the interchange, along northbound I-29 adjacent to the interchange, along the eastbound to northbound loop ramp, and along the northbound to westbound loop ramp. This indicates that further improvements are needed in the future to mitigate operations at the I-29/I-94 interchange. The average speed of traffic was found to be 8 MPH along westbound I-94 between the loop ramps which indicates that the interchange will be deficient well beyond LOS "F."

Figure 24 – 2045 Lane Utilization Build PM Peak Level of Service

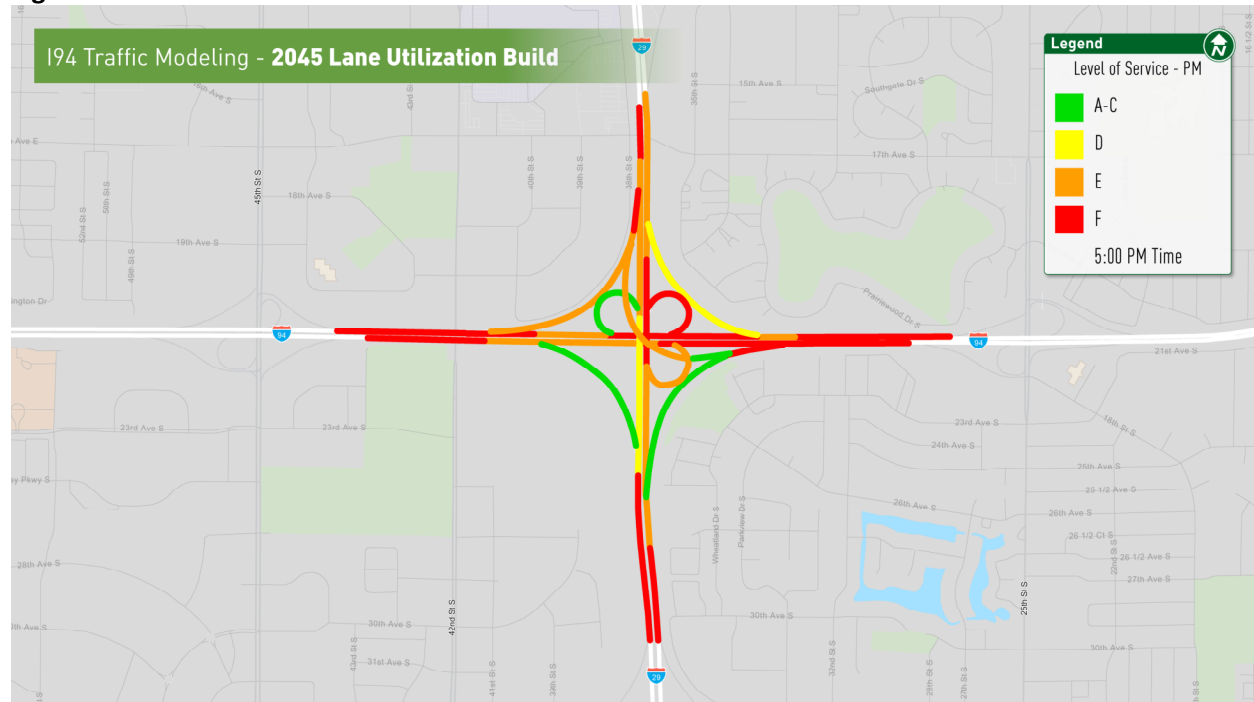


Figure 24 shows similar operation to the 2045 Baseline Build scenario with failing LOS along both eastbound and westbound I-94, along northbound and southbound I-29 south of the interchange, along southbound I-29 north of the interchange, along northbound I-29 adjacent to the interchange, and along the northbound to westbound loop ramp. The average speed of traffic was found to be 9 MPH along westbound I-94 between the loop ramps which indicates that the interchange will be deficient well beyond LOS "F."

Sensitivity Analysis

Traffic Speeds

A sensitivity analysis was completed to estimate when traffic speeds would drop below 40 and 30 MPH along westbound I-94. This was completed by comparing speed, density, and assuming linear growth between 2019 and 2045. The analysis indicates that traffic speeds along westbound I-94 between the loop ramps will be less than 40 MPH by 2025 and less than 30 MPH by 2030.

Flyover Ramp Lane Utilization

The lane utilization analysis indicated that drivers start changing lanes between 0.4 and 1.1 miles prior to exiting. For exit ramps where data wasn't available (including the 25th Street exit ramp), we used a half mile as the basis. Since the flyover ramp is the primary improvement in focus, we completed a sensitivity analysis of the 2019 Build model testing multiple lane change distance scenarios for traffic exiting at 25th Street. The lane change distance for traffic exiting at 25th Street was increased from half a mile to three-fourths a mile and one mile to see how an increased lane change distance impacts the lane utilization and traffic operations. The PM peak hour lane utilization was compared for each option and is shown in **Table 7** below. The lane utilization data was collected at the end of the flyover ramp just before the northbound to eastbound traffic merges with the southbound to eastbound traffic. This location is about a half mile from the 25th Street exit.

Table 7. PM Peak Hour (5:00-6:00pm) Sensitivity Analysis

Lane Change Distance	Number of Vehicles		SB to EB Travel Time (seconds)			Change in Density along Flyover Ramp (pc/mi/ln)
	Inside/Left Lane	Outside/Right Lane	Minimum	Average	Maximum	
1/2 Mile	659 (49%)	688 (51%)	84	87	91	-
3/4 Mile	1093 (81%)	260 (19%)	85	88	92	+3
1 Mile	1071 (79%)	284 (21%)	91	97	102	+8

Table 7 shows how with the lane change distance half a mile the lane utilization along the flyover ramp is about 50/50. With the lane change distance increased to three-fourths a mile or a mile most of the traffic uses the inside/left lane. Of the vehicles on the flyover ramp during the 2019 PM peak hour, 298 (22%) exit at 25th Street and 1061 (78%) continue along eastbound I-94 so with a lane change distance of three-fourths a mile or a mile traffic is only in the outside lane if they exit at 25th Street.

The average travel time per hour was analyzed with each lane change option. With the lane change distance set to three-fourths a mile all travel times were found to be the same or change by at most one second compared to the travel times shown with the half mile lane change distance. With the lane change distance set to one mile the southbound I-29 to eastbound I-94 movement travel time was found to minimally increase between 7 and 11 seconds throughout the day. All other movements remained the same.

The LOS analysis comparison between the three lane change options showed nearly identical density and LOS results. The density along the flyover ramp changed by at most three passenger cars per mile per lane with the lane change distance increased to three-fourths a mile and by at most eight passenger cars per mile per lane with the lane change distance increased to one mile.

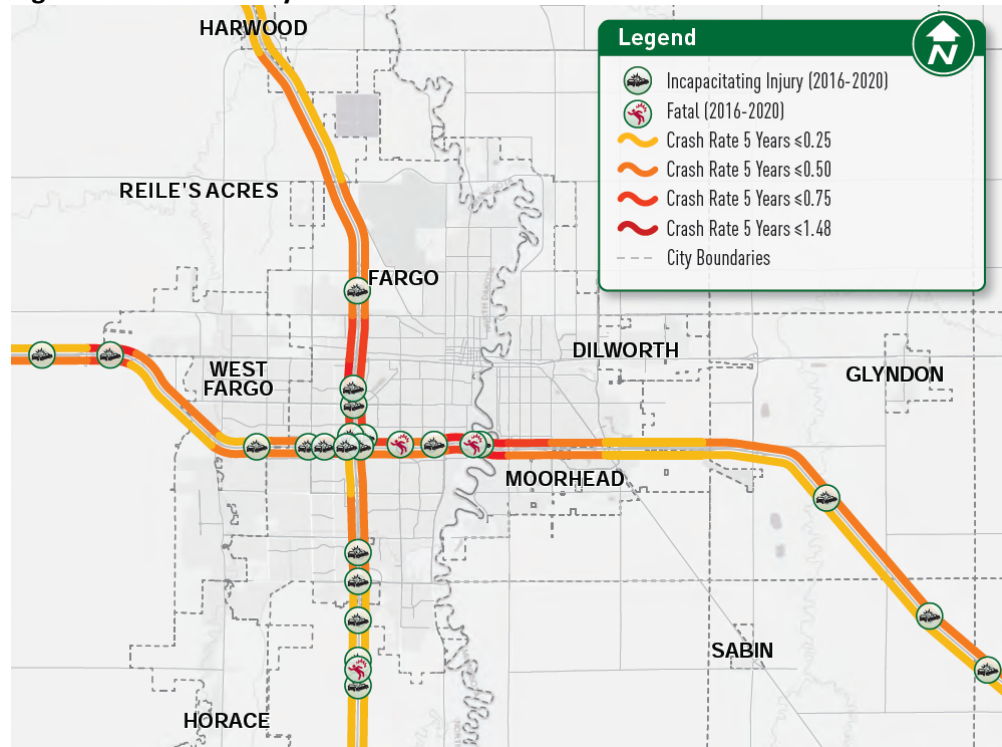
The sensitivity analysis indicates traffic operations remain about the same with the lane change distance increased and most people using the inside lane.

A way to improve lane utilization for the flyover ramps could be to alter the lane configuration of the two lane section leading up to the I-94 ramps from southbound I-29. Prior to the flyover ramp, instead of all of the traffic in the left lane entering the flyover ramp to eastbound I-94 and all of the traffic in the right lane entering the ramp to westbound I-94, the right lane could be altered so that vehicles could choose to either get onto the ramp to westbound I-94 as they do today or enter the outside flyover ramp lane. The left lane along the southbound exit ramp lane would be directed to enter the left or inside lane on the flyover ramp.

Conflict/Crash Potential Analysis

The connection between safety and congestion is never more evident than at this location, where high-speed traffic converges with stopped traffic. As shown in **Figure 25** below there have been several incapacitating injury crashes and a few fatal crashes in the project area within the last five years (2016-2020). The areas experiencing more congestion are the portions of roadway with higher crash rates due to friction caused by stopped or slowing vehicles which disrupts driver expectancy. As congestion worsens it leads to a disproportionate number of severe injury crashes. Addressing congestion in the project area is necessary to improve the safety of the entire interstate system through the Fargo-Moorhead-West Fargo metro.

Figure 25 – Crash Analysis



Methodology

Potential safety impacts associated with existing and projected congestion issues, as well as safety impacts that could be expected with roadway improvements were assessed using the Surrogate Safety Assessment Model (SSAM). SSAM is an FHWA-sponsored computer program that quantifies vehicle conflicts using vehicle trajectory information derived from the outputs of Vissim traffic simulation models.

SSAM quantifies conflict totals for the following types of conflicts:

- Rear-end conflicts
- Crossing conflicts (i.e. angle conflicts)
- Lane change conflicts

It is important to understand that SSAM-tabulated conflicts do not only reflect modeled vehicle collisions, but also reflect near-misses. As such, SSAM results should not be interpreted as the number of crashes, rather the number of situations that have a high potential for collisions to occur.

Safety analysis in this project quantified SSAM-tabulated conflicts for each scenario during the AM peak period (7 am to 9 am) and during the PM peak period (4 pm to 6 pm). Note that SSAM analysis focused only on the influence area of the I-94/I-29 interchange and not on other interchanges in the study area. As such, crossing conflicts are not tabulated as part of this analysis.

Analysis Results

Existing Roadway Configuration

- 2019 Typical Day
 - The PM peak hour has over 18 times the number of simulated conflicts when compared to the AM peak hour
 - The majority of PM peak hour conflicts are rear-end conflicts (59 percent), where the vast majority of AM peak hour conflicts are lane change conflicts (91 percent). Higher

rear-end crash potential in the PM peak hour is a result of increased congestion resulting in significant queuing

- 2019 Holiday
 - Conflict potential on the Interstate system is lower during the holiday season, with 28 percent fewer PM peak hour conflicts and 52 percent fewer AM conflicts. The large discrepancy between AM and PM peak hour conflict potential however persists, with PM peak hour conflicts being 28 times higher than AM peak hour conflicts
 - The lower overall conflict potential is a result of atypically high traffic conditions during the holiday season generally being confined to the 13th Avenue business district
 - Similar conflict distribution trends are seen during the holiday season when compared to a typical day. 55 percent of PM peak hour conflicts are rear-end conflicts, where 93 percent of AM peak hour conflicts are lane change conflicts
- 2045 Baseline Scenario (LRTP Forecast Scenario)
 - Traffic increases are expected to increase crash potential, with 2045 conflict totals being around 3.6 times higher in the 2045 AM peak when compared to the 2019 AM peak, and 2045 conflict totals being 4.9 times higher in the 2045 PM peak compared to the 2019 PM peak
 - The discrepancy between AM and PM peak hour conflicts is expected to remain through 2045, with the 2045 PM peak hour having 25 times the number of conflicts when compared to the 2045 AM peak hour
- 2045 Lane Utilization Scenario
 - Traffic redistribution off the Interstate system is expected to have a modest impact on AM peak hour conflicts, with conflicts being 16 percent lower in the Lane Utilization Scenario.
 - Simulated conflicts are slightly higher in the Lane Utilization Scenario when compared to the Baseline Scenario (three percent higher). The increase is primarily a consequence of simulation in very congested environments. Small operations improvements from modest volume shifts in the Lane Utilization scenario result in traffic being able to move slightly better. This results in more stop and go traffic conditions, which in turn yields a higher rear-end crash potential.

With Proposed Roadway Improvements

- 2019 Typical Day
 - Roadway improvements are not expected to have a significant impact on crash potential in the AM peak hour.
 - Significant improvements are expected in the PM peak hour, with a 98 percent reduction in rear-end conflicts and a 63 percent reduction in lane change conflicts, resulting in an overall conflict reduction of 84 percent.
- 2019 Holiday
 - Roadway improvements are not expected to have a significant impact on crash potential in the AM peak hour.
 - Significant improvements are however expected in the PM peak hour, with a 98 percent reduction in rear-end conflicts and a 55 percent reduction in lane change conflicts, resulting in an overall conflict reduction of 79 percent.

- 2045 Baseline Scenario (LRTP Forecast Scenario)
 - Overall conflict potential is expected to be reduced by 26 percent in the AM peak hour, with a 36 percent reduction in rear-end conflicts, and a 21 percent reduction in lane change conflicts
 - A greater conflict reduction is expected in the PM peak hour, with an overall conflict reduction of 55 percent. Rear end conflicts would be expected to reduce by 53 percent, and there is a projected 59 percent reduction in lane change conflicts
 - While the proposed improvement is expected to provide significant safety benefits in 2045, the future PM peak conditions are still expected to have a crash potential that is 2.2 times higher than the 2019 PM peak hour with the existing roadway configuration.
- 2045 Lane Utilization Scenario
 - Overall, the AM peak hour conflict potential is expected to be reduced by 16 percent with roadway improvements, with a 46 percent reduction in rear-end conflicts, and a 7 percent reduction in lane change conflicts
 - A significant conflict reduction is expected with improvements in the PM peak, with an overall 66 percent conflict reduction (68 percent reduction in rear-end conflicts, 64 percent reduction in lane change conflicts)
 - Like the Baseline Scenario, 2045 PM peak hour conflict reduction is expected to be significant with improvements, however the 2045 PM peak conflict total with improvements is still 1.7 times higher than the 2019 PM peak hour under the existing roadway configuration.

Crash Analysis Summary

Based on the analysis results described above, the following high-level takeaways were found:

- AM peak hour crash benefits will be minimal with roadway improvements under existing traffic volumes. However, these benefits will become more significant as traffic volumes increase over time
- PM peak hour crash benefits with roadway improvements are significant under existing traffic volumes and under 2045 traffic volumes. PM peak hour crash potential with improvements in 2045 will still be elevated compared to existing conditions, suggesting that a more comprehensive set of roadway improvements will be necessary to mitigate long-term crash potential

The detailed results of the SSAM analysis are summarized below in **Table 8**.

Table 8. Summary of SSAM Crash Conflicts

SSAM Safety Analysis								
SSAM Conflicts	AM Peak Conflict Results							
	2019 Existing	2019 Build	2019 Holiday	2019 Holiday Build	2045 No build	2045 Build	2045 LU No Build	2045 LU Build
Total	628	618 1.7%	303	319 -5.3%	2238	1874 16.3%	1662	1579 5%
Rear End	55	51 7.4%	21	15 28.6%	686	413 39.8%	440	224 49.1%
Lane Change	573	566 1.1%	282	304 -7.8%	1552	1461 5.9%	1222	1355 -10.9%
PM Peak Conflict Results								
SSAM Conflicts	2019 Existing	2019 Build	2019 Holiday	2019 Holiday Build	2045 No build	2045 Build	2045 LU No Build	2045 LU Build
	Total	11668	1854 84.1%	8477	1810 78.6%	56890	25608 55%	58738
Rear End	6875	99 98.6%	4631	75 98.4%	42257	19627 53.6%	44627	15083 66.2%
Lane Change	4793	1755 63.4%	3846	1735 54.9%	14633	5981 59.1%	14111	5073 64%

Benefit Cost Analysis

A benefit cost analysis was completed to determine if the proposed alternative design is an investment that offers delay and safety benefits offsetting the cost to construct the alternative.

Delay Benefit

The total interchange delay in hours for the 12-hour model was determined for the 2019 Existing Conditions and the 2019 Build scenarios. **Table 9** shows the total delay for each scenario.

Table 9. Total Delay (Hours)

Scenario	No Build Delay (Hours)	Build Delay (Hours)
2019	700	438

Auto delay and truck delay values were computed using a truck percentage of 6.4 percent. The 6.4 percent truck traffic was estimated by averaging the most recent heavy commercial counts along I-94 and I-29 in the project area from the NDDOT Transportation Information Map. The following values of travel time savings per person-hour were taken from the U.S. Department of Transportation benefit-cost analysis guidance:

- \$16.60 for autos
- \$29.50 for trucks

Taking the reduction in delay and travel time savings into account, the first year of delay benefits for the build scenario come to \$1,666,410.

Safety Benefit

Crash reduction factors for the build alternative were determined based on the SSAM results in Vissim. SSAM results were analyzed to determine the percent reduction in rear end and lane change conflicts by comparing the existing conditions and build alternative. Since SSAM conflicts were tabulated for both the AM peak period (7 am to 9 am) and the PM peak period (4 pm to 6 pm), a weighted average percent reduction was determined based on traffic volumes during the AM and PM peak periods. **Table 10** shows the weighted average percent reduction in rear end and lane change SSAM conflicts for the build scenario in 2019.

Table 10. Percent Reduction in SSAM Conflicts

Scenario	Rear End	Lane Change
2019 Build	59%	37%

Rear end and sideswipe same direction crash data from 2015 to 2019 were used with the percent reduction data to generate benefits associated with crash reductions. Monetized values for crashes by severity were also taken from the U.S. Department of Transportation benefit-cost analysis guidance. The rear end crash reduction benefit was found to be \$450,123 in 2019 and the lane change crash reduction benefit was found to be \$19,411 making the overall safety benefit \$469,534.

Benefit Cost Summary

The safety and delay benefits are summarized in **Table 11** along with concept-level cost estimate and the benefit to cost ratio. A ratio greater than one indicates the project cost is less than the anticipated benefit from the investment. A ratio lower than one indicates the anticipated benefit does not offset the cost.

Table 11. Benefit Cost Summary

Safety Benefit	Delay Benefit	Total Cost	B/C Ratio
\$ 469,534	\$ 1,666,410	\$ 1,493,000	1.4

Table 11 indicates that anticipated benefits are anticipated to be higher than project costs in just the first year (2019). Since the project shows such high benefits compared to the lower cost of the improvement in just one year, a full 20+ year service life benefit cost analysis was not completed. Detailed information used in the benefit cost analysis is included in **Appendix E**.

Conclusion

The detailed traffic operations shown in this report indicate that the most congested movement at the I-29/I-94 interchange today is the southbound I-29 to eastbound I-94 movement. The PM peak travel time for this movement is five minutes which is an increase of three minutes from the off-peak travel time. The excessive delay and queuing from this movement would also cause slowdowns for the northbound I-29 to eastbound I-94 and southbound I-29 to westbound I-94 movements. If no changes are made the movement is anticipated to breakdown with congestion expected to last for several hours instead of only during the PM peak hour. In addition to longer travel times, the congested areas are showing higher crash rates. Addressing congestion in the project area is necessary to improve the safety.

A build alternative was analyzed to improve traffic operations for the southbound I-29 to eastbound I-94 movement by maintaining the two lanes along the flyover ramp and adding a lane along eastbound I-94 between the entrance ramp from northbound/southbound I-29 and the exit ramp to 25th St. This improvement shows significant operational and safety improvements with both 2019 and 2045 volumes.

In 2019 all movements at the I-29/I-94 interchange showed minimal delays and consistent travel times indicating that there was no longer congestion with the proposed improvement. The 2045 operational analysis showed minimal and consistent travel times for the southbound I-29 to eastbound I-94

movement indicating that the improvement to this movement is anticipated to continue to operate well with higher volumes in the future. The crash potential analysis indicated that the PM peak hour crash benefits with roadway improvements are significant under existing and 2045 traffic volumes. However, in 2045 the PM peak hour crash potential with improvements is higher than the existing condition, suggesting that a more comprehensive set of roadway improvements will be necessary to mitigate long-term crash potential.

By 2045 other movements start to show operational issues. The movements that show poor operations in 2045 include the westbound I-94 to southbound I-29, westbound I-94 to westbound I-94, and northbound I-29 to westbound I-94 movements. These movements operate with a longer travel time due to the congestion surrounding the weave area between the two loop ramps on the north side of the interchange.

Overall, this analysis indicates that the investment to improve the southbound I-29 to eastbound I-94 movement is worthwhile as the anticipated delay and safety benefits in the first year after construction exceed the construction cost of the improvements. Additionally, these improvements are anticipated to maintain an acceptable level of service even with 2045 volumes.

Future Considerations

The intent of this report was to analyze the effectiveness of the Build Improvement. While this goal was achieved, several new issues arose through the process. While these are outside the scope of this report, they are noted to guide future analysis.

Traffic Growth

The regional travel demand model projected uncontrolled growth along the interstate system, which the microsimulation model illustrates cannot be reasonably serviced. The travel demand model uses travel time assumptions to route traffic through the system. The high speeds and minimal access on the interstate system make these routes appealing to the math-based model, even under the most congested situations. Further efforts should be made to calibrate the travel demand model to better reflect realistic limitations on the interstate system. Otherwise, traffic volumes and subsequent congestion will be underrepresented on the local system in the future.

Technology

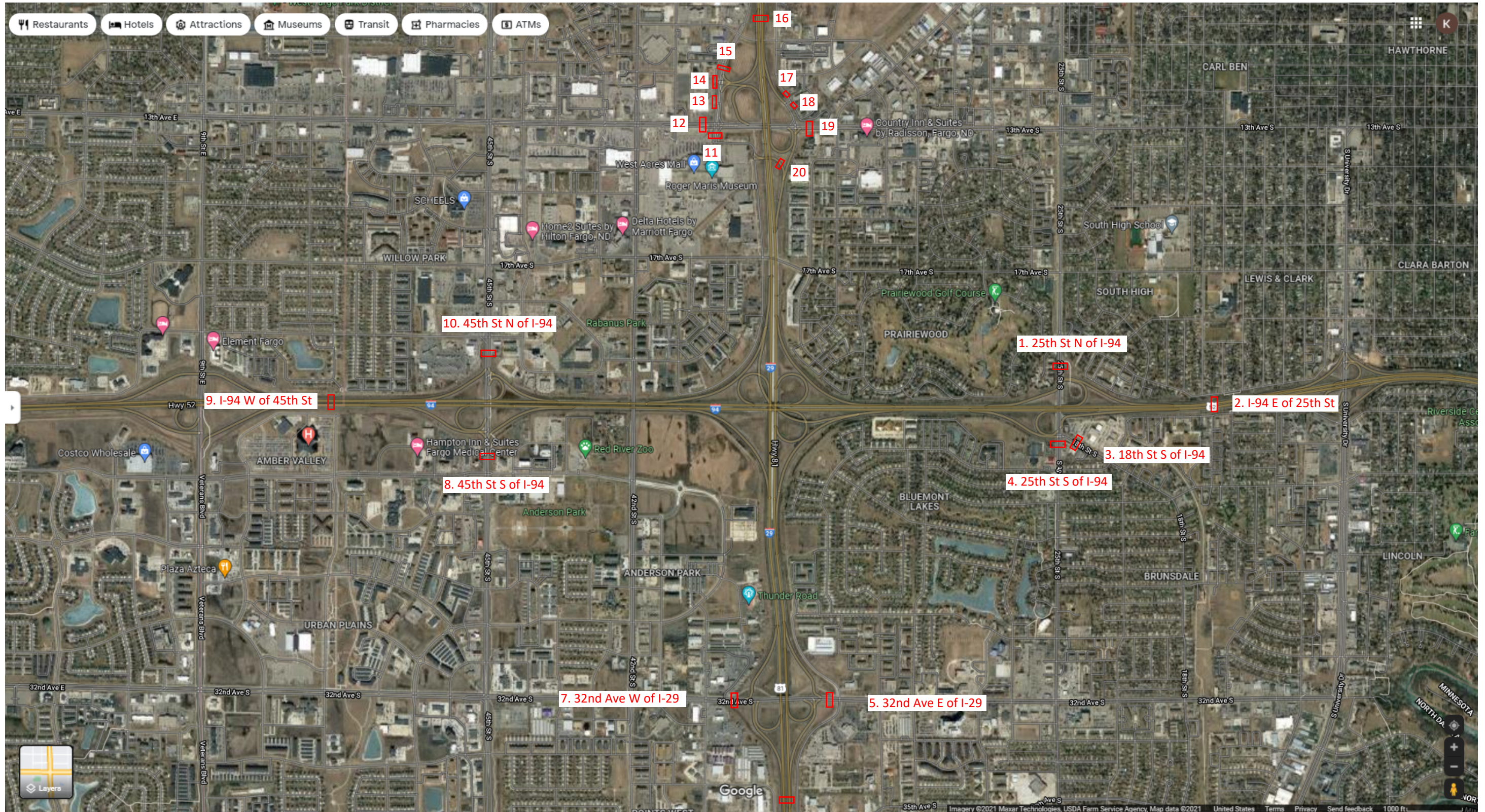
A considerable amount of friction in the model is induced by local trips during peak hours from adjacent interchanges. The purpose of the interstate system is to support the regional economy. Improvements such as ramp metering can help adjust driver behavior so that the local trips are no longer using the interstate system. cursory analysis illustrates these changes could be significant. However, further analysis would be required to determine whether the local system is capable of handling these altered traffic flows.

Infrastructure

Several movements at the interchange are anticipated to become very congested by 2045. Further improvements will be needed in the future to mitigate these operational issues. A new flyover ramp would help minimize congestion at the existing loop weaving areas. The most congested movement is projected to be the westbound to southbound movement. However, clearance and merging behavior should be studied further before an infrastructure plan is evaluated.

Appendix A: Lane Utilization Data

Figure A1. StreetLight Insight Zones for Origin-Destination Analysis



6. I-29 S of 32nd Ave

Figure A2. StreetLight Insight Zones for Interchange Travel Time Analysis

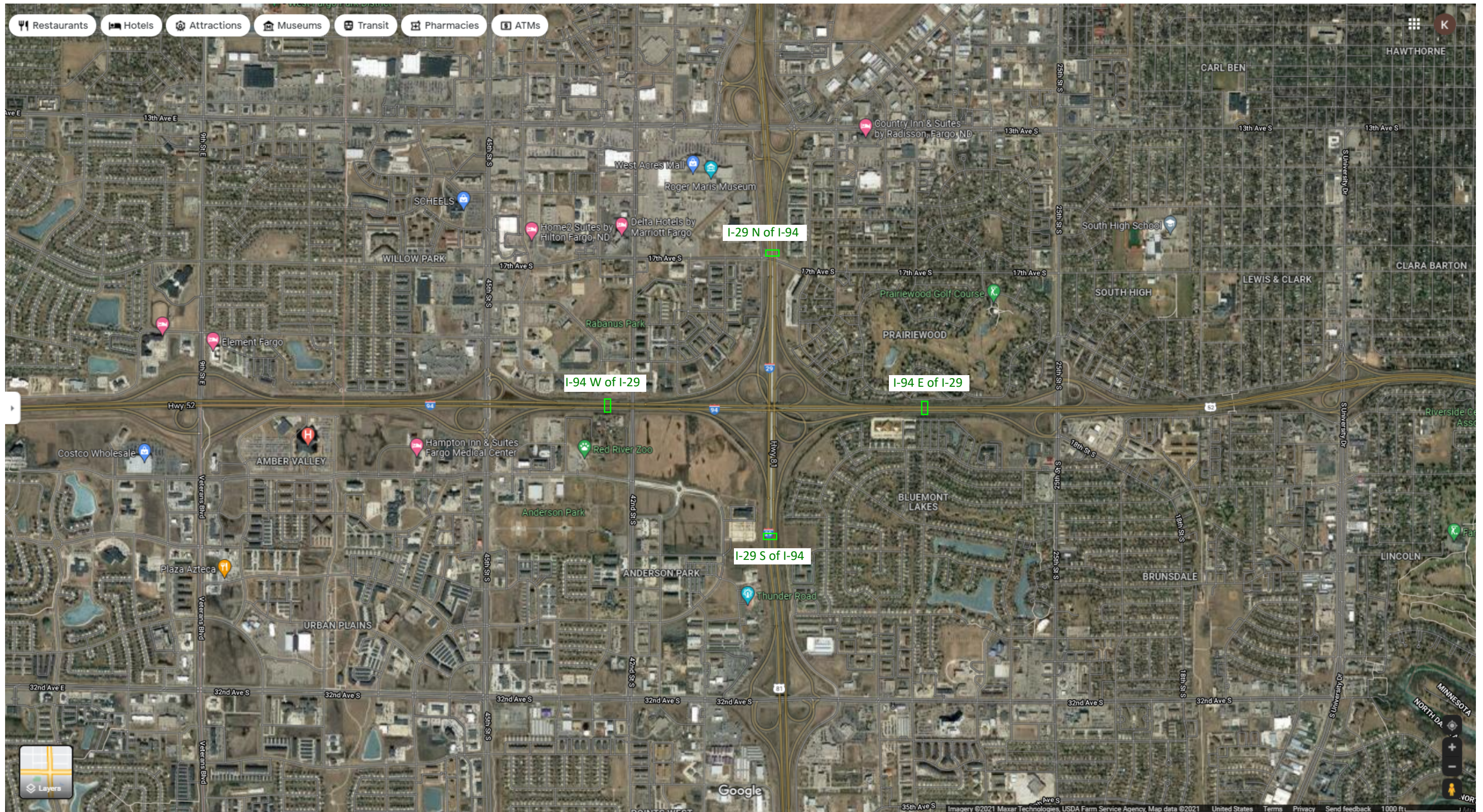


Table A1. 2020 Monthly Traffic Distribution (StreetLight Insight)

Time of Day	2020 Volumes											
	January	February	March	April	May	June	July	August	September	October	November	December
12am-1am	3,416	2,990	3,045	2,161	2,676	3,182	3,017	3,446	2,470	2,529	2,354	2,991
1am-2am	2,149	1,827	2,008	1,619	1,876	1,799	1,782	1,940	1,699	1,582	1,523	1,960
2am-3am	1,546	1,416	1,384	1,383	1,424	1,667	1,392	1,248	1,400	1,667	1,208	1,408
3am-4am	2,360	1,773	1,752	1,573	1,566	1,443	1,353	1,467	1,612	1,802	1,674	1,723
4am-5am	2,774	2,923	2,952	2,467	2,841	2,950	3,091	3,501	3,426	2,967	3,395	3,226
5am-6am	7,137	6,828	6,304	5,763	7,086	7,199	6,969	7,987	8,045	7,188	6,793	6,675
6am-7am	17,425	17,632	17,640	16,598	18,840	20,549	19,618	20,677	20,372	18,956	17,519	17,283
7am-8am	50,181	51,955	45,059	30,550	36,782	39,819	39,790	43,808	47,345	46,608	39,640	39,749
8am-9am	40,837	40,114	35,208	23,659	28,334	32,832	34,412	35,012	37,392	35,963	31,724	32,606
9am-10am	27,689	26,191	26,644	21,076	26,726	30,179	30,901	31,294	29,565	27,563	26,879	28,171
10am-11am	28,622	27,839	27,712	22,426	29,608	36,067	38,000	36,089	33,627	31,458	28,597	31,801
11am-12pm	34,130	33,898	31,767	26,830	35,624	42,154	44,436	43,672	38,901	37,239	35,182	37,727
12pm-1pm	39,875	38,557	38,344	33,871	43,931	52,022	52,971	50,862	46,641	43,590	42,466	45,339
1pm-2pm	38,135	38,602	37,711	32,521	43,782	49,158	50,819	48,806	44,147	42,332	38,905	43,842
2pm-3pm	39,437	41,245	37,049	32,169	42,660	46,841	49,657	47,047	45,683	44,159	41,011	43,702
3pm-4pm	49,241	48,982	42,466	33,738	43,899	51,969	52,194	51,305	53,878	49,813	48,708	50,137
4pm-5pm	62,147	63,441	54,820	41,109	52,357	62,159	61,484	60,217	61,778	58,526	57,814	55,132
5pm-6pm	68,124	70,696	61,356	45,984	57,536	68,017	69,735	69,502	70,138	65,603	65,821	64,024
6pm-7pm	45,432	45,673	38,149	27,190	38,887	46,890	48,489	50,371	50,690	47,366	43,984	40,943
7pm-8pm	32,320	35,530	28,066	17,886	30,066	34,066	35,784	37,461	36,908	34,305	28,654	29,924
8pm-9pm	24,759	26,569	22,508	12,202	21,262	26,290	29,613	30,012	26,827	23,231	20,038	20,833
9pm-10pm	18,624	19,546	14,839	8,918	14,065	17,883	23,177	19,601	16,021	15,063	12,829	14,967
10pm-11pm	9,292	10,544	7,950	6,168	8,946	10,982	13,067	10,325	9,424	8,712	8,349	8,862
11pm-12am	5,437	5,463	4,980	3,833	4,965	5,557	7,052	5,720	4,263	4,627	4,177	4,110

Table A2. 2021 Monthly Traffic Distribution (StreetLight Insight)

Time of Day	2021 Volumes											
	January	February	March	April	May	June	July	August	September	October	November	December
12am-1am	2,528	3,268	2,622	2,570	2,864	3,515	2,360	1,439				
1am-2am	1,904	4,697	2,575	2,670	1,823	2,296	562	386				
2am-3am	1,498	4,991	2,926	2,819	1,627	1,650	1,382	1,225				
3am-4am	1,774	4,118	2,763	2,474	1,352	1,482	1,751	1,444				
4am-5am	3,111	5,135	4,151	4,173	2,885	3,699	3,434	3,429				
5am-6am	7,308	7,194	7,397	7,131	7,034	8,580	7,707	7,088				
6am-7am	17,510	17,396	17,639	18,633	19,490	21,330	20,932	20,123				
7am-8am	46,114	44,302	44,261	43,933	45,738	44,992	44,888	46,483				
8am-9am	34,332	35,683	37,154	36,617	38,152	37,826	39,398	36,293				
9am-10am	25,655	26,708	28,894	29,618	29,651	32,696	34,910	32,632				
10am-11am	28,268	28,055	31,726	31,728	34,166	38,334	39,451	36,990				
11am-12pm	33,692	31,236	38,926	38,615	38,777	46,549	48,654	47,364				
12pm-1pm	39,557	37,454	44,383	43,508	45,097	54,666	57,387	54,965				
1pm-2pm	37,915	36,250	41,985	40,852	44,890	51,586	55,199	51,892				
2pm-3pm	38,541	39,181	43,140	43,324	47,768	50,173	53,097	51,326				
3pm-4pm	47,149	47,039	50,604	51,982	55,654	54,804	59,088	55,782				
4pm-5pm	57,025	57,292	61,547	59,261	60,404	67,391	69,230	66,587				
5pm-6pm	62,570	61,978	65,240	66,567	69,624	73,490	74,802	67,656				
6pm-7pm	41,591	42,349	47,624	48,246	52,348	52,563	53,839	53,982				
7pm-8pm	29,191	29,153	34,651	36,657	40,986	41,187	44,048	41,429				
8pm-9pm	21,103	22,854	25,222	29,873	33,089	34,769	34,887	33,122				
9pm-10pm	15,962	17,524	16,857	17,984	19,719	25,208	26,140	22,833				
10pm-11pm	8,889	9,150	9,273	10,373	11,176	15,089	16,279	13,972				
11pm-12am	4,826	4,856	4,892	5,302	5,734	7,776	10,012	7,843				

I-94 at 25th St Lane Utilization

TIME	EASTBOUND							TIME	WESTBOUND						
	LEFT		CENTER		RIGHT		TOTAL		LEFT		CENTER		RIGHT		TOTAL
COUNT	%	COUNT	%	COUNT	%	COUNT	COUNT	COUNT	%	COUNT	%	COUNT	%	COUNT	
600	257	20%	607	46%	443	34%	1307	600	659	36%	783	43%	382	21%	1824
700	680	24%	962	34%	1166	42%	2808	700	1041	33%	1233	39%	887	28%	3161
800	508	22%	904	39%	887	39%	2299	800	814	35%	1015	44%	500	21%	2329
900	336	19%	711	41%	677	39%	1724	900	664	38%	747	42%	349	20%	1760
1000	362	20%	784	44%	622	35%	1768	1000	677	36%	860	46%	352	19%	1889
1100	435	21%	895	43%	731	35%	2061	1100	739	36%	965	47%	370	18%	2074
1200	539	23%	1005	42%	824	35%	2368	1200	766	35%	1001	46%	417	19%	2184
1300	508	23%	975	44%	752	34%	2235	1300	723	35%	956	46%	412	20%	2091
1400	520	22%	1013	42%	863	36%	2396	1400	757	33%	1048	46%	455	20%	2260
1500	577	23%	1069	42%	880	35%	2526	1500	841	34%	1137	46%	508	20%	2486
1600	913	27%	1307	38%	1183	35%	3403	1600	980	31%	1324	41%	888	28%	3192
1700	1038	29%	1386	39%	1134	32%	3558	1700	936	31%	1293	43%	806	27%	3035
1800	550	23%	1041	43%	814	34%	2405	1800	646	30%	1010	47%	489	23%	2145

Average

23%

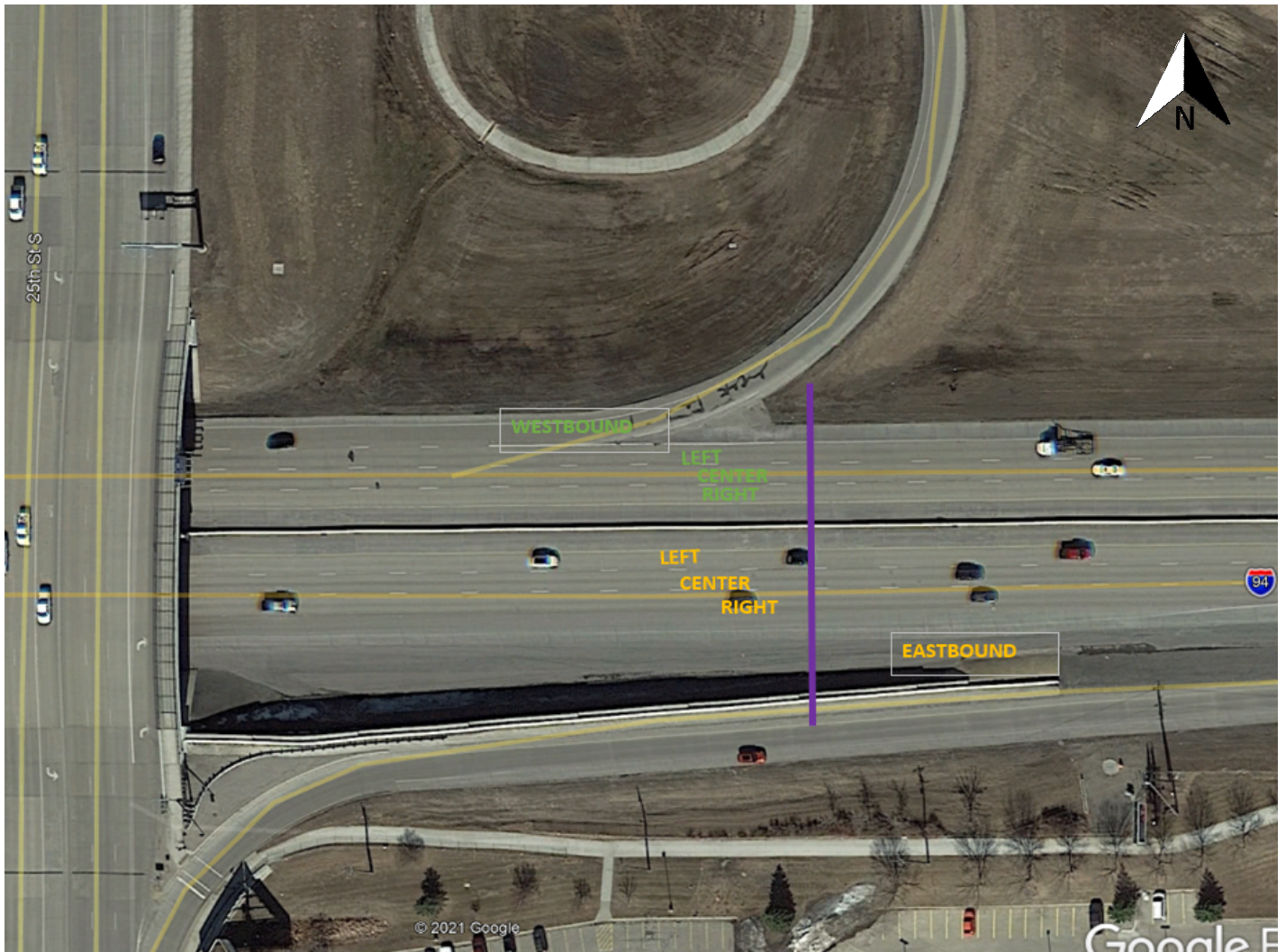
42%

36%

34%

44%

22%



I-94 at 42nd St Lane Utilization

TIME	EASTBOUND							TIME	WESTBOUND						
	LEFT		CENTER		RIGHT		TOTAL		LEFT		CENTER		RIGHT		TOTAL
COUNT	%	COUNT	%	COUNT	%	COUNT	COUNT	COUNT	%	COUNT	%	COUNT	%	COUNT	
600	282	16%	618	36%	816	48%	1716	600	238	17%	833	60%	306	22%	1377
700	1126	28%	1260	31%	1680	41%	4066	700	487	18%	1582	58%	654	24%	2723
800	532	21%	982	39%	1018	40%	2532	800	493	22%	1345	60%	409	18%	2247
900	288	16%	752	43%	707	40%	1747	900	350	21%	1064	63%	269	16%	1683
1000	300	17%	808	46%	663	37%	1771	1000	409	23%	1091	61%	274	15%	1774
1100	350	17%	906	43%	832	40%	2088	1100	493	24%	1256	61%	322	16%	2071
1200	425	18%	1040	44%	916	38%	2381	1200	582	25%	1350	59%	372	16%	2304
1300	389	17%	984	44%	854	38%	2227	1300	545	26%	1233	58%	334	16%	2112
1400	399	18%	1018	45%	846	37%	2263	1400	580	26%	1288	57%	398	18%	2266
1500	418	17%	1076	44%	938	39%	2432	1500	901	34%	1340	50%	416	16%	2657
1600	697	23%	1228	41%	1066	36%	2991	1600	1057	29%	1755	48%	838	23%	3650
1700	610	20%	1313	43%	1147	37%	3070	1700	1118	32%	1597	45%	801	23%	3516
1800	491	21%	995	42%	888	37%	2374	1800	713	30%	1235	51%	460	19%	2408

Average

19%

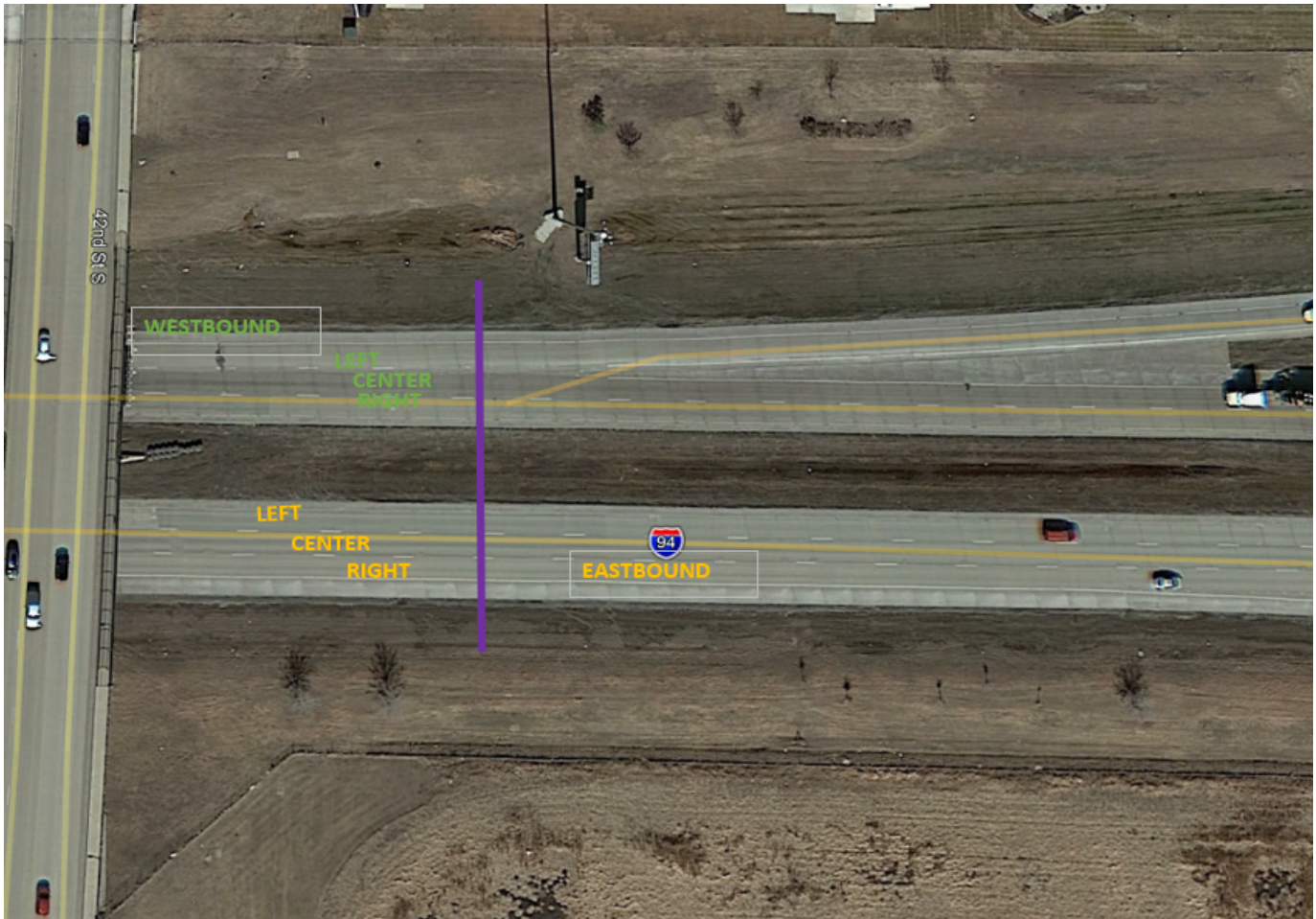
42%

39%

25%

56%

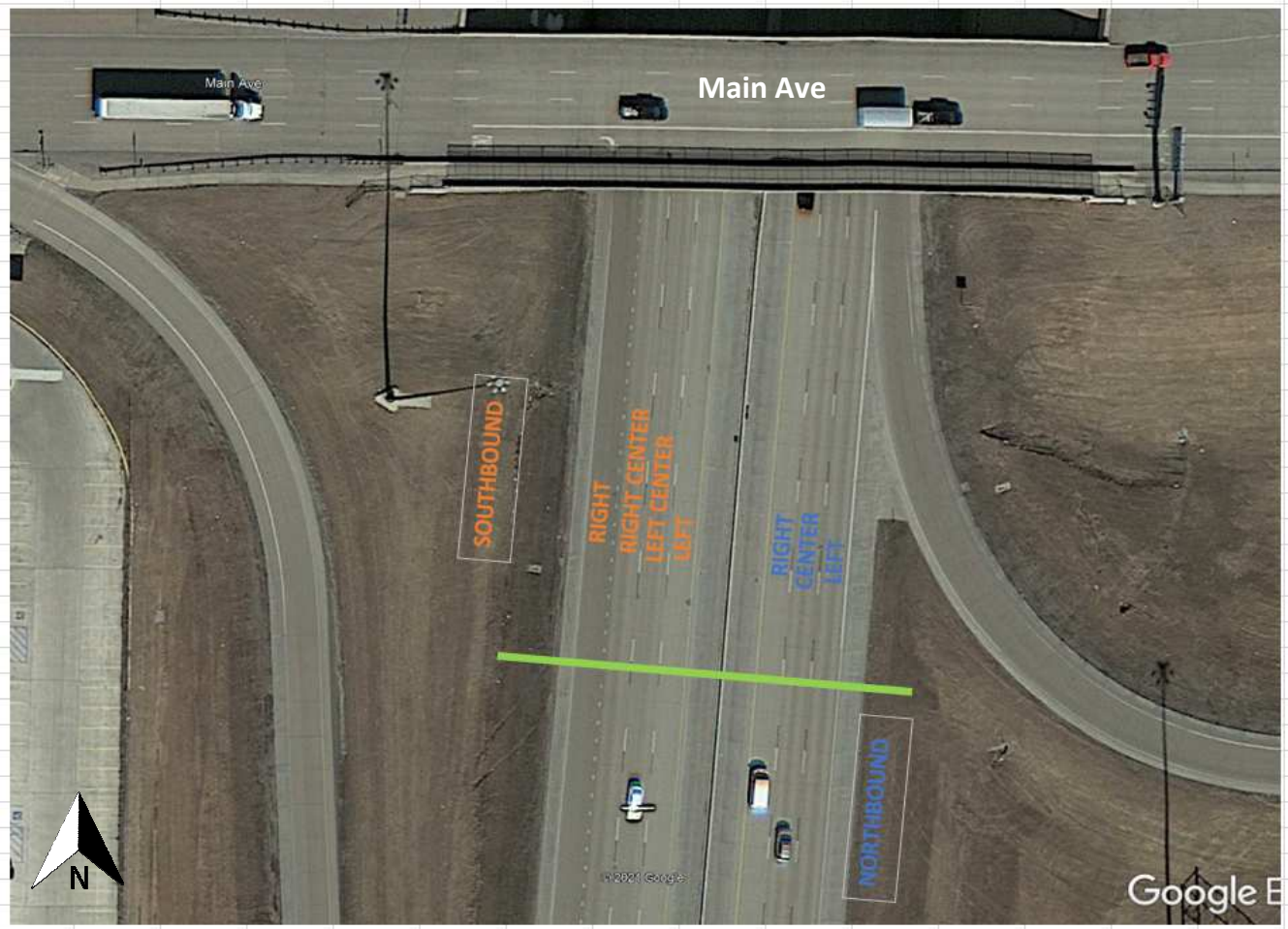
19%



I-29 at Main Ave Lane Utilization

TIME	SOUTHBOUND									TIME	NORTHBOUND						
	LEFT		LEFT CENTER		RIGHT CENTER		RIGHT		TOTAL		LEFT		CENTER		RIGHT		TOTAL
	COUNT	%	COUNT	%	COUNT	%	COUNT	%	COUNT		COUNT	%	COUNT	%	COUNT	%	COUNT
600	103	11%	388	40%	353	37%	123	13%	967	600	590	33%	863	48%	327	18%	1780
700	283	15%	761	41%	601	33%	189	10%	1834	700	963	33%	1251	43%	689	24%	2903
800	203	12%	657	39%	616	36%	213	13%	1689	800	647	36%	946	53%	185	10%	1778
900	107	8%	502	39%	514	40%	149	12%	1272	900	558	38%	686	47%	220	15%	1464
1000	132	9%	606	40%	567	38%	201	13%	1506	1000	462	36%	634	49%	187	15%	1283
1100	197	11%	628	36%	673	38%	270	15%	1768	1100	522	33%	869	56%	170	11%	1561
1200	236	12%	743	37%	737	37%	298	15%	2014	1200	597	35%	882	51%	246	14%	1725
1300	150	9%	648	38%	660	38%	258	15%	1716	1300	580	40%	662	45%	226	15%	1468
1400	243	12%	755	37%	756	37%	284	14%	2038	1400	556	42%	587	44%	184	14%	1327
1500	308	12%	900	35%	980	38%	372	15%	2560	1500	623	41%	642	42%	263	17%	1528
1600	532	15%	1254	35%	1227	34%	582	16%	3595	1600	647	35%	853	46%	338	18%	1838
1700	423	12%	1192	35%	1236	36%	583	17%	3434	1700	743	39%	871	45%	308	16%	1922
1800	177	9%	741	37%	783	39%	295	15%	1996	1800	569	39%	660	45%	234	16%	1463

Average 11% 38% 37% 14% 37% 47% 16%



I-29 at 32nd Ave Lane Utilization

TIME	SOUTHBOUND						TOTAL
	LEFT		CENTER		RIGHT		
	COUNT	%	COUNT	%	COUNT	%	COUNT
600	234	29%	428	52%	154	19%	816
700	417	32%	640	48%	266	20%	1323
800	365	33%	572	52%	158	14%	1095
900	222	26%	506	60%	112	13%	840
1000	270	31%	454	53%	137	16%	861
1100	288	28%	564	55%	181	18%	1033
1200	368	30%	644	52%	224	18%	1236
1300	335	30%	598	53%	191	17%	1124
1400	340	27%	679	54%	243	19%	1262
1500	397	26%	798	53%	318	21%	1513
1600	513	24%	1040	48%	614	28%	2167
1700	495	21%	1148	50%	665	29%	2308
1800	316	25%	715	56%	241	19%	1272

TIME	NORTHBOUND					TOTAL
	LEFT		RIGHT			
	COUNT	%	COUNT	%	COUNT	
600	553	40%	829	60%	1382	
700	1264	45%	1515	55%	2779	
800	693	39%	1100	61%	1793	
900	365	31%	819	69%	1184	
1000	337	31%	745	69%	1082	
1100	316	29%	792	71%	1108	
1200	430	33%	863	67%	1293	
1300	368	31%	816	69%	1184	
1400	365	31%	808	69%	1173	
1500	447	32%	942	68%	1389	
1600	541	33%	1122	67%	1663	
1700	605	34%	1199	66%	1804	
1800	422	32%	881	68%	1303	

Average

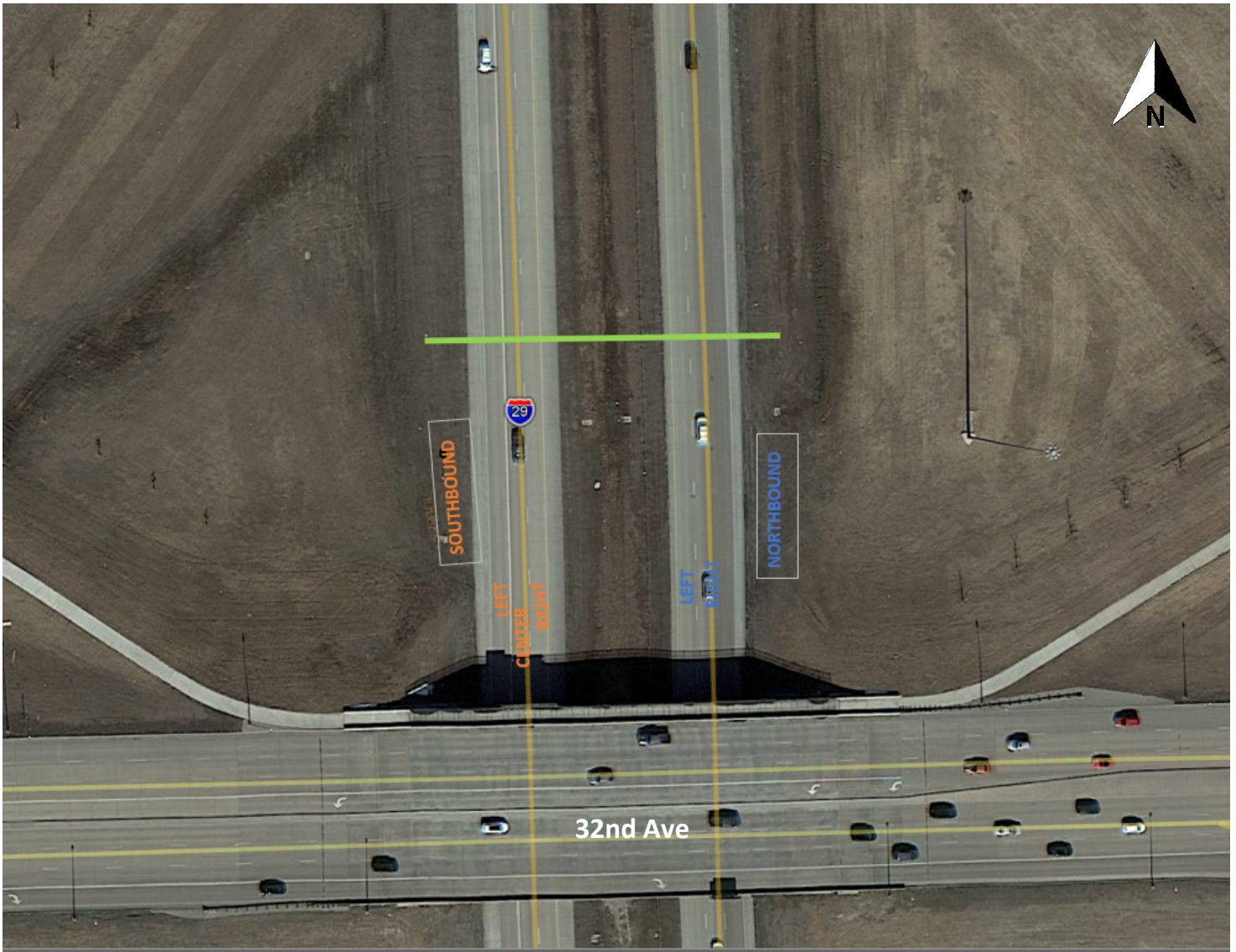
28%

53%

19%

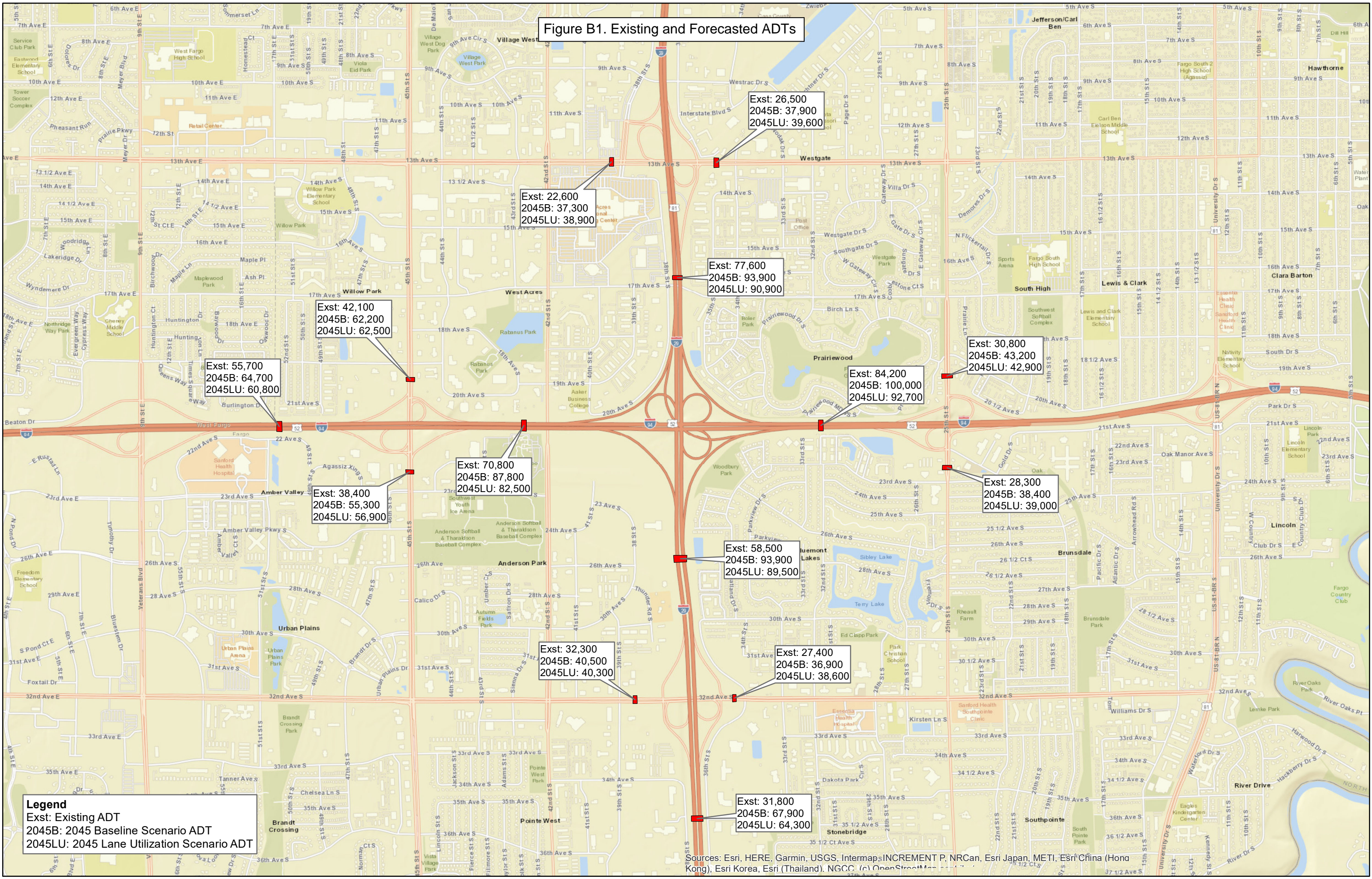
34%

66%



Appendix B: 2045 Forecasting

Figure B1. Existing and Forecasted ADTs



Legend
 Exst: Existing ADT
 2045B: 2045 Baseline Scenario ADT
 2045LU: 2045 Lane Utilization Scenario ADT

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors

Appendix C: Traffic Model Calibration

Table C1. Lane Utilization Calibration

Location	WB I-94 at 25th St			EB I-94 at 25th St		
Lane	Outside Lane	Center Lane	Inside Lane	Inside Lane	Center Lane	Outside Lane
Modeled	40%	43%	17%	18%	42%	40%
Field Collected	34%	44%	22%	23%	42%	36%
Difference	6%	-1%	-5%	-5%	0%	4%
Location	WB I-94 at 42nd St			EB I-94 at 42nd St		
Lane	Outside Lane	Center Lane	Inside Lane	Inside Lane	Center Lane	Outside Lane
Modeled	32%	48%	20%	17%	44%	39%
Field Collected	25%	56%	19%	19%	42%	39%
Difference	7%	-8%	1%	-2%	2%	0%
Location	SB I-29 at Main Ave			NB I-29 at Main Ave		
Lane	Outside Lane	Center Lane	Inside Lane	Inside Lane	Center Lane	Outside Lane
Modeled	58%	32%	10%	17%	43%	40%
Field Collected	51%	38%	11%	16%	47%	37%
Difference	7%	-6%	-1%	1%	-4%	3%
Location	SB I-29 at 32nd Ave			NB I-29 at 32nd Ave		
Lane	Outside Lane	Center Lane	Inside Lane	Inside Lane	Outside Lane	
Modeled	25%	51%	24%	34%	66%	
Field Collected	28%	53%	19%	34%	66%	
Difference	-3%	-2%	5%	0%	0%	

Table C2. Traffic Volume Calibration

Location	13-Hour Volume in Vissim	AADT from NDDOT Map	13 Hour Percentage (13-Hour Volume / AADT)
Southbound I-29 between 13 th Ave and I-94	32,484	36,885	88.1%
Northbound I-29 between 13 th Ave and I-94	35,670	40,735	87.6%
Southbound I-29 between I-94 and 32 nd Ave	21,893	25,660	85.3%
Northbound I-29 between I-94 and 32 nd Ave	28,027	32,800	85.4%
Southbound I-29 south of 32 nd Ave	13,684	15,650	87.4%
Northbound I-29 south of 32 nd Ave	17,800	16,100	110.6%
Westbound I-94 west of 45 th St	23,917	27,965	85.5%
Eastbound I-94 west of 45 th St	24,193	27,735	87.2%
Westbound I-94 between I-29 and 25 th St	38,431	42,460	90.5%
Eastbound I-94 between I-29 and 25 th St	37,541	41,700	90.0%
25 th St north of I-94	27,527	30,760	89.5%
25 th St south of I-94	25,065	28,255	88.7%
45 th St north of I-94	37,202	42,100	88.4%
45 th St south of I-94	32,952	38,375	85.9%
32 nd Ave east of I-29	24,736	27,395	90.3%
32 nd Ave west of I-29	27,701	32,275	85.8%
13 th Ave east of I-29	23,796	27,820	85.5%
13 th Ave west of I-29	22,899	25,425	90.1%
SB I-29 to WB I-94 Ramp	8,952	10,190	87.9%
WB I-94 to SB I-29 Ramp	4,887	5,620	87.0%
NB I-29 to WB I-94 Ramp	4,582	5,115	89.6%
WB I-94 to NB I-29 Ramp	11,685	12,935	90.3%
EB I-94 to NB I-29 Ramp	5,747	6,365	90.3%
NB I-29 to EB I-94 Ramp	5,148	5,840	88.2%
SB I-29 to EB I-94 Ramp	10,269	11,885	86.4%
EB I-94 to SB I-29 Ramp	3,795	4,190	90.6%

Table C3. Traffic Travel Time Calibration

Location	Average Travel Time (seconds)		Percent Difference
	Vissim Model	StreetLight	
EB I-94 to NB I-29	134	125	7%
EB I-94 to EB I-94	91	95	-5%
EB I-94 to SB I-29	84	96	-13%
SB I-29 to EB I-94	121	97	25%
SB I-29 to SB I-29	88	95	-8%
SB I-29 to WB I-94	83	84	-2%
WB I-94 to SB I-29	125	120	4%
WB I-94 to WB I-94	92	97	-5%
WB I-94 to NB I-29	82	86	-5%
NB I-29 to WB I-94	142	134	6%
NB I-29 to NB I-29	92	105	-12%
NB I-29 to EB I-94	88	84	4%

Appendix D: Detailed Operational Results

2019 Existing Condition Travel Time (seconds)												
Location	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
EB I-94 to NB I-29	139	134	132	132	131	132	131	132	133	135	136	134
EB I-94 to EB I-94	92	91	90	90	90	90	90	90	91	92	93	91
EB I-94 to SB I-29	85	84	83	83	84	84	84	84	85	85	85	84
SB I-29 to EB I-94	88	87	88	89	89	90	91	91	93	205	299	146
SB I-29 to SB I-29	83	85	87	87	88	90	89	88	88	89	91	90
SB I-29 to WB I-94	76	78	77	77	78	78	78	79	80	92	113	85
WB I-94 to SB I-29	127	126	124	124	124	125	125	125	126	127	127	125
WB I-94 to WB I-94	93	92	91	91	91	92	91	92	92	95	95	93
WB I-94 to NB I-29	83	82	81	81	81	82	82	81	82	82	83	82
NB I-29 to WB I-94	143	141	140	140	141	141	141	141	142	144	145	143
NB I-29 to NB I-29	94	93	92	92	92	92	92	92	92	93	93	92
NB I-29 to EB I-94	78	77	76	76	76	76	77	77	78	119	137	110

2019 Build Condition Travel Time (seconds)												
Location	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
EB I-94 to NB I-29	139	134	132	132	131	132	131	132	133	135	136	134
EB I-94 to EB I-94	92	91	90	90	90	90	90	90	91	92	93	91
EB I-94 to SB I-29	85	84	83	83	84	84	84	84	85	85	85	84
SB I-29 to EB I-94	85	84	85	86	86	87	88	88	88	91	90	89
SB I-29 to SB I-29	83	85	87	87	88	90	89	88	88	88	88	90
SB I-29 to WB I-94	76	78	77	77	78	78	78	79	80	83	82	80
WB I-94 to SB I-29	127	126	124	124	124	125	125	125	126	127	127	126
WB I-94 to WB I-94	93	92	91	91	91	92	91	92	92	95	95	93
WB I-94 to NB I-29	83	82	81	81	81	82	82	81	82	82	83	82
NB I-29 to WB I-94	143	142	140	140	141	141	141	141	142	145	145	143
NB I-29 to NB I-29	94	93	92	92	92	92	92	92	92	93	93	92
NB I-29 to EB I-94	77	76	75	75	76	76	76	76	76	78	78	76

2019 Friday Holiday Existing Condition Travel Time (seconds)												
Location	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
EB I-94 to NB I-29	135	134	133	134	134	134	135	136	136	137	138	135
EB I-94 to EB I-94	90	89	89	90	90	91	90	91	91	91	92	91
EB I-94 to SB I-29	84	84	84	84	84	84	85	85	85	85	85	84
SB I-29 to EB I-94	86	88	89	88	90	93	92	95	139	189	244	149
SB I-29 to SB I-29	84	90	90	88	89	91	91	91	89	91	89	92
SB I-29 to WB I-94	76	79	76	77	78	79	78	80	83	94	102	88
WB I-94 to SB I-29	126	125	124	124	126	127	125	126	126	129	127	125
WB I-94 to WB I-94	92	92	91	92	92	92	92	93	93	93	94	94
WB I-94 to NB I-29	83	82	82	82	83	83	83	82	83	83	83	83
NB I-29 to WB I-94	142	142	142	141	141	142	142	143	143	144	144	144
NB I-29 to NB I-29	92	92	92	92	92	92	92	93	92	93	93	92
NB I-29 to EB I-94	76	76	76	76	77	77	78	79	99	101	96	82

2019 Friday Holiday Build Condition Travel Time (seconds)												
Location	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
EB I-94 to NB I-29	134	133	133	133	132	133	134	134	134	135	136	134
EB I-94 to EB I-94	90	90	90	90	90	91	91	91	92	92	93	91
EB I-94 to SB I-29	84	84	84	84	84	84	84	85	85	85	85	84
SB I-29 to EB I-94	84	85	86	87	88	89	89	90	90	91	90	89
SB I-29 to SB I-29	84	86	89	90	89	91	90	90	90	90	89	91
SB I-29 to WB I-94	75	78	77	78	79	80	79	80	82	83	82	80
WB I-94 to SB I-29	125	125	124	124	126	126	125	125	127	127	127	125
WB I-94 to WB I-94	92	91	91	91	92	92	92	92	93	94	94	93
WB I-94 to NB I-29	82	82	82	82	82	82	82	81	82	82	82	82
NB I-29 to WB I-94	141	141	140	141	141	142	141	142	143	144	144	143
NB I-29 to NB I-29	93	92	92	92	92	92	92	92	93	92	93	92
NB I-29 to EB I-94	76	76	76	76	76	76	76	77	77	78	77	76

2045 No Build Condition Travel Time (seconds)												
Location	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
EB I-94 to NB I-29	147	141	137	136	136	136	136	135	138	145	177	513
EB I-94 to EB I-94	95	92	90	90	91	91	91	92	92	97	99	105
EB I-94 to SB I-29	86	85	84	84	84	84	84	85	85	86	86	90
SB I-29 to EB I-94	136	211	123	98	119	102	112	233	694	1165	1229	959
SB I-29 to SB I-29	83	84	85	86	87	88	87	87	138	238	225	200
SB I-29 to WB I-94	77	81	78	78	79	79	80	94	216	370	394	327
WB I-94 to SB I-29	131	128	125	125	125	126	125	126	127	182	222	254
WB I-94 to WB I-94	96	94	93	93	93	93	93	94	95	190	245	204
WB I-94 to NB I-29	86	84	83	82	82	83	82	82	83	88	144	447
NB I-29 to WB I-94	146	145	143	144	144	143	143	144	146	196	213	478
NB I-29 to NB I-29	96	95	94	94	94	93	93	93	94	105	129	290
NB I-29 to EB I-94	105	118	89	79	85	81	85	99	159	335	425	302

2045 Build Condition Travel Time (seconds)												
Location	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
EB I-94 to NB I-29	148	141	137	135	134	136	135	135	138	154	174	188
EB I-94 to EB I-94	96	92	91	90	91	91	91	92	93	100	106	95
EB I-94 to SB I-29	86	85	84	84	84	84	84	85	85	87	87	86
SB I-29 to EB I-94	86	86	86	86	87	87	89	90	93	106	103	96
SB I-29 to SB I-29	83	83	84	84	85	86	86	85	87	91	90	89
SB I-29 to WB I-94	77	79	78	78	79	80	80	81	85	95	93	115
WB I-94 to SB I-29	132	129	125	125	126	127	126	127	129	242	361	381
WB I-94 to WB I-94	96	95	93	93	93	93	93	94	95	223	325	353
WB I-94 to NB I-29	86	84	83	82	82	82	82	82	83	91	105	106
NB I-29 to WB I-94	147	146	144	143	143	143	143	144	146	271	408	539
NB I-29 to NB I-29	96	94	94	93	93	93	93	93	93	95	99	107
NB I-29 to EB I-94	79	78	77	77	77	77	77	78	79	88	88	94

2045 Lane Utilization No Build Condition Travel Time (seconds)												
Location	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
EB I-94 to NB I-29	147	140	137	136	135	136	135	135	137	151	245	507
EB I-94 to EB I-94	94	92	90	90	91	91	91	91	92	96	100	105
EB I-94 to SB I-29	86	85	84	84	84	84	84	84	85	85	86	90
SB I-29 to EB I-94	126	158	97	91	99	97	113	252	708	1136	1164	1026
SB I-29 to SB I-29	83	84	85	86	87	88	88	87	141	222	216	203
SB I-29 to WB I-94	77	80	78	78	79	79	80	92	211	365	373	337
WB I-94 to SB I-29	129	127	125	125	126	126	125	126	127	149	211	263
WB I-94 to WB I-94	95	94	92	93	93	93	93	94	95	134	207	183
WB I-94 to NB I-29	85	84	82	82	82	82	82	82	83	103	243	533
NB I-29 to WB I-94	146	144	143	144	144	144	143	144	147	205	259	408
NB I-29 to NB I-29	96	94	94	94	94	93	93	93	94	118	180	319
NB I-29 to EB I-94	92	104	80	78	82	81	86	106	206	400	461	326

2045 Lane Utilization Build Condition Travel Time (seconds)												
Location	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
EB I-94 to NB I-29	146	140	137	134	134	135	134	134	137	142	154	179
EB I-94 to EB I-94	94	92	90	90	91	91	91	91	92	96	98	93
EB I-94 to SB I-29	86	85	84	84	84	84	84	85	85	86	86	85
SB I-29 to EB I-94	86	86	86	86	87	87	89	89	91	100	97	93
SB I-29 to SB I-29	83	83	84	84	85	87	86	85	87	90	90	88
SB I-29 to WB I-94	77	79	78	78	79	79	80	81	84	99	97	114
WB I-94 to SB I-29	129	127	125	125	126	127	126	126	128	174	315	383
WB I-94 to WB I-94	95	94	92	92	93	93	93	93	95	173	330	358
WB I-94 to NB I-29	85	83	82	82	82	82	82	82	82	85	102	105
NB I-29 to WB I-94	146	145	144	142	142	143	143	144	146	199	299	475
NB I-29 to NB I-29	96	94	94	93	93	93	93	93	93	94	96	100
NB I-29 to EB I-94	78	78	77	76	77	77	77	78	79	84	83	87

I-29 / I-94 Interstate Operation for 2019 Existing

Roadway	Segment	Level of Service (Hours of Day)											
		7	8	9	10	11	12	13	14	15	16	17	18
Eastbound I-94	Between 45th St and I-29	E	D	C	C	C	D	D	D	D	E	E	D
	At Exit Ramp to SB I-29	E	D	C	C	C	C	C	D	D	E	E	D
	At Exit Ramp to NB I-29	D	D	C	C	C	C	C	C	D	E	E	D
	Between NB I-29 Exit and Entrance Ramps	D	C	C	B	C	C	C	C	C	E	E	D
	At Entrance Ramp from NB I-29/Between I-29 and 25th St	D	C	C	C	C	C	C	D	D	E	F	D
Westbound I-94	Between 25th St and I-29	F	E	D	D	D	E	D	E	E	F	F	E
	At Exit Ramp to NB I-29	E	E	D	D	D	E	D	D	E	E	E	E
	Between NB I-29 Exit and Entrance Ramps	D	D	C	C	C	C	C	D	D	E	E	D
	At NB I-29 Entrance Ramp and SB I-29 Exit Ramp (between loop ramps)	E	D	D	D	D	D	D	D	E	F	F	E
	Between SB I-29 Exit and Entrance ramp (3 lane section)	E	E	D	D	D	D	D	E	E	E	E	E
	Between SB I-29 Exit and Entrance ramp (2 lane section)	E	E	D	D	D	D	D	E	E	F	F	E
At Entrance Ramp from SB I-29/Between I-29 and 45th St	E	E	D	D	D	D	D	D	E	F	F	E	
Northbound I-29	Between 32nd Ave and I-94	D	C	B	B	B	B	B	B	C	C	D	C
	At Exit Ramp to EB I-94	C	B	B	B	B	B	B	B	C	C	C	C
	Between EB I-94 Exit and EB Entrance Ramps	D	B	B	A	A	A	B	A	B	B	C	B
	Between EB I-94 Entrance Ramp and WB I-94 Exit Ramp	D	C	B	B	B	B	B	B	B	C	C	C
	Between WB I-94 Exit and Entrance Ramps	E	D	D	D	D	D	D	D	E	F	F	E
	At Entrance Ramp from WB I-94/Between I-94 and 13th Ave	E	D	C	C	C	C	C	C	C	D	D	C
Southbound I-29	Between 13th Ave and I-94 Exit Ramps	C	B	C	B	C	C	C	D	D	F	F	E
	Between I-94 Exit Ramps and WB I-94 Entrance Ramp	B	B	A	A	A	A	A	A	B	B	C	A
	At WB I-94 Entrance Ramp	B	B	A	A	A	B	A	B	B	B	B	B
	Between I-94 WB and EB Entrance Ramps	B	A	A	A	A	A	A	A	B	B	B	A
	At Entrance Ramp from EB I-94/Between I-29 and 32nd Ave	C	B	B	B	B	B	B	B	C	D	D	B
I-29 & I-94 Interchange Ramps	EB I-94 to SB I-29 Ramp	B	A	A	A	A	A	A	A	A	A	A	A
	WB I-94 to NB I-29 Ramp	D	D	C	C	C	C	C	C	C	D	D	D
	NB I-29 Ramp to EB I-94	B	A	A	A	A	A	A	A	A	D	E	C
	SB I-29 Ramp to WB I-94	B	B	A	B	B	B	B	B	C	D	D	C
	SB I-29 to EB and WB I-94	B	B	B	B	B	B	C	C	D	F	F	E
	SB I-29 to EB I-94 (two lane section)	B	B	B	B	B	B	C	C	C	F	F	E
	SB I-29 to EB I-94 (single lane section)	B	B	B	B	B	B	B	B	C	F	F	E
	SB I-29 to EB I-94 and NB I-29 to EB I-94 Merge Area	D	C	C	C	C	C	C	D	E	F	F	F
	I-29 to EB I-94 Ramp	D	C	C	C	C	C	C	D	E	F	F	E
	EB I-94 to NB I-29 Ramp	D	C	B	B	B	B	B	B	C	C	C	C
	WB I-94 to SB I-29 Ramp	C	C	B	B	B	B	B	B	C	C	C	B
	NB I-29 to WB I-94 Ramp	C	B	B	B	B	B	B	B	B	C	C	C

I-29 / I-94 Interstate Operation for 2019 Build

Roadway	Segment	Level of Service (Hours of Day)											
		7	8	9	10	11	12	13	14	15	16	17	18
Eastbound I-94	Between 45th St and I-29	E	D	C	C	C	D	D	D	D	E	E	D
	At Exit Ramp to SB I-29	E	D	C	C	C	C	C	D	D	E	E	D
	At Exit Ramp to NB I-29	D	D	C	C	C	C	C	C	D	E	E	D
	Between NB I-29 Exit and Entrance Ramps	D	C	C	B	C	C	C	C	C	E	E	D
	At Entrance Ramp from NB I-29/Between I-29 and 25th St	C	C	B	B	C	C	C	C	D	E	E	D
Westbound I-94	Between 25th St and I-29	F	E	D	D	D	E	D	E	E	F	F	E
	At Exit Ramp to NB I-29	E	E	D	D	D	E	D	D	E	E	E	E
	Between NB I-29 Exit and Entrance Ramps	D	D	C	C	C	C	C	D	D	E	E	D
	At NB I-29 Entrance Ramp and SB I-29 Exit Ramp (between loop ramps)	E	D	D	D	D	D	D	D	E	F	F	E
	Between SB I-29 Exit and Entrance ramp (3 lane section)	E	E	D	D	D	D	D	E	E	E	E	E
	Between SB I-29 Exit and Entrance ramp (2 lane section)	E	E	D	D	D	D	D	E	E	F	F	E
At Entrance Ramp from SB I-29/Between I-29 and 45th St	E	E	D	D	D	D	D	E	E	F	F	E	
Northbound I-29	Between 32nd Ave and I-94	D	C	B	B	B	B	B	B	C	C	D	C
	At Exit Ramp to EB I-94	E	D	C	C	C	C	C	C	D	E	E	D
	Between EB I-94 Exit and EB Entrance Ramps	D	B	B	A	A	A	B	A	B	B	C	B
	Between EB I-94 Entrance Ramp and WB I-94 Exit Ramp	D	C	B	B	B	B	B	B	B	C	C	C
	Between WB I-94 Exit and Entrance Ramps	D	C	B	B	B	B	B	B	B	C	C	C
	At Entrance Ramp from WB I-94/Between I-94 and 13th Ave	E	D	C	C	C	C	C	C	C	D	D	C
Southbound I-29	Between 13th Ave and I-94 Exit Ramps	C	B	C	B	C	C	C	D	D	F	E	D
	Between I-94 Exit Ramps and WB I-94 Entrance Ramp	B	A	A	A	A	A	A	A	B	B	B	A
	At WB I-94 Entrance Ramp	B	B	A	A	A	B	A	B	B	B	B	B
	Between I-94 WB and EB Entrance Ramps	B	B	A	A	A	A	A	A	B	B	B	A
	At Entrance Ramp from EB I-94/Between I-29 and 32nd Ave	C	B	B	B	B	B	B	B	C	D	D	B
I-29 & I-94 Interchange Ramps	EB I-94 to SB I-29 Ramp	B	A	A	A	A	A	A	A	A	A	A	A
	WB I-94 to NB I-29 Ramp	D	D	C	C	C	C	C	C	C	D	D	D
	NB I-29 Ramp to EB I-94	B	A	A	A	A	A	A	A	A	B	B	A
	SB I-29 Ramp to WB I-94	B	B	A	B	B	B	B	B	C	D	D	B
	SB I-29 to EB and WB I-94	B	B	B	B	B	B	C	C	D	E	E	C
	SB I-29 to EB I-94 (two lane section)	B	B	B	B	B	B	B	C	C	E	D	C
	SB I-29 to EB I-94 (new two lane section - former single lane section)	A	A	A	A	A	A	B	B	B	C	C	B
	SB I-29 to EB I-94 and NB I-29 to EB I-94 Merge Area	C	B	B	B	B	C	C	C	D	E	E	C
	I-29 to EB I-94 Ramp	C	B	B	B	C	C	C	C	D	E	E	C
	EB I-94 to NB I-29 Ramp	D	C	B	B	B	B	B	B	C	C	C	C
	WB I-94 to SB I-29 Ramp	C	C	B	B	B	B	B	B	C	C	C	B
NB I-29 to WB I-94 Ramp	C	B	B	B	B	B	B	B	B	C	C	C	

I-29 / I-94 Interstate Operation for 2019 Holiday Existing

Roadway	Segment	Level of Service (Hours of Day)											
		7	8	9	10	11	12	13	14	15	16	17	18
Eastbound I-94	Between 45th St and I-29	D	C	C	C	C	D	D	D	D	E	E	D
	At Exit Ramp to SB I-29	C	C	C	C	C	D	D	D	D	E	E	D
	At Exit Ramp to NB I-29	C	B	B	C	B	D	C	D	D	D	E	D
	Between NB I-29 Exit and Entrance Ramps	C	B	B	B	B	C	C	C	C	D	D	D
	At Entrance Ramp from NB I-29/Between I-29 and 25th St	C	C	C	B	C	D	D	E	E	E	F	E
Westbound I-94	Between 25th St and I-29	F	E	E	E	F	F	E	E	F	F	F	F
	At Exit Ramp to NB I-29	E	E	D	D	E	E	E	E	E	E	E	E
	Between NB I-29 Exit and Entrance Ramps	C	C	C	C	C	C	D	D	D	D	D	D
	At NB I-29 Entrance Ramp and SB I-29 Exit Ramp (between loop ramps)	D	D	D	D	D	D	E	E	E	E	E	E
	Between SB I-29 Exit and Entrance ramp (3 lane section)	D	D	D	D	D	E	E	E	E	E	E	E
	Between SB I-29 Exit and Entrance ramp (2 lane section)	D	D	D	D	D	E	E	E	E	E	F	F
At Entrance Ramp from SB I-29/Between I-29 and 45th St	D	D	D	D	D	D	E	E	E	E	F	E	
Northbound I-29	Between 32nd Ave and I-94	B	B	B	B	B	C	C	C	C	C	C	C
	At Exit Ramp to EB I-94	B	B	B	B	B	B	B	C	C	C	C	C
	Between EB I-94 Exit and EB Entrance Ramps	B	B	B	B	B	B	B	C	B	C	B	B
	Between EB I-94 Entrance Ramp and WB I-94 Exit Ramp	C	C	B	C	C	C	C	C	C	D	D	C
	Between WB I-94 Exit and Entrance Ramps	D	D	C	D	D	D	D	D	E	E	E	E
	At Entrance Ramp from WB I-94/Between I-94 and 13th Ave	D	C	C	C	D	D	D	D	D	D	D	D
Southbound I-29	Between 13th Ave and I-94 Exit Ramps	A	B	C	B	C	D	D	E	F	F	F	F
	Between I-94 Exit Ramps and WB I-94 Entrance Ramp	B	A	A	A	B	B	A	B	B	B	B	A
	At WB I-94 Entrance Ramp	B	B	A	A	B	B	B	B	B	B	B	B
	Between I-94 WB and EB Entrance Ramps	A	A	A	A	A	B	A	B	B	B	B	A
	At Entrance Ramp from EB I-94/Between I-29 and 32nd Ave	B	B	B	B	B	B	B	C	C	D	C	B
I-29 & I-94 Interchange Ramps	EB I-94 to SB I-29 Ramp	A	A	A	A	A	A	B	B	B	B	B	A
	WB I-94 to NB I-29 Ramp	E	C	C	C	D	E	D	D	D	E	E	E
	NB I-29 Ramp to EB I-94	A	A	A	A	A	A	A	B	C	C	B	B
	SB I-29 Ramp to WB I-94	A	B	A	B	B	B	B	B	C	D	D	B
	SB I-29 to EB and WB I-94	A	B	B	B	C	C	C	D	E	F	F	E
	SB I-29 to EB I-94 (two lane section)	A	B	B	B	C	C	C	D	F	F	F	E
	SB I-29 to EB I-94 (single lane section)	A	A	B	B	B	C	C	D	F	F	F	E
	SB I-29 to EB I-94 and NB I-29 to EB I-94 Merge Area	B	C	C	B	D	D	D	F	F	F	F	F
	I-29 to EB I-94 Ramp	B	C	C	B	D	D	D	E	F	F	F	F
	EB I-94 to NB I-29 Ramp	D	D	C	C	C	C	D	D	D	E	E	D
	WB I-94 to SB I-29 Ramp	C	C	B	B	C	C	B	B	C	D	C	B
NB I-29 to WB I-94 Ramp	B	B	B	B	B	B	B	C	C	C	C	C	

I-29 / I-94 Interstate Operation for 2019 Holiday Build

Roadway	Segment	Level of Service (Hours of Day)											
		7	8	9	10	11	12	13	14	15	16	17	18
Eastbound I-94	Between 45th St and I-29	D	D	C	D	D	D	E	E	E	E	F	D
	At Exit Ramp to SB I-29	C	C	C	C	C	D	D	E	E	E	E	D
	At Exit Ramp to NB I-29	C	C	C	C	C	D	D	D	D	E	E	D
	Between NB I-29 Exit and Entrance Ramps	C	C	C	C	C	C	D	D	D	E	E	D
	At Entrance Ramp from NB I-29/Between I-29 and 25th St	B	B	B	C	C	C	D	D	D	E	E	D
Westbound I-94	Between 25th St and I-29	E	E	D	D	E	E	E	E	E	F	F	E
	At Exit Ramp to NB I-29	E	E	D	D	E	E	E	D	E	E	E	E
	Between NB I-29 Exit and Entrance Ramps	D	C	C	C	D	D	D	D	D	E	E	D
	At NB I-29 Entrance Ramp and SB I-29 Exit Ramp (between loop ramps)	D	D	D	D	E	E	D	E	E	F	F	E
	Between SB I-29 Exit and Entrance ramp (3 lane section)	E	D	D	D	E	E	E	E	E	E	E	E
	Between SB I-29 Exit and Entrance ramp (2 lane section)	E	D	D	D	E	E	E	E	E	F	F	E
At Entrance Ramp from SB I-29/Between I-29 and 45th St	E	D	D	D	E	E	E	E	E	F	F	E	
Northbound I-29	Between 32nd Ave and I-94	C	B	B	B	B	C	C	C	C	D	C	C
	At Exit Ramp to EB I-94	D	C	C	C	C	D	C	D	E	E	E	D
	Between EB I-94 Exit and EB Entrance Ramps	B	B	B	B	B	B	B	B	B	C	C	B
	Between EB I-94 Entrance Ramp and WB I-94 Exit Ramp	C	B	B	B	B	C	B	B	C	C	C	C
	Between WB I-94 Exit and Entrance Ramps	C	B	B	B	B	C	B	B	C	C	C	C
	At Entrance Ramp from WB I-94/Between I-94 and 13th Ave	D	C	C	C	C	C	C	C	D	D	D	C
Southbound I-29	Between 13th Ave and I-94 Exit Ramps	B	B	C	C	D	D	D	D	E	F	E	D
	Between I-94 Exit Ramps and WB I-94 Entrance Ramp	A	A	A	A	A	B	A	B	B	B	B	A
	At WB I-94 Entrance Ramp	B	B	A	A	B	B	B	B	B	B	B	B
	Between I-94 WB and EB Entrance Ramps	A	A	A	A	A	B	A	B	B	B	B	A
	At Entrance Ramp from EB I-94/Between I-29 and 32nd Ave	B	B	B	B	B	C	B	C	C	D	D	B
I-29 & I-94 Interchange Ramps	EB I-94 to SB I-29 Ramp	A	A	A	A	A	A	A	B	B	B	B	A
	WB I-94 to NB I-29 Ramp	D	C	C	C	C	D	C	C	C	D	D	D
	NB I-29 Ramp to EB I-94	A	A	A	A	A	A	A	A	B	B	B	A
	SB I-29 Ramp to WB I-94	A	B	A	B	B	C	B	C	D	D	C	B
	SB I-29 to EB and WB I-94	A	B	B	B	C	C	C	D	D	E	D	C
	SB I-29 to EB I-94 (two lane section)	A	A	B	B	C	C	C	C	D	E	D	C
	SB I-29 to EB I-94 (new two lane section - former single lane section)	A	A	A	A	B	B	B	B	C	C	C	B
	SB I-29 to EB I-94 and NB I-29 to EB I-94 Merge Area	B	B	B	B	C	C	C	D	D	E	D	C
	I-29 to EB I-94 Ramp	B	B	B	B	C	C	C	D	D	E	D	C
	EB I-94 to NB I-29 Ramp	C	C	C	C	B	C	C	C	C	C	C	C
	WB I-94 to SB I-29 Ramp	C	B	B	B	B	C	B	B	C	C	C	B
NB I-29 to WB I-94 Ramp	B	B	A	B	B	B	B	C	C	C	C	C	

I-29 / I-94 Interstate Operation for 2045 No Build

Roadway	Segment	Level of Service (Hours of Day)											
		7	8	9	10	11	12	13	14	15	16	17	18
Eastbound I-94	Between 45th St and I-29	F	E	D	D	D	D	E	E	E	F	F	F
	At Exit Ramp to SB I-29	E	E	D	D	D	D	D	E	E	E	E	E
	At Exit Ramp to NB I-29	E	E	C	C	D	D	D	D	E	E	E	E
	Between NB I-29 Exit and Entrance Ramps	E	D	C	C	D	D	D	D	E	F	F	E
	At Entrance Ramp from NB I-29/Between I-29 and 25th St	E	E	D	D	D	D	D	E	E	F	F	E
Westbound I-94	Between 25th St and I-29	F	F	E	E	E	F	E	E	F	F	F	F
	At Exit Ramp to NB I-29	E	E	E	E	E	E	E	E	E	E	E	E
	Between NB I-29 Exit and Entrance Ramps	E	D	D	D	D	D	D	D	E	F	F	F
	At NB I-29 Entrance Ramp and SB I-29 Exit Ramp (between loop ramps)	F	E	D	E	E	E	E	E	F	F	F	F
	Between SB I-29 Exit and Entrance ramp (3 lane section)	E	E	E	E	E	E	E	E	E	E	E	E
	Between SB I-29 Exit and Entrance ramp (2 lane section)	F	F	E	E	E	E	E	E	F	F	F	F
At Entrance Ramp from SB I-29/Between I-29 and 45th St	F	E	E	E	E	E	E	E	F	F	F	F	
Northbound I-29	Between 32nd Ave and I-94	E	E	E	E	D	D	D	D	E	F	F	F
	At Exit Ramp to EB I-94	D	D	D	D	D	C	C	C	E	E	E	E
	Between EB I-94 Exit and EB Entrance Ramps	D	D	D	D	C	C	C	C	C	E	E	F
	Between EB I-94 Entrance Ramp and WB I-94 Exit Ramp	F	E	D	D	D	C	C	C	D	F	F	F
	Between WB I-94 Exit and Entrance Ramps	F	E	E	E	E	E	E	E	E	F	F	F
	At Entrance Ramp from WB I-94/Between I-94 and 13th Ave	F	E	E	E	D	D	D	D	D	E	F	F
Southbound I-29	Between 13th Ave and I-94 Exit Ramps	C	D	D	C	D	D	D	F	F	F	F	F
	Between I-94 Exit Ramps and WB I-94 Entrance Ramp	B	B	A	A	B	B	B	B	B	B	B	A
	At WB I-94 Entrance Ramp	B	B	B	A	B	B	B	B	B	B	B	B
	Between I-94 WB and EB Entrance Ramps	B	B	A	A	A	B	B	B	B	B	B	B
	At Entrance Ramp from EB I-94/Between I-29 and 32nd Ave	F	D	B	B	B	C	C	C	C	C	C	C
I-29 & I-94 Interchange Ramps	EB I-94 to SB I-29 Ramp	B	A	A	A	A	A	A	B	B	B	B	B
	WB I-94 to NB I-29 Ramp	E	E	C	D	C	D	D	D	D	D	F	F
	NB I-29 Ramp to EB I-94	D	E	B	B	B	B	B	C	F	F	F	F
	SB I-29 Ramp to WB I-94	B	C	B	B	C	C	C	C	C	B	B	C
	SB I-29 to EB and WB I-94	C	D	C	C	C	C	C	F	F	F	F	F
	SB I-29 to EB I-94 (two lane section)	E	F	D	C	D	C	D	F	F	F	F	F
	SB I-29 to EB I-94 (single lane section)	E	F	D	C	D	C	E	F	F	F	F	F
	SB I-29 to EB I-94 and NB I-29 to EB I-94 Merge Area	F	F	F	E	F	F	F	F	F	F	F	F
	I-29 to EB I-94 Ramp	F	F	E	E	F	E	F	F	F	F	F	F
	EB I-94 to NB I-29 Ramp	F	D	C	C	C	D	C	C	D	E	E	F
	WB I-94 to SB I-29 Ramp	D	D	B	B	B	C	B	C	C	C	D	B
NB I-29 to WB I-94 Ramp	C	D	C	D	D	C	C	D	D	E	E	E	

I-29 / I-94 Interstate Operation for 2045 Build

Roadway	Segment	Level of Service (Hours of Day)											
		7	8	9	10	11	12	13	14	15	16	17	18
Eastbound I-94	Between 45th St and I-29	F	E	D	D	D	D	E	E	E	F	F	E
	At Exit Ramp to SB I-29	E	E	D	D	D	D	D	E	E	E	E	E
	At Exit Ramp to NB I-29	E	E	C	C	D	D	D	D	E	E	E	E
	Between NB I-29 Exit and Entrance Ramps	E	D	C	C	D	D	D	D	D	F	F	E
	At Entrance Ramp from NB I-29/Between I-29 and 25th St	E	D	D	C	D	D	D	D	E	F	F	E
Westbound I-94	Between 25th St and I-29	F	F	E	E	E	F	E	E	F	F	F	F
	At Exit Ramp to NB I-29	E	E	E	E	E	E	E	E	E	E	E	E
	Between NB I-29 Exit and Entrance Ramps	E	D	D	D	D	D	D	D	E	F	F	F
	At NB I-29 Entrance Ramp and SB I-29 Exit Ramp (between loop ramps)	F	F	E	E	E	E	E	E	F	F	F	F
	Between SB I-29 Exit and Entrance ramp (3 lane section)	E	E	E	E	E	E	E	E	E	E	E	E
	Between SB I-29 Exit and Entrance ramp (2 lane section)	F	F	E	E	E	E	E	E	F	F	F	F
At Entrance Ramp from SB I-29/Between I-29 and 45th St	F	E	E	E	E	E	E	E	F	F	F	F	
Northbound I-29	Between 32nd Ave and I-94	E	E	E	D	D	D	D	D	E	F	F	F
	At Exit Ramp to EB I-94	E	E	D	D	D	D	D	E	E	E	E	E
	Between EB I-94 Exit and EB Entrance Ramps	D	D	D	C	B	C	C	C	C	D	F	F
	Between EB I-94 Entrance Ramp and WB I-94 Exit Ramp	F	D	D	C	C	C	C	C	D	F	F	F
	Between WB I-94 Exit and Entrance Ramps	F	D	D	C	C	C	C	C	D	D	D	D
	At Entrance Ramp from WB I-94/Between I-94 and 13th Ave	F	E	D	D	D	D	D	D	D	E	E	D
Southbound I-29	Between 13th Ave and I-94 Exit Ramps	D	C	D	C	D	D	D	E	F	F	F	F
	Between I-94 Exit Ramps and WB I-94 Entrance Ramp	C	B	B	B	B	B	B	C	D	E	E	D
	At WB I-94 Entrance Ramp	C	B	B	B	B	B	B	B	C	C	D	C
	Between I-94 WB and EB Entrance Ramps	C	C	B	B	B	B	B	C	C	D	D	C
	At Entrance Ramp from EB I-94/Between I-29 and 32nd Ave	F	D	C	B	C	C	C	D	E	F	F	E
I-29 & I-94 Interchange Ramps	EB I-94 to SB I-29 Ramp	B	A	A	A	A	A	A	B	B	B	B	B
	WB I-94 to NB I-29 Ramp	E	E	C	D	C	D	D	D	D	D	D	D
	NB I-29 Ramp to EB I-94	C	C	B	B	B	B	B	B	C	D	C	C
	SB I-29 Ramp to WB I-94	C	C	B	B	C	C	C	C	E	F	E	F
	SB I-29 to EB and WB I-94	C	C	C	C	C	C	D	D	E	F	F	F
	SB I-29 to EB I-94 (two lane section)	C	B	C	C	C	C	C	D	E	E	E	E
	SB I-29 to EB I-94 (new two lane section - former single lane section)	B	B	B	B	B	B	B	B	C	D	D	C
	SB I-29 to EB I-94 and NB I-29 to EB I-94 Merge Area	D	D	D	C	D	D	D	D	E	F	F	F
	I-29 to EB I-94 Ramp	D	D	D	C	D	D	D	D	E	F	F	F
	EB I-94 to NB I-29 Ramp	F	D	C	C	C	D	C	C	D	E	F	F
	WB I-94 to SB I-29 Ramp	D	D	B	B	B	C	B	C	C	C	C	C
NB I-29 to WB I-94 Ramp	C	D	D	C	C	C	C	C	D	F	F	F	

I-29 / I-94 Interstate Operation for 2045 Lane Utilization No Build

Roadway	Segment	Level of Service (Hours of Day)											
		7	8	9	10	11	12	13	14	15	16	17	18
Eastbound I-94	Between 45th St and I-29	F	E	D	D	D	D	D	E	C	F	F	F
	At Exit Ramp to SB I-29	E	E	D	D	D	D	D	E	C	E	E	E
	At Exit Ramp to NB I-29	E	E	C	C	D	D	D	D	C	E	E	E
	Between NB I-29 Exit and Entrance Ramps	E	D	C	C	C	D	D	D	D	F	F	E
	At Entrance Ramp from NB I-29/Between I-29 and 25th St	E	E	D	D	D	D	D	E	D	F	F	E
Westbound I-94	Between 25th St and I-29	F	F	E	E	E	E	E	E	D	F	F	F
	At Exit Ramp to NB I-29	E	E	E	E	E	E	E	E	C	E	E	E
	Between NB I-29 Exit and Entrance Ramps	E	D	C	D	D	D	D	D	D	F	F	F
	At NB I-29 Entrance Ramp and SB I-29 Exit Ramp (between loop ramps)	F	E	D	E	E	E	E	E	E	F	F	F
	Between SB I-29 Exit and Entrance ramp (3 lane section)	E	E	E	E	E	E	E	E	E	E	E	E
	Between SB I-29 Exit and Entrance ramp (2 lane section)	F	E	E	E	E	E	E	E	E	F	F	E
At Entrance Ramp from SB I-29/Between I-29 and 45th St	F	E	E	E	E	E	E	E	E	F	F	E	
Northbound I-29	Between 32nd Ave and I-94	E	E	E	D	D	D	D	D	D	F	F	F
	At Exit Ramp to EB I-94	D	D	C	D	D	C	C	C	E	E	E	E
	Between EB I-94 Exit and EB Entrance Ramps	D	D	D	C	C	C	C	C	F	E	F	F
	Between EB I-94 Entrance Ramp and WB I-94 Exit Ramp	F	D	D	D	D	D	C	C	E	E	F	F
	Between WB I-94 Exit and Entrance Ramps	F	E	E	D	E	E	E	E	F	F	F	F
	At Entrance Ramp from WB I-94/Between I-94 and 13th Ave	F	E	D	D	D	D	D	D	F	F	F	F
Southbound I-29	Between 13th Ave and I-94 Exit Ramps	D	D	C	C	D	D	D	F	F	F	F	F
	Between I-94 Exit Ramps and WB I-94 Entrance Ramp	B	B	A	A	A	B	B	B	E	B	B	A
	At WB I-94 Entrance Ramp	B	B	A	A	B	B	B	B	C	B	B	B
	Between I-94 WB and EB Entrance Ramps	B	B	A	A	B	B	B	B	C	B	B	A
	At Entrance Ramp from EB I-94/Between I-29 and 32nd Ave	F	C	B	B	B	C	C	C	D	C	C	C
I-29 & I-94 Interchange Ramps	EB I-94 to SB I-29 Ramp	B	A	A	A	A	A	A	B	D	B	B	B
	WB I-94 to NB I-29 Ramp	E	E	C	C	C	D	D	C	F	E	F	F
	NB I-29 Ramp to EB I-94	C	D	B	B	B	B	B	C	F	F	F	F
	SB I-29 Ramp to WB I-94	B	C	B	B	C	C	C	C	A	B	B	C
	SB I-29 to EB and WB I-94	C	C	C	C	C	C	C	F	A	F	F	F
	SB I-29 to EB I-94 (two lane section)	D	E	C	C	C	C	D	F	B	F	F	F
	SB I-29 to EB I-94 (single lane section)	E	F	C	B	D	C	E	F	A	F	F	F
	SB I-29 to EB I-94 and NB I-29 to EB I-94 Merge Area	F	F	E	D	F	F	F	F	A	F	F	F
	I-29 to EB I-94 Ramp	F	F	E	D	E	E	F	F	A	F	F	F
	EB I-94 to NB I-29 Ramp	F	D	C	C	B	C	C	C	B	D	F	F
	WB I-94 to SB I-29 Ramp	D	C	B	B	B	C	B	C	A	C	C	B
NB I-29 to WB I-94 Ramp	C	C	C	D	D	C	C	C	B	D	D	E	

I-29 / I-94 Interstate Operation for 2045 Lane Utilization Build

Roadway	Segment	Level of Service (Hours of Day)											
		7	8	9	10	11	12	13	14	15	16	17	18
Eastbound I-94	Between 45th St and I-29	F	E	D	D	D	D	D	E	E	F	F	E
	At Exit Ramp to SB I-29	E	E	D	D	D	D	D	E	E	E	E	E
	At Exit Ramp to NB I-29	E	E	C	C	D	D	D	D	E	E	E	E
	Between NB I-29 Exit and Entrance Ramps	E	D	C	C	C	D	D	D	D	F	F	E
	At Entrance Ramp from NB I-29/Between I-29 and 25th St	E	D	D	C	D	D	D	D	E	F	F	F
Westbound I-94	Between 25th St and I-29	F	F	E	E	E	E	E	E	F	F	F	F
	At Exit Ramp to NB I-29	E	E	E	E	E	E	E	E	E	E	E	E
	Between NB I-29 Exit and Entrance Ramps	E	D	C	D	D	D	D	D	E	F	F	F
	At NB I-29 Entrance Ramp and SB I-29 Exit Ramp (between loop ramps)	F	E	E	E	E	E	E	E	F	F	F	F
	Between SB I-29 Exit and Entrance ramp (3 lane section)	E	E	E	E	E	E	E	E	E	E	E	E
	Between SB I-29 Exit and Entrance ramp (2 lane section)	F	F	E	E	E	E	E	E	F	F	F	F
At Entrance Ramp from SB I-29/Between I-29 and 45th St	F	E	E	E	E	E	E	E	F	F	F	F	
Northbound I-29	Between 32nd Ave and I-94	E	E	D	C	C	D	D	D	D	F	F	F
	At Exit Ramp to EB I-94	E	E	D	D	D	D	D	E	E	E	E	E
	Between EB I-94 Exit and EB Entrance Ramps	D	D	C	B	B	C	C	C	C	D	E	F
	Between EB I-94 Entrance Ramp and WB I-94 Exit Ramp	F	D	D	C	C	C	C	C	C	D	F	F
	Between WB I-94 Exit and Entrance Ramps	F	D	D	C	C	C	C	C	C	D	E	D
	At Entrance Ramp from WB I-94/Between I-94 and 13th Ave	F	E	D	D	D	D	D	C	D	E	E	D
Southbound I-29	Between 13th Ave and I-94 Exit Ramps	D	C	D	C	D	D	D	E	F	F	F	F
	Between I-94 Exit Ramps and WB I-94 Entrance Ramp	C	B	B	B	B	B	B	C	D	E	E	D
	At WB I-94 Entrance Ramp	C	B	B	B	B	B	B	B	C	D	D	C
	Between I-94 WB and EB Entrance Ramps	C	B	B	B	B	B	B	C	C	D	D	D
	At Entrance Ramp from EB I-94/Between I-29 and 32nd Ave	F	D	C	B	C	C	C	D	E	F	F	E
I-29 & I-94 Interchange Ramps	EB I-94 to SB I-29 Ramp	B	A	A	A	A	A	A	B	B	B	B	B
	WB I-94 to NB I-29 Ramp	E	E	C	C	C	D	D	C	D	D	D	D
	NB I-29 Ramp to EB I-94	C	C	B	A	B	B	B	B	C	D	C	C
	SB I-29 Ramp to WB I-94	C	C	B	B	C	C	C	C	E	F	E	F
	SB I-29 to EB and WB I-94	C	C	C	C	C	C	D	D	E	F	F	F
	SB I-29 to EB I-94 (two lane section)	C	B	C	C	C	C	C	D	E	F	E	E
	SB I-29 to EB I-94 (new two lane section - former single lane section)	B	B	B	B	B	B	B	B	C	D	C	C
	SB I-29 to EB I-94 and NB I-29 to EB I-94 Merge Area	D	D	D	C	D	D	D	D	E	F	F	F
	I-29 to EB I-94 Ramp	D	D	D	C	D	D	D	D	E	F	F	F
	EB I-94 to NB I-29 Ramp	F	D	C	C	B	C	C	C	D	D	E	F
	WB I-94 to SB I-29 Ramp	D	C	B	B	B	C	B	C	C	C	C	C
NB I-29 to WB I-94 Ramp	C	D	D	C	C	C	C	C	D	E	F	F	

Appendix E: Benefit Cost Analysis Calculations

2015-2019 Crashes

Type of Crash	Frequency
Angle	14
Head On	2
Non-Coll. w/Motor Veh.	101
Rear End	147
Rear to Rear	1
Rear to Side	3
Right Angle	1
Sideswipe (opp. dir.)	3
Sideswipe (same dir.)	63

Rear End Crashes	
K	0
A	2
B	11
C	18
PDO	116

Sideswipe Same Direction Crashes	
K	0
A	0
B	0
C	1
PDO	62

AM Peak (7-9 am)

Scenario	Total	rear end	lane change
2019 Existing Typical Day	628	55	573
2019 Build Typical Day	618	51	566

PM Peak (4-6 pm)

Scenario	Total	rear end	lane change
2019 Existing Typical Day	11668	6875	4793
2019 Build Typical Day	1854	99	1755

Crash Severity	Crash Cost
K crashes	\$9,600,000
A crashes	\$459,100
B crashes	\$125,000
C crashes	\$63,900
PDO crashes	\$3,200

Percent Decrease

Total Rear End Lane Change

AM Reduction 1.7% 7.4% 1.1%

PM Reduction 84.1% 98.6% 63.4%

Volume

AM 23126

PM 30481

Weighted Average of Percent Reduction

AM % Reduction 59% 37% 2019 Build
0.43139888 CMF 0.41 0.63

PM
0.56860112

Annual Benefit

Severity	Rear End Crashes
K	\$0
A	\$108,348
B	\$162,250
C	\$135,724
PDO	\$43,802
Total	\$450,123

Option	Rear End Benefit	Lane Change Benefit
2019 Build	\$450,123	\$19,411

Severity	Rear End Crashes
K	\$0
A	\$0
B	\$0
C	\$4,729
PDO	\$14,682
Total	\$19,410