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Interstate Operations Study: Fargo-Moorhead Metropolitan Area

2015 Simulation Output

Technical Memorandum III

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Prepared for:
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(Metro COG)

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EXECUTIVE SUMMARY

This document provides the simulation results for the 2015 planning horizon of the Fargo-Moorhead Interstate Operations Study. Previous material focused on the simulation development process (Technical Memorandum I) and the calibration process and the simulation results of the 2008 base cases (Technical Memorandum II). Major sections of this document include the network modifications, traffic demand, and simulation results for the 2015 peak-hour scenarios. The simulation analysis will produce numerical data and animation to evaluate freeway operations that incorporate several improvements from the 2008 base cases.

The simulation study area includes all of the freeway interchanges of I-29 and I-94 within the cities of Fargo, ND; West Fargo, ND; and Moorhead, MN. Ten interchanges were modeled with local roadways along the 15-mile portion of I-94 and 7 interchanges along the 9-mile portion of I-29. The simulation analysis was performed using PTV AG's VISSIM simulation program.

The freeway mainline densities that experienced congestion were generally along I-94 east of I-29. The highest density values for the 2015 AM scenario were along the westbound sections of I-94 from 34th St. (Moorhead, MN) to I-29, which exhibited densities between 29 pc/mi/ln to 36 pc/mi/ln (LOS D-E). For the 2015 PM scenario, the highest density values were along the eastbound sections of I-94 from 25th St. (Fargo, ND) to 8th St. (Moorhead, MN) with densities ranging from 29 pc/mi/ln to 32 pc/mi/ln (LOS D).

The I-29 & I-94 Interchange experienced a significant number of vehicles during the 2015 peak periods. Although the interchange did not experience congestion during the AM peak period, significant congestion developed at the tri-level merge area during the PM peak period. Over 2,200 vehicles from two ramps (tri-level and southeast ramps) merged into one lane during the PM peak-hour period, causing significant queue lengths to develop. During the 2008 PM scenario, the average maximum length was just over 2,000 ft, which grew to over 5,500 ft for the 2015 PM scenario. The congestion at this area during the 2008 PM occurred for 15 to 20 minutes, while the 2015 PM scenario experienced congestion throughout the entire peak hour.

The construction of the I-94 & 9th St/57th St. Interchange, which was included in the 2015 scenarios, improved the operations of both the I-94 & Sheyenne St. Interchange and I-94 and 45th St. Interchange. In addition, the construction of the auxiliary lanes between I-29 and 45th St. improved traffic operations during the PM peak period, which eliminated the queues that developed during the 2008 scenarios for the westbound section.

The I-94 & 8th St. (TH 75) Interchange was the only ramp terminal that experienced significant congestion for the 2015 scenarios. During the 2015 AM scenario, the north ramp experienced congestion due to the high number of vehicles making northbound left-turn and southbound right-turn movements (both of which are accessing westbound I-94). During the 2015 PM, the south ramp experienced congestion from the high number of vehicles traveling eastbound along I-94 and taking the 8th St. off-ramp. In addition to having a high delay time for the off-ramp traffic, the traffic queues back onto I-94 and had an average maximum queue length of over 5,600 ft.

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OVERVIEW

This document provides information related to the 2015 simulation scenario for the Fargo-Moorhead Interstate Operations Study (F-M IOS). Previous material focused on the simulation development process, calibration process, and the simulation results of the 2008 AM and PM base cases (Technical Memorandums I and II). The major sections of this document include the network modifications, traffic demand, and the simulation output for the 2015 AM and PM peak-hour scenarios.

2015 SIMULATION STUDY AREA

The simulation study area includes all of the freeway interchanges of Interstate 29 (I-29) and Interstate 94 (I-94) within the cities of Fargo, ND; West Fargo, ND; and Moorhead, MN (Figure 1). Ten interchanges will be modeled with local roadways along the 15 mile portion of I-94 and 7 interchanges along the 9 mile portion of I-29. The simulation analysis, which uses PTV AG's VISSIM 5.1, will produce numerical data and animation to evaluate the freeway operations that will incorporate several short-term improvements, which will be incorporated by 2015.

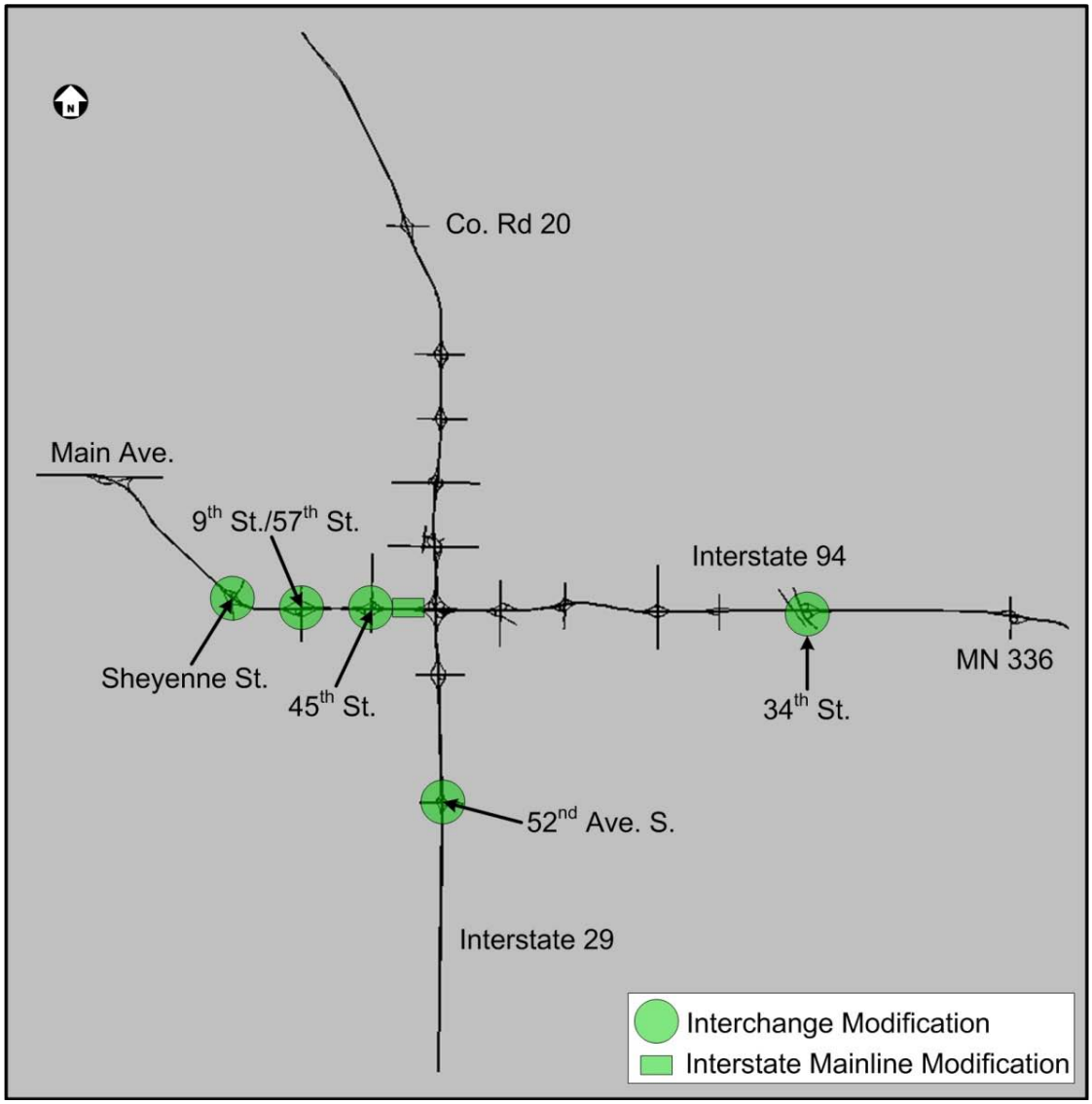


Figure 1. 2015 F-M IOS VISSIM network (differences from 2008 base case are noted)

NETWORK CONDITIONS

Several interchanges were modified to replicate the 2015 freeway conditions. The 2015 conditions include all of the freeway projects that were under construction in 2008 and those that are included in the F-M 2010-2013 Transportation Improvement Program (TIP). In 2008, the I-29 & 52nd Ave. S. Interchange was reconstructed and the I-94 & Sheyenne St. Interchange was changed to signalized control. In 2009, two interchanges will be constructed: I-94 & 9th St./57th St. and I-94 & 34th St. The I-94 & 34th St. Interchange will replace the existing I-94 & Main Ave. Interchange (Moorhead, MN). In 2010, the I-94 & 45th St. Interchange will be modified and auxiliary lanes will be constructed along I-94 between 45th St. and I-29.

Some speed limit zones will also be adjusted for this study area. The 75 mph zone on the west side of I-94 has been moved from west of 45th St. to west of Sheyenne St. This was performed due to the additional interchange at 9th St./57th St. In addition, the 75 mph zone on the south side of I-29 has been moved from south of 52nd Ave. S. to just south of 32nd Ave. S. Due to the reconstruction of the 52nd Ave. S. interchange in 2008, the work zone had a 55 mph speed limit.

Since this study's focus relates to evaluating the freeway operations, the details of the signal timing and arterial roadways are not critical to the study. However, these data will be beneficial for future simulation projects within the F-M area. Descriptions and VISSIM screenshots of the 2015 network are provided in the following sections.

I-29 & 52nd Ave. S. Interchange

- Updated Geometry: 52nd Ave. S., SB off-ramp, NB off-ramp
- New Geometry: SE loop-ramp, NW loop-ramp
- Updated Traffic Control: Signal phasing/timing, vehicle detectors (both ramp terminals)

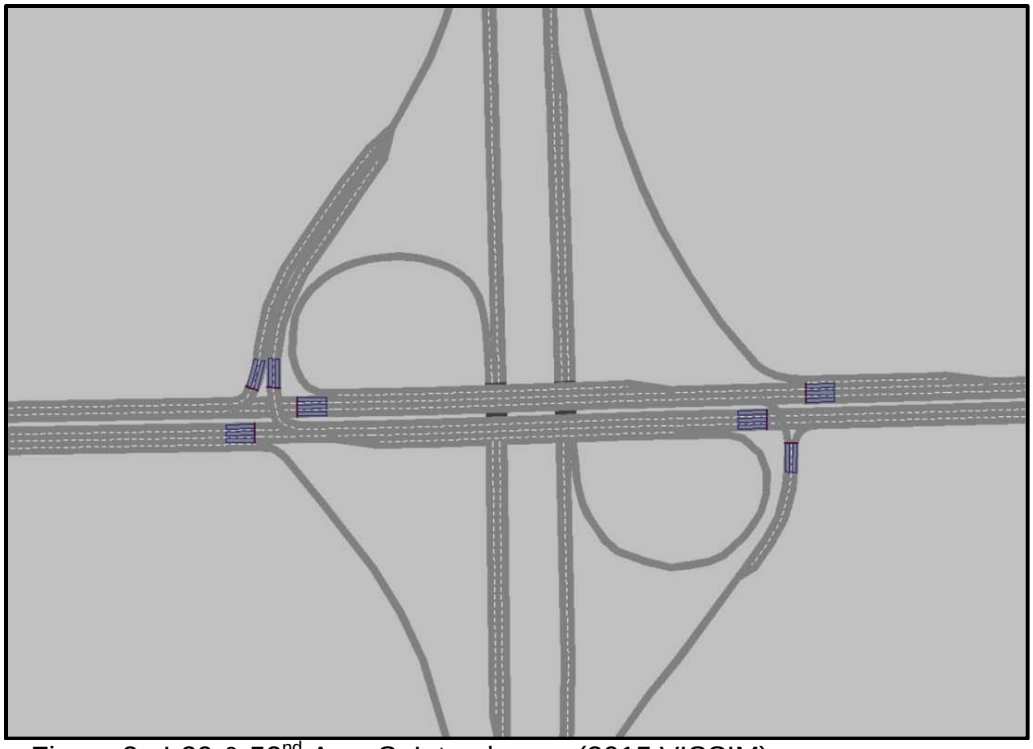


Figure 2. I-29 & 52nd Ave. S. Interchange (2015 VISSIM)

I-94 & Sheyenne St. Interchange

- Updated Traffic Control: Signal phasing/timing, vehicle detectors (both ramp terminals)

Figure 3. I-94 & Sheyenne St. Interchange (2015 VISSIM)

I-94 & 9th St./57th St. Interchange

- New Geometry: 9th St. overpass, EB off-ramp, WB off-ramp, NE loop-ramp, SW loop ramp
- New Traffic Control: Signal phasing/timing, vehicle detectors (both ramp terminals)

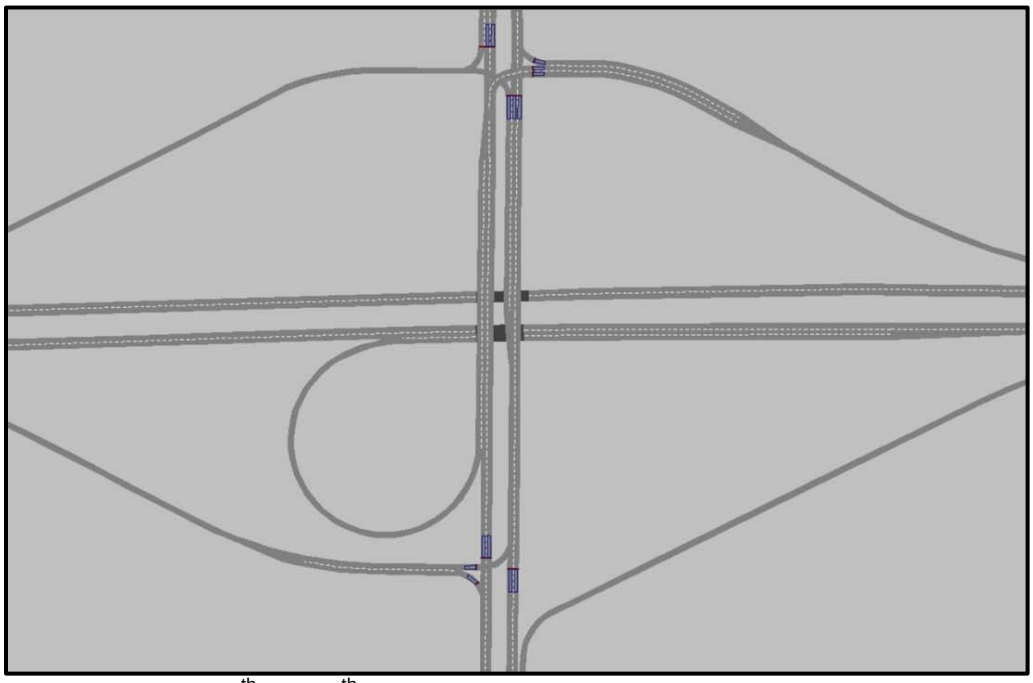


Figure 4. I-94 & 9th St./57th St. Interchange (2015 VISSM)

I-94 & 34th St. Interchange

- Updated/new Geometry: Main Ave. SE., 34th St., EB off-ramp, WB off-ramp, NE loop-ramp, SE loop-ramp
- Updated/new Traffic Control: Signal phasing/timing, vehicle detectors (both ramp terminals)

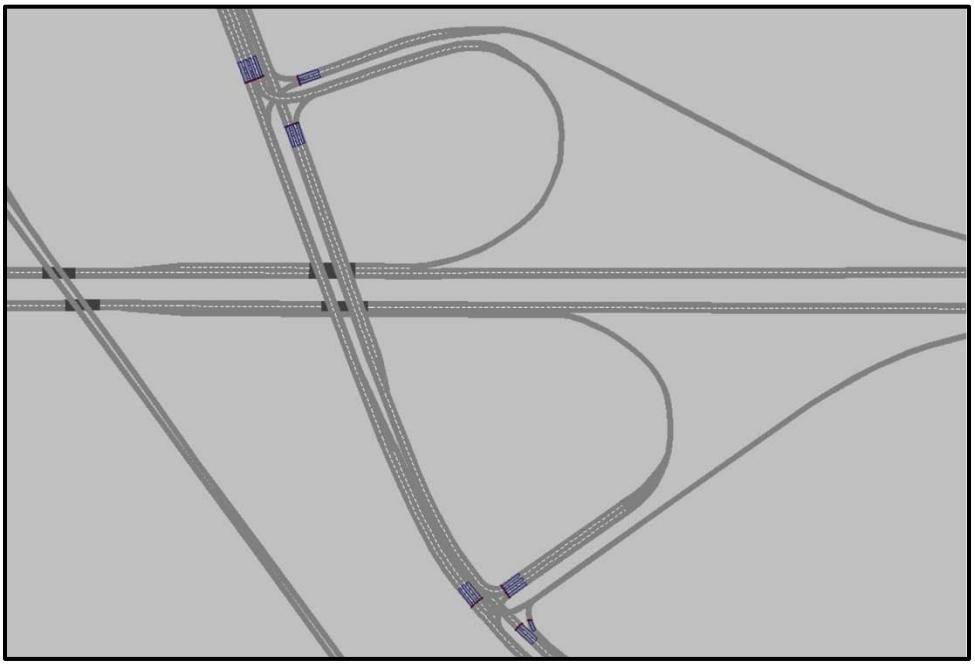


Figure 5. I-94 & 34th St. Interchange (2015 VISSIM)

I-94 & 45th St. Interchange

- New Geometry: 45th St. overpass, NE loop-ramp, WB off-ramp and left turn will have 2 lanes
- Updated Traffic Control: Signal phasing/timing, vehicle detectors (north ramp)

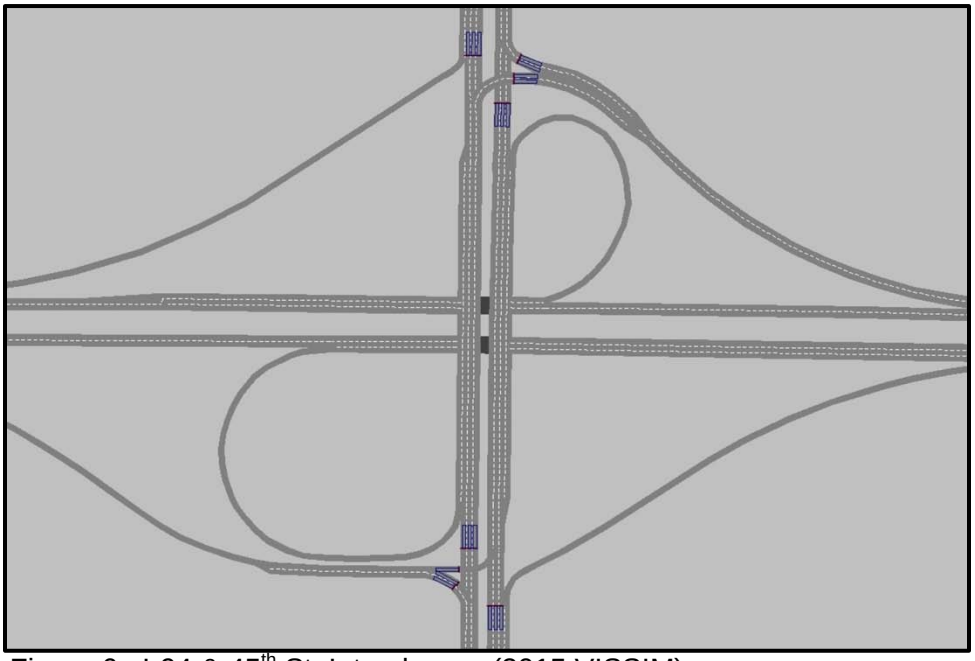


Figure 6. I-94 & 45th St. Interchange (2015 VISSIM)

I-94 between 45th St. and I-29

- Updated Geometry: Incorporate auxiliary lanes for eastbound and westbound traffic

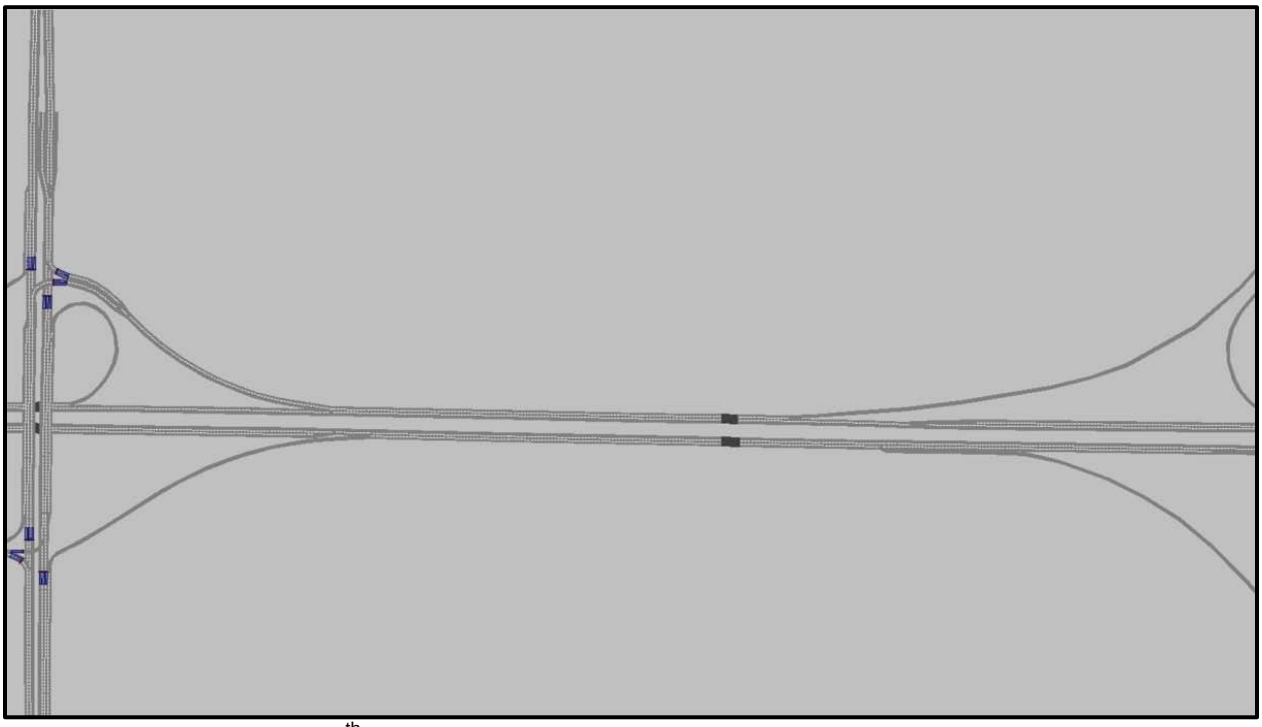


Figure 7. I-94 between 45th St. and I-29 (2015 VISSIM)

TRAFFIC CONTROL DEVICES

Most of the ramp terminals located within the metro area are controlled by traffic signals. The signal timing data for the 2008 AM and 2008 PM peak periods were used for the 2015 AM and 2015 PM simulation scenarios. In addition to modeling the original 23 traffic signals, new traffic signals were incorporated at the I-94 & 9th St./57th St. Interchange, I-94 & Sheyenne St. Interchange, and I-94 & 34th St. Interchange (note: signals at the I-94 & Main Ave. SE Interchange were removed from the network). In addition, the I-94 & 45th St. North Ramp had phase/timing modifications due to the geometric changes that will occur in 2010.

TRAFFIC VOLUME INFORMATION

Based on the projected socio-economic data, which include employment and household data, traffic volume will continue to increase within the F-M metro area, especially to the south and west. This is evident when comparing the average daily traffic (ADT) between the 2005 base case (which is the travel demand model's calibrated base case) and the 2015 forecast. Daily traffic volume increases along I-29 range from 3% to 50%, while I-94 volume increases range from 12% to 40% (Table 1).

Table 1. Interstate Mainline Average Daily Traffic Comparison (Modeled 2005 and 2015)

Interstate 29	**Combined Mainline Traffic**		
Freeway Mainline	**2005**	**2015**	**% Change**
CR 20 - 19th Ave. N	17,847	21,908	23%
19th Ave. N - 12th Ave. N	21,880	22,472	3%
12th Ave. N - Main Ave.	33,088	37,995	15%
Main Ave. - 13th Ave. S	41,569	46,073	11%
13th Ave. S - I-94	58,436	61,036	4%
I-94 – 32nd Ave. S	37,297	42,027	13%
32nd Ave. S – 52nd Ave. S	22,575	33,780	50%
Interstate 94	**Combined Mainline Traffic**		
Freeway Mainline	**2005**	**2015**	**% Change**
Main Ave. - Sheyenne St.	17,781	22,499	27%
Sheyenne St. – 9th St./57th St.	-	26,266	-
9th St./57th St. – 45th St.	26,512	32,905	24%
45th St. - I-29	38,650	54,282	40%
I-29 – 25th St.	59,277	71,027	20%
25th St. - University Dr.	58,442	65,607	12%
University Dr. – 8th St. (TH 75)	54,919	62,165	13%
8th St. (TH 75) – 20th St.	35,950	45,885	28%
20th St. – 34th St.	25,003	31,773	27%
34th St. - MN 336	26,389	31,853	21%

Origin-Destination Demands

Several issues can develop when using travel demand models for performing peak-hour analyses. Most regional planning models are based on daily trip generation. Therefore, the hourly matrix is a percentage of the daily matrix. Based on past analysis of hourly traffic data, the daily traffic for F-M regional planning model is divided into the following groups: AM peak hour (7.5%), PM peak hour (8.5%), and off peak (6% for 14 hours). The PM peak-hour traffic portion of the daily traffic (8.5%) is an approximate percentage of traffic on a regional level; however, peak-hour percentages for different areas and facility types vary significantly. Based on reviewing hourly data along freeway portions of the F-M area, the PM peak hour represents about 10% of the ADT. If 8.5% of the daily traffic was used to represent the freeway traffic during the PM peak-hour conditions (rather than 10%), the travel demand model would under estimate traffic by almost 17.5%.

To overcome the peak-hour traffic issue and to evaluate different planning horizons, target values can be incorporated into the planning model. Most planning models are capable of performing this function by assigning the proper amount of traffic to the network (sub-area) based on traffic counts in the field. Evaluating future planning horizons may be difficult since the base model may not generate enough traffic to replicate peak-hour conditions. Therefore, future peak-hour targets (counts) may be required. It should be noted that the primary function of a travel demand model is to provide traffic conditions on a regional level based on socio-economic data and network changes. When corridor studies are conducted, which use a sub-

area network of the model, the accuracy of model output can be significantly improved by using field data.

The 2008 AM and PM simulation scenarios incorporated field counts into the regional travel demand model. Target values were based on AM and PM peak-hour counts, which were primarily conducted in April of 2008. The target values were incorporated into a sub-area network, which included all freeway interchanges and mainline sections of the travel demand model (2005 base year), to replicate the existing traffic levels. Coding was performed to incorporate Cube's Matrix Estimator (ME) logic, producing an O-D matrix that satisfied the target values for both the 2008 AM and PM scenarios. To achieve the study area's target values, which were on the freeway mainlines, ramps, and arterials intersecting the freeways, the sub-area's O-D matrices from the 2008 AM and PM using ME were higher than the 2005 base model by 11.9% and 40.0% (Table 2 and Table 3).

Table 2. Travel Demand Model Comparisons (2005 AM Base Case and 2005 AM ME)

AM Peak Hour Origin-Destination Matrix	Trips	% Change
2005 Base Model (Calibrated Base Case)	26,455	11.9%
2008 AM ME - 2005 Base Model with Target Values (2008 Field Counts) Using ME	29,593	

Table 3. Travel Demand Model Comparisons (2005 PM Base Case and 2005 PM ME)

PM Peak Hour Origin-Destination Matrix	Trips	% Change
2005 Base Model (Calibrated Base Case)	25,443	40.0%
2008 PM ME - 2005 Base Model with Target Values (2008 Field Counts) Using ME	35,622	

The large difference between the 2005 PM case and the 2008 PM ME case can be explained by two reasons. First, the travel demand model is underestimating PM peak-hour traffic (at least for this study area consisting of the freeway facilities). Second, the traffic volume for the study area has increased since 2005. Therefore, using target values were essential in producing a realistic O-D matrix.

Unlike the 2008 AM and PM simulation scenarios, the 2015 AM and PM scenarios do not have target values based on field data. When comparing the sub-area network's O-D matrix between the 2005 base model and the forecasted traffic from the 2015 model, vehicle-trips increased 27.3% for the AM peak and 18.7% for the PM peak (Table 4 and Table 5). It should be noted that the 2008 PM case (which used field counts as targets) had more trips than the 2015 PM forecast.

Table 4. Travel Demand Model Comparisons (2005 AM Base Case and 2015 AM)

AM Peak Hour Origin-Destination Matrix	Trips	% Change
2005 Base Model (Calibrated Base Case)	26,455	27.3%
2015 Forecast – 2015 Model Network and Socio-economic Data	33,685	

Table 5. Travel Demand Model Comparisons (2005 PM Base Case and 2015 PM)

PM Peak Hour Origin-Destination Matrix	Trips	% Change
2005 Base Model (Calibrated Base Case)	25,443	18.7%
2015 Forecast – 2015 Model Network and Socio-economic Data	30,207	

To produce more realistic peak-hour traffic volume, target values were incorporated into the 2015 AM and 2015 PM travel demand model's sub-area networks. Initially, only the 2015 PM scenario was analyzed and documented; however, at the request of the study's steering review committee (SRC), the 2015 AM scenario was also analyzed. Since several network changes were introduced into the 2015 network, target values were used at the boundaries of the analysis network and areas adjacent to the I-29 & I-94 Interchange. Due to the significant level of development for the southern portion of the study area, a target value was not used for this boundary section. A list of the locations incorporating target values is as follows:

- CR 20 - 19th Ave. N (mainline sections, northern boundary)
- Main Ave. - Sheyenne St. (mainline sections, western boundary)
- 34th St. - MN 336 (mainline sections, eastern boundary)
- 13th Ave. S - I-94 (mainline sections, north of I-29 & I-94 Interchange)
- I-94 - 32nd Ave. S (mainline sections, south of I-29 & I-94 Interchange)
- 45th St. - I-29 (mainline sections, west of I-29 & I-94 Interchange)
- I-29 - 25th St. (mainline sections, east of I-29 & I-94 Interchange))
- Tri-level/SE Ramp (tri-level merge area)
- I-94 and 8th St. Interchange (eastbound off-ramp)
- I-94 and 25th St. Interchange (eastbound off-ramp)

Note: The 2015 AM scenario also included target values for all mainline, on-ramp, and off-ramp segments north and east of the I-29 and I-94 Interchange.

To account for conservative traffic growth from 2008 to 2015, an average growth rate of 1.75% was used for the 7 year period, providing a 12% increase to the 2008 field counts. The 2015 target volumes were entered into the sub-area networks and Cube's ME was used to provide updated O-D matrices. The target values produced sub-area O-D matrices for the 2015 AM and 2015 PM scenarios that deferred from the original 2015 AM and PM forecasts by -7.1% and 6.9%, respectively (Table 6 and 7).

Table 6. Travel Demand Model Comparisons (2015 AM Base Case and 2015 AM ME)

AM Peak Hour Origin-Destination Matrix	Trips	% Change
2015 AM Forecast	33,685	-7.1%
2015 AM ME - 2015 Forecast with Target Values (2008 Field Counts With a Growth Factor) Using ME	31,278	

Table 7. Travel Demand Model Comparisons (2015 PM Base Case and 2015 PM ME)

PM Peak Hour Origin-Destination Matrix	Trips	% Change
2015 PM Forecast	30,207	6.9%
2015 PM ME - 2015 Forecast with Target Values (2008 Field Counts With a Growth Factor) Using ME	32,305	

In contrast to the previous trip comparisons, the 2015 AM ME trips were lower than the 2015 AM Forecast. Although the PM peak-hour traffic is generally higher than the AM peak-hour traffic, the AM O-D matrices are higher than the PM O-D matrices for both the 2005 and 2015 regional models. Upon further review, the various peak-period factors of the F-M regional travel demand model, such as percentage of ADT that occurs in each peak hour based on trip type [home-based work (HBW), home-based other (HBO), and non-home based (NHB)] and the home-based school (HBS) trip generation rates, generate more trips during the AM peak hour than the PM peak hour. Therefore, the 2015 AM ME trips were lower than those of the 2015 AM Forecast while the 2015 PM ME trips were higher than those of the 2015 PM Forecast. For future peak-hour studies, the average peak-hour percentages of the ADT (7.53 for the AM peak and 8.52 for the PM peak) could be adjusted to more accurately reflect the peak-hour counts.

It should also be noted that the 2015 PM ME is less than the 2008 PM ME. This occurrence is due to the fact that target values with growth factors were not used for all of the sub-area's links, which is unlike the 2008 AM and 2008 PM scenarios. Since none of the arterial links were factored for the 2015 AM ME and PM ME runs, the overall O-D matrix can be significantly different.

After performing the ME procedure, the 2015 AM and PM peak-hour matrices were adjusted to account for pass-through trips based on the 2008 external O-D study. The higher of the two external-external freeway trip values between the ME O-D matrix and the O-D study matrix were used in the 2015 simulation scenarios.

Vehicle Composition

Similar to the 2008 AM and PM simulation scenarios, the 2015 AM and PM scenarios incorporated both passenger car and truck O-D matrices. The traffic composition for both 2015 simulation scenarios consisted of passenger cars (95%), tractor-trailer trucks (3%), and single-unit trucks (2%). These vehicle percentages were applied to the O-D matrices.

Peak Hour Origin-Destination Demand

To account for the variation in traffic demand within the peak-hour periods, the peak-hour O-D matrices were factored at 5-minute intervals. The 2015 simulation scenarios used the same O-D factors as their respective 2008 simulation scenario.

SIMULATION DURATION

The simulation duration followed the same procedure as the 2008 AM and PM scenarios. The major components of the two and a half hour simulation are as follows:

- 30-minute off-peak traffic to load traffic into the network
  (The numerical output will not be collected during this period)
- 60-minute peak-hour traffic with 12, 5-minute periods
- 30-minute off peak to clear any congestion from the peak-hour period
  (The duration of this period may increase based on the severity of congestion)
- 30-minutes of no traffic demand to ensure all vehicles complete their trip

SIMULATION ERROR CHECKING

Since most of the simulation network was already developed, error checking for the 2015 scenario focused on the modifications that were made to the original networks. Similar to the 2008 AM and PM scenarios, screen shots of the simulation network were captured and reviewed to ensure all of the network elements were incorporated. In addition, the simulation animation was reviewed, which primarily focused on traffic control and driving behavior.

Error checking also focused on the simulated traffic volume. The simulation output was reviewed to determine if the model was producing the desired traffic based on the O-D matrices. In addition, PTV AG's VISUM travel demand model was used to read/review the VISSIM O-D paths to ensure that invalid paths did not exist.

SIMULATION CALIBRATION

Calibration is the process of adjusting the simulation model's parameters to reproduce local driver behavior and traffic performance characteristics. The 2008 AM and PM simulation scenarios followed an extensive calibration process (Technical Memorandum II). The process primarily focused on VISSIM's driving behavior, which include car-following and lane-changing models. The 2015 simulation scenarios incorporated the calibration parameters of the 2008 scenarios.

Based on reviewing the simulation animation, two significant changes were incorporated into the 2015 PM simulation scenario. The eastbound off-ramp of the I-94 & 8th St. Interchange experienced significant congestion due to capacity constraints. To help alleviate some of the congestion, the traffic signal plan was adjusted to provide off-ramp traffic with 80 seconds of green time, which doubled the original green time. In addition, the driving behavior of the mainline link serving the eastbound off-ramp was changed to allow more realistic lane changing behavior (more aggressive). Otherwise, queues were observed from the 8th St. off-ramp back (upstream) to University Dr.

2015 VISSIM OUTPUT

Similar to the 2008 AM and PM base scenarios, several measures of effectiveness (MOE) were extracted from the 2015 simulation scenarios. The 2015 AM output is provided in Appendices A-C while the 2015 PM output is provided in Appendices D-F. The values reported for each MOE are averaged from the 30 runs. The project team identified several measures and locations which are summarized as follows:

- Overall Network - vehicle trips, travel time, delay time, etc.
- Interchange Ramps - turning movement volume, delay time, queue length, etc.
- Routes/Locations - vehicle trips, travel time, speed, etc.

Since the O-D matrices were significantly different between the 2008 scenarios and the 2015 scenarios, direct comparisons related to the overall network and interchange node data should not be performed. In addition, the speed limit changes made to portions of I-94 and I-29 for the 2015 network will affect the travel time output for the pass-through trips. However, comparisons related to freeway queue lengths and mainline data collection (especially those with target values) will be performed in this report.

2015 AM Output

Freeway queue length was measured at the tri-level merge area and westbound I-94 between 45th St. and I-29 primarily because these two freeway locations experienced congestion during the 2008 PM scenario. Similar to the 2008 AM scenario, the 2015 AM scenario does not experience congestion at these locations (Table 8). To improve traffic operations for I-94 westbound traffic between I-29 and 45th St., an auxiliary lane will be constructed in 2010. The auxiliary lane will provide more benefits for the PM peak period.

Table 8. Freeway Queue Measurement Locations (2008 AM and 2015 AM)

Simulation Scenario	Tri-Level Merge			I-94 WB (45th St)		
	Avg. (ft)	Max. (ft)	Stops	Avg. (ft)	Max. (ft)	Stops
2008 PM	0	98	1	0	31	1
2015 PM	1	174	3	0	0	0

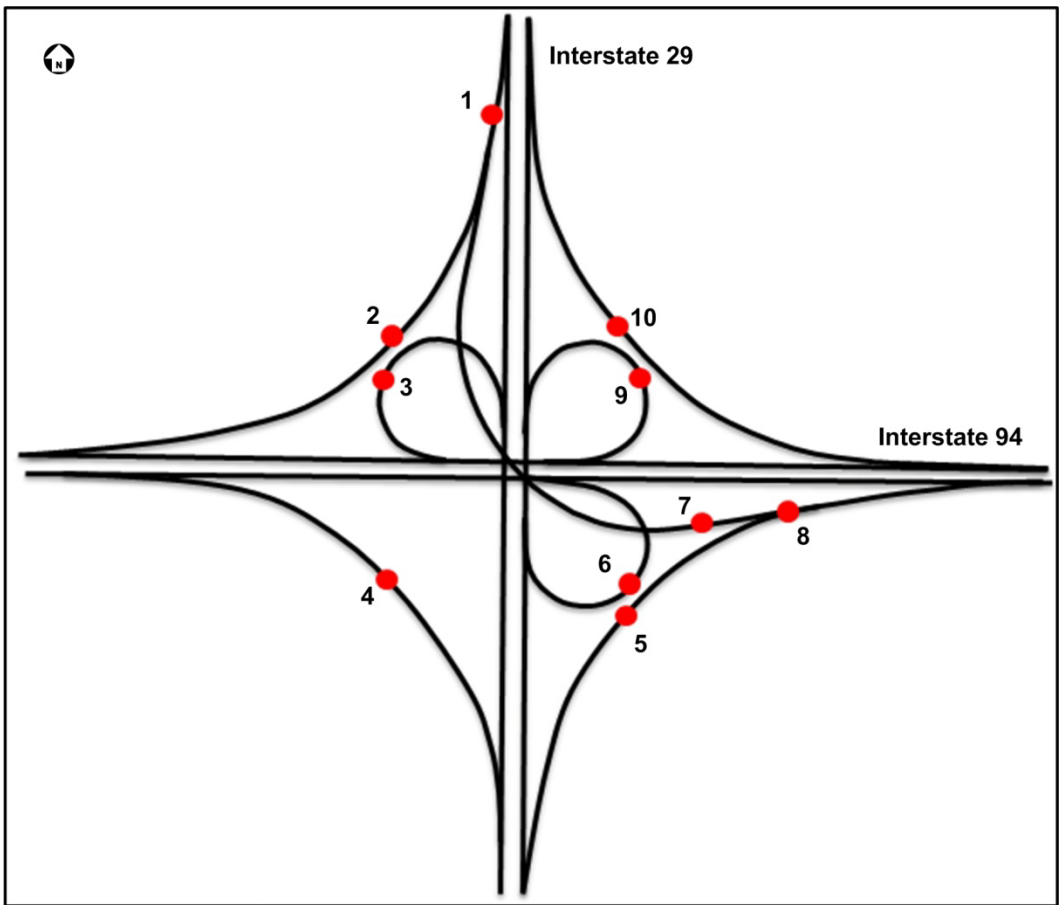
The freeway densities of the 2015 AM scenario were higher than those of the 2008 AM scenario (Table 9). Density values for I-94 and I-29 ranged from 4 pc/mi/ln to 36 pc/mi/ln and 5 pc/mi/ln to 27 pc/mi/ln, respectively. The highest density values were along the section of I-94 from 34th St. to I-29, which exhibited densities between 29 pc/mi/ln to 36 pc/mi/ln (LOS D-E).

Table 9. Freeway Mainline Density (2008 AM and 2015 AM)

I-29 Freeway Mainline	**Northbound (pc/mi/ln)**		**Southbound (pc/mi/ln)**	
	2008 AM	**2015 AM**	**2008 AM**	**2015 AM**
CR 20 - 19th Ave. N	4	5	8	9
19th Ave. N - 12th Ave. N	9	10	10	11
12th Ave. N - Main Ave.	18	20	11	12
Main Ave. - 13th Ave. S	24	27	13	14
13th Ave. S - I-94	23	26	10	11
I-94 - 32nd Ave. S	19	22	9	10
32nd Ave. S - 52nd Ave. S	17	21	5	12
I-94 Freeway Mainline	**Eastbound (pc/mi/ln)**		**Westbound (pc/mi/ln)**	
	2008 AM	**2015 AM**	**2008 AM**	**2015 AM**
Main Ave. - Sheyenne St.	3	4	6	7
Sheyenne St. - 9th St/57th St.	12	11	9	10
9th St/57th St. - 45th St.		19		12
45th St. - I-29	27	20	24	17
I-29 - 25th St.	19	21	27	31
25th St. - University Dr.	20	23	28	31
University Dr. - TH 75	17	19	29	33
TH 75 - 20th St.	16	18	32	36
20th St. - 34th St.	11	13	25	29
34th St. - MN 336	4	6	15	17

Note: The yellow highlighted sections represent a LOS D, orange sections represent a LOS E.

Density values for the 2015 AM scenario also increased for several ramps at the I-29 & I-94 Interchange, especially for the northeast ramp and southeast loop ramp (Figure 7). The northeast ramp had a high density value (39 pc/mi/ln) since it served the most vehicles (1,570) during the AM peak period. The southeast loop ramp reported a high density (49 pc/mi/ln) since it served 879 vehicles and had a low speed due to the geometric design of the loop ramp. When viewing the simulation's animation, congestion was not observed on the ramps. However, congestion would develop occasionally on the westbound weaving segment accessing the northeast ramp.



Simulation Scenario	Data Collection Points of the I-29/I-94 Interchange									
	1	2	3	4	5	6	7	8	9	10
2008 AM (pc/mi/ln)	10	7	28	4	12	42	14	26	10	35
2015 AM (pc/mi/ln)	11	8	32	5	14	49	16	29	15	39

Figure 8. I-29 & I-94 Interchange Density Values (2008 AM and 2015 AM)
Note: LOS D (Yellow), LOS E (Orange), LOS F (Red) – Weaving Segment Methodology

During the 2008 AM scenario, some ramp terminals experienced congestion for at least one movement/approach. By 2015, several geometric and traffic control modifications will be performed to improve traffic operations. The 2008 AM congested areas that were improved in the 2015 AM network include the following:

- I-94 & Sheyenne St. North Ramp: Improved due to new traffic control and 9th St./57th St. interchange

- I-94 & Sheyenne St. South Ramp: southbound left-turn movement improved due to new traffic control and 9th St./57th St. interchange. Northbound approach incurs more delay due to signal installation.

Traffic congestion continued to be evident at the I-94 & 8th St. (TH 75) North Ramp during the 2015 AM scenario. A significant amount of traffic travels westbound from the ramp and significant queues develop for the northbound left-turn movement and the southbound right-turn movements.

2015 PM Output

As previously discussed, queue length measurements were collected at the tri-level merge area and westbound I-94 weaving section between 45th St. and I-29 based on congestion experienced during the 2008 PM peak-hour period. The tri-level merge area during the 2015 PM scenario experienced average and maximum queue lengths of 2,323 ft and 5,506 ft, respectively (Table 10). These queue lengths are significantly greater than the 2008 PM scenario, which was already experiencing oversaturated conditions for a portion of the peak hour. Therefore, the additional traffic (12% more than the 2008 PM peak-hour volume) modeled during the 2015 PM scenario created major operational issues.

To improve traffic operations for I-94 westbound traffic between I-29 and 45th St., an auxiliary lane will be constructed in 2010. The 2008 PM simulation scenario experienced some congestion at this area. Incorporating the auxiliary lane into the 2015 PM simulation scenario eliminated the queues that developed in the 2008 PM scenario (Table 10).

Table 10. Freeway Queue Measurement Locations (2008 PM and 2015 PM)

Simulation Scenario	Tri-Level Merge			I-94 WB (45th St)		
	Avg. (ft)	Max. (ft)	Stops	Avg. (ft)	Max. (ft)	Stops
2008 PM	184	2,027	454	19	439	49
2015 PM	2,323	5,506	3,201	0	0	0

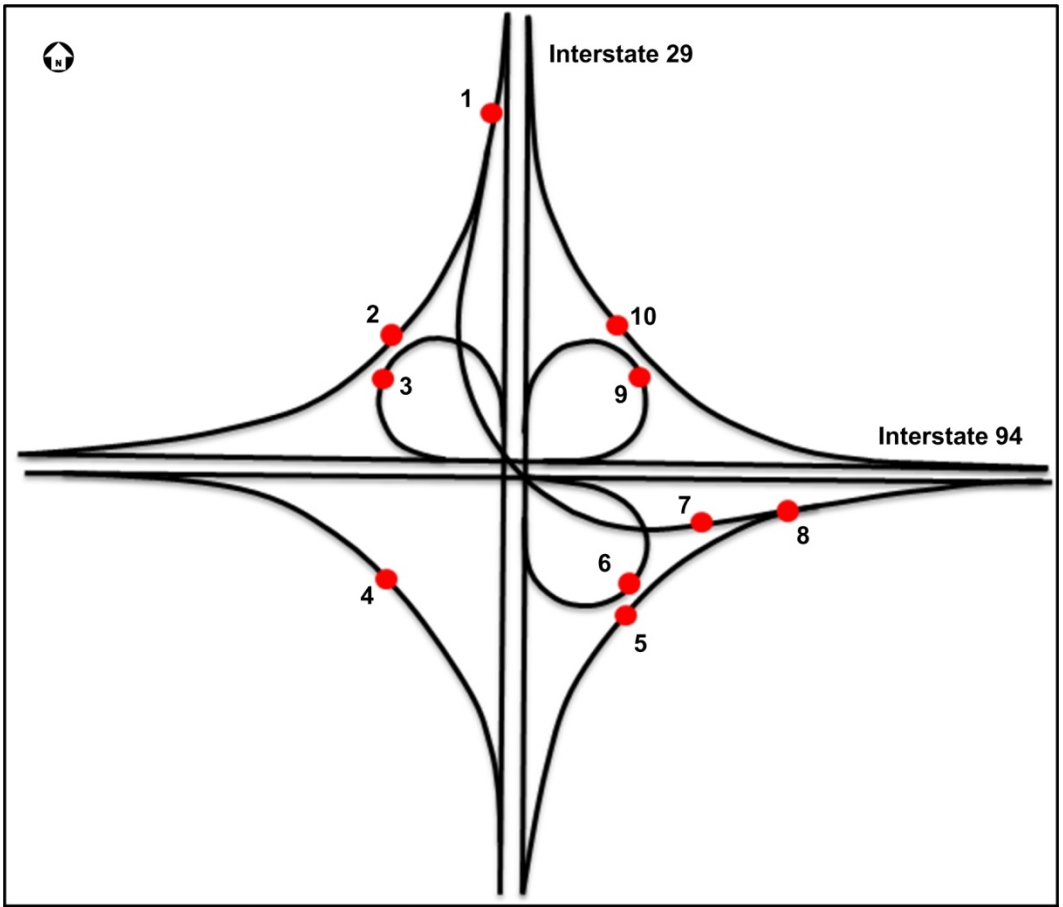
The freeway densities of the 2015 PM scenario were generally higher than those of the 2008 PM scenario (Table 11). Density values for I-94 and I-29 ranged from 3 pc/mi/ln to 32 pc/mi/ln and 7 pc/mi/ln to 22 pc/mi/ln, respectively. The highest density values were along the section of I-94 from 8th St. (TH 75) to I-29, which exhibited densities between 29 pc/mi/ln to 32 pc/mi/ln (LOS D).

Table 11. Freeway Mainline Density (2008 PM and 2015 PM)

I-29 Freeway Mainline	Northbound (pc/mi/ln)		Southbound (pc/mi/ln)	
	2008 PM	2015 PM	2008 PM	2015 PM
CR 20 - 19th Ave. N	9	10	6	7
19th Ave. N - 12th Ave. N	11	9	9	8
12th Ave. N - Main Ave.	14	13	17	16
Main Ave. - 13th Ave. S	15	15	27	22
13th Ave. S - I-94	14	16	19	22
I-94 - 32nd Ave. S	13	15	10	11
32nd Ave. S - 52nd Ave. S	9	13	10	17
I-94 Freeway Mainline	**Eastbound (pc/mi/ln)**		**Westbound (pc/mi/ln)**	
	2008 PM	**2015 PM**	**2008 PM**	**2015 PM**
Main Ave. - Sheyenne St.	5	5	2	3
Sheyenne St. - 9th St/57th St.	8	9	10	7
9th St/57th St. - 45th St.		12		13
45th St. - I-29	25	17	26	17
I-29 - 25th St.	26	29	22	23
25th St. - University Dr.	24	29	21	22
University Dr. - TH 75	26	32	20	23
TH 75 - 20th St.	24	27	19	22
20th St. - 34th St.	19	16	15	12
34th St. - MN 336	10	11	7	7

Note: The highlighted sections represent a LOS D.

Density values for the 2015 PM scenario also increased for several ramps at the I-29 & I-94 Interchange, especially for the tri-level and southeast ramp. The highest density and most congested area for the 2015 PM scenario (which was the same for the 2008 PM scenario) occurred at the tri-level merge area (Figure 8). Over 2,200 vehicles from two ramps (tri-level and southeast ramps) merged into one lane during the 2015 PM peak-hour analysis period, creating a density of 71 pc/mi/ln. The congestion at this area occurred throughout the PM peak.



Simulation Scenario	Data Collection Points of the I-29/I-94 Interchange									
	1	2	3	4	5	6	7	8	9	10
2008 PM (pc/mi/ln)	23	13	19	4	10	17	36	51	7	25
2015 PM (pc/mi/ln)	31	15	21	5	12	18	55	71	14	30

Note: Original density was increased by 15%.

Figure 9. I-29 & I-94 Interchange Density Values (2008 PM and 2015 PM)
Note: LOS D (Yellow), LOS E (Orange), LOS F (Red) – Weaving Segment Methodology

During the 2008 PM scenario, several ramp terminals experienced congestion for at least one movement/approach. Most of these locations were along I-94 between Sheyenne St. and I-29. By 2015, the NDDOT will perform several geometric and traffic control modifications within this area to improve traffic operations. The 2008 PM congested areas that were significantly improved in the 2015 PM network include the following:

- I-94 & Sheyenne St. North Ramp: Improved due to new traffic control and 9th St./57th St. interchange
- I-94 & 45th St. North Ramp: Improved due to modified traffic control and geometry, as well as the 9th St./57th St. interchange
- I-94 & 45th St. South Ramp: Improved due to modified traffic control and geometry, as well as the 9th St./57th St. interchange

Traffic congestion increased at the I-94 & 8th St. (TH 75) Interchange during the 2015 PM scenario. Congestion for the eastbound off-ramp existed during the 2008 PM scenario, which was compounded due to the increased traffic volume in the 2015 PM scenario (12% growth

from 2008). Traffic queued significantly at the ramp signal throughout the peak-hour period. In addition the southbound right-turn and northbound left-turn movements at the north ramp experienced significant congestion.

SUMMARY

This document provided the simulation output of the 2015 AM and PM scenarios for the Fargo-Moorhead Interstate Operations Study. These scenarios provide insight into potential traffic operational issues that may occur in the 2015 planning horizon. Based on the simulation output, the proposed near-term improvements to the freeway system reduced congestion along I-94 west of I-29 during the PM peak-hour period. However, congestion at the tri-level merge area (average maximum queue of 5,506 ft) and the I-94 & 8th St. (TH 75) eastbound off-ramp (average maximum queue of 5,647 ft) increased significantly from the 2008 PM scenario.

During the 2015 AM scenario, the highest density values were along the westbound portion of I-94 from 34th St. to I-29, which exhibited densities between 29 pc/mi/ln to 36 pc/mi/ln (LOS D-E). Some congestion also developed on the westbound I-94 weaving segment accessing the northeast ramp of the I-29 & I-94 Interchange due to number of vehicles traveling westbound to northbound during the AM peak-hour period (1,570).

For the 2015 PM scenario, the highest density values were along the eastbound portion of I-94 from I-29 to 8th St. (TH 75), which exhibited densities between 29 pc/mi/ln to 32 pc/mi/ln (LOS D). The highest density for both peak periods occurred at the tri-level ramp and southeast ramp merge area. Over 2,200 vehicles from two ramps (tri-level and southeast ramps) merged into one lane during the PM peak-hour analysis period, creating a density of 71 pc/mi/ln. In addition, congestion at this area occurred throughout the PM peak period compared to 15 to 20 minutes during the 2008 PM scenario.

Appendix A: 2015 AM Simulation Output (Network Performance, Travel Time, Freeway Queues)

2015 AM Peak - Network MOE, Queue Length, Travel Time

Network Performance

Total Delay Time (hr)	402
Total Travel Time (hr)	3,747
Number of Active Vehicles	0
Number of Arrived Vehicles	44,524
Total Stopped Delay (hr)	150
Total Distance Traveled (mi)	182,640

Queue Measurement

Time	Tri-Level Merge			I-94 WB (45th St)		
	Avg.	Max.	Stop	Avg.	Max.	Stop
AM Peak	1	174	3	0	0	0

Travel Time (Network)

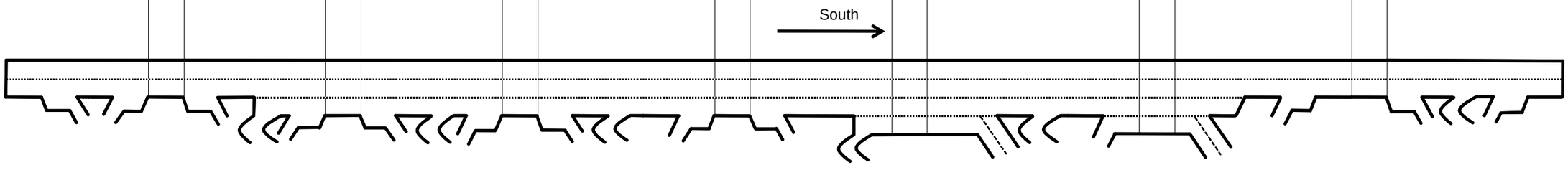
Origin		Destination					
		I-29 SB		I-94 EB		I-29 NB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-94 EB	1630-1645	12.3	3	15.1	3	15.7	3
	1645-1700	12.1	3	15.2	3	15.7	3
	1700-1715	12.3	4	15.3	4	15.8	4
	1715-1730	12.2	3	15.2	3	15.9	3
		I-29 SB		I-94 WB		I-29 NB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-94 WB	1630-1645	15.5	4	14.9	6	17.2	6
	1645-1700	15.4	4	14.9	6	17.2	5
	1700-1715	15.7	5	15.1	7	17.6	6
	1715-1730	15.9	6	15.2	8	18.1	7
		I-94 WB		I-29 NB		I-94 EB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-29 NB	1630-1645	13.1	3	14.6	5	14.6	3
	1645-1700	13.0	3	14.6	5	14.9	3
	1700-1715	13.4	4	14.7	7	14.9	4
	1715-1730	13.3	3	14.8	6	14.7	4
		I-94 WB		I-29 SB		I-94 EB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-29 SB	1630-1645	14.7	3	14.5	8	17.5	4
	1645-1700	14.8	3	14.5	8	17.4	4
	1700-1715	14.8	4	14.6	11	17.6	5
	1715-1730	14.9	3	14.5	10	17.6	5

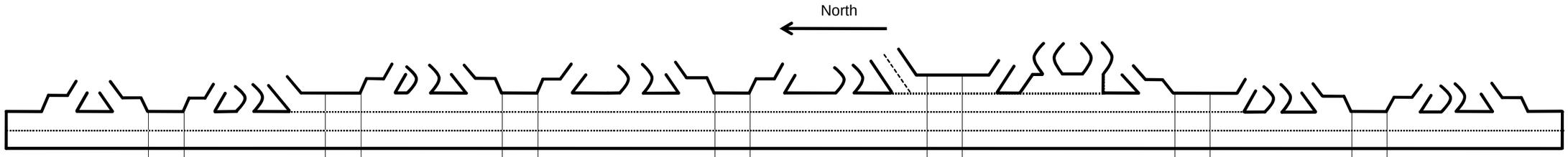
Appendix B: 2015 AM Simulation Output (Data Collection Points)

I-29 Data Collection: 2015 AM Peak Hour

Southbound

	CR20				19th Ave. N					12th Ave. N					Main Ave.						13th Ave. S					I-94						32nd Ave. S							52nd Ave. S					
Distance (ft.)	8050	650	1885	1150	7550	570	1015	1030	1040	1715	680	835	840	765	2240	455	735	230	1215	740	1230	945	840		3840			1300	640	1150	285	2325	285	950	1395	625	7200			620	670	960	510	1900
2008 Vol. (vph)					899					1315					1459						1580				1674							1505					447						
2015 Sim. Vol. (vph)					1029					1493					1650						1788				1876							1694					1303						
Volume % Difference					14%					14%					13%						13%				12%							13%					192%						
Speed (mph)					74.4					59.2					59.1						57.6				58.9							59.2					73.8						
# of Lanes					2					3					3						3				4							4					2						
Density (pc/mi/ln)					9					11					12						14				11							10					12						
Level of Service					A					B					B						B				B							A					B						





Northbound

	CR 20				19th Ave. N					12th Ave. N					Main Ave.						13th Ave. S					I-94						32nd Ave. S							52nd Ave. S					
Distance (ft.)	8050	650	1885	1150	7140	1165	1045	1015	2520		830	921	765	580	2190	525	745	570	655	760	1930	685	755	665	1310	2100			910	505	485	1260	990	1495			1450	860	720	7100	760	775	595	800	1675
2008 Vol. (vph)					488					1166					2269						3050					3943								2508					1485						
2015 Sim. Vol. (vph)					570					1338					2592						3466					4456								2838					2330						
Volume % Difference					17%					15%					14%						14%					13%								13%					57%						
Speed (mph)					74.8					58					56.8						56.8					57.9								58.1					72.3						
# of Lanes					2					3					3						3					4								3					2						
Density (pc/mi/ln)					5					10					20						27					26								22					21						
Level of Service					A					B					C						C					C								C					C						

Note: Density values were adjusted using the following data:
Peak-hour factor = .78
Heavy vehicle percent = 5
This data increased the original density by 25%.

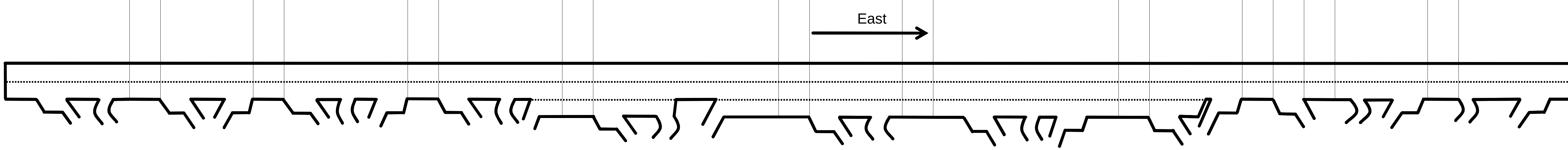
= Target Growth Percentage of 12%

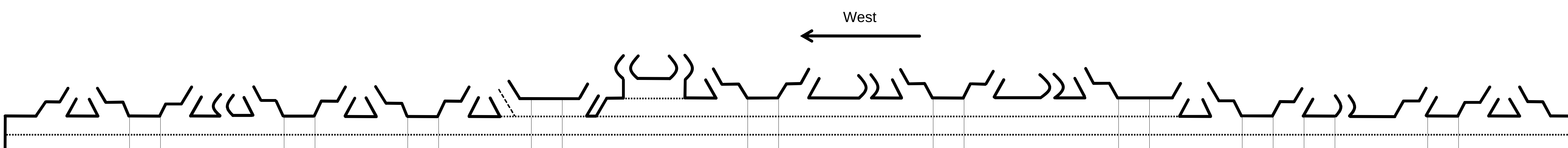
I-94 Data Collection: 2015 AM Peak Hour

Eastbound

Main Ave. | Sheyenne St. | 9th St. | 45th St. | I-29 | 25th St. | University Dr. | TH 75 | 20th St. | 34th St. | MN 336

Distance (ft.)	2660	575	1005	1440	11770	755	2050	1040	7520	765	1650	1800	835	1475	705	930	1450	615	1570	760	465	1345	1365	1415			795	930	990	2610		960	740	1050	1125	4225		520	2005	840	1740	455	5645	410	955	585	12850	710	1365	1080	2170
2008 Vol. (vph)					325				-					1298					2335							2471				2645							2250				1406		1015				504				
2015 Sim. Vol. (vph)					399				954					1622					2660							2786				2995							2555				1611		1169				593				
Volume % Difference					23%				-					25%					14%							13%				13%							14%				15%		15%				18%				
Speed (mph)					75.2				59					58.3					58.4							59				58.3							58.4				58.2		58.6				70				
# of Lanes					2				2					2					3							3				3							3				2		2				2				
Density (pc/mi/ln)					4				11					19					20							21				23							19				18		13				6				
Level of Service					A				B					B					C							C				C							B				B		B				A				





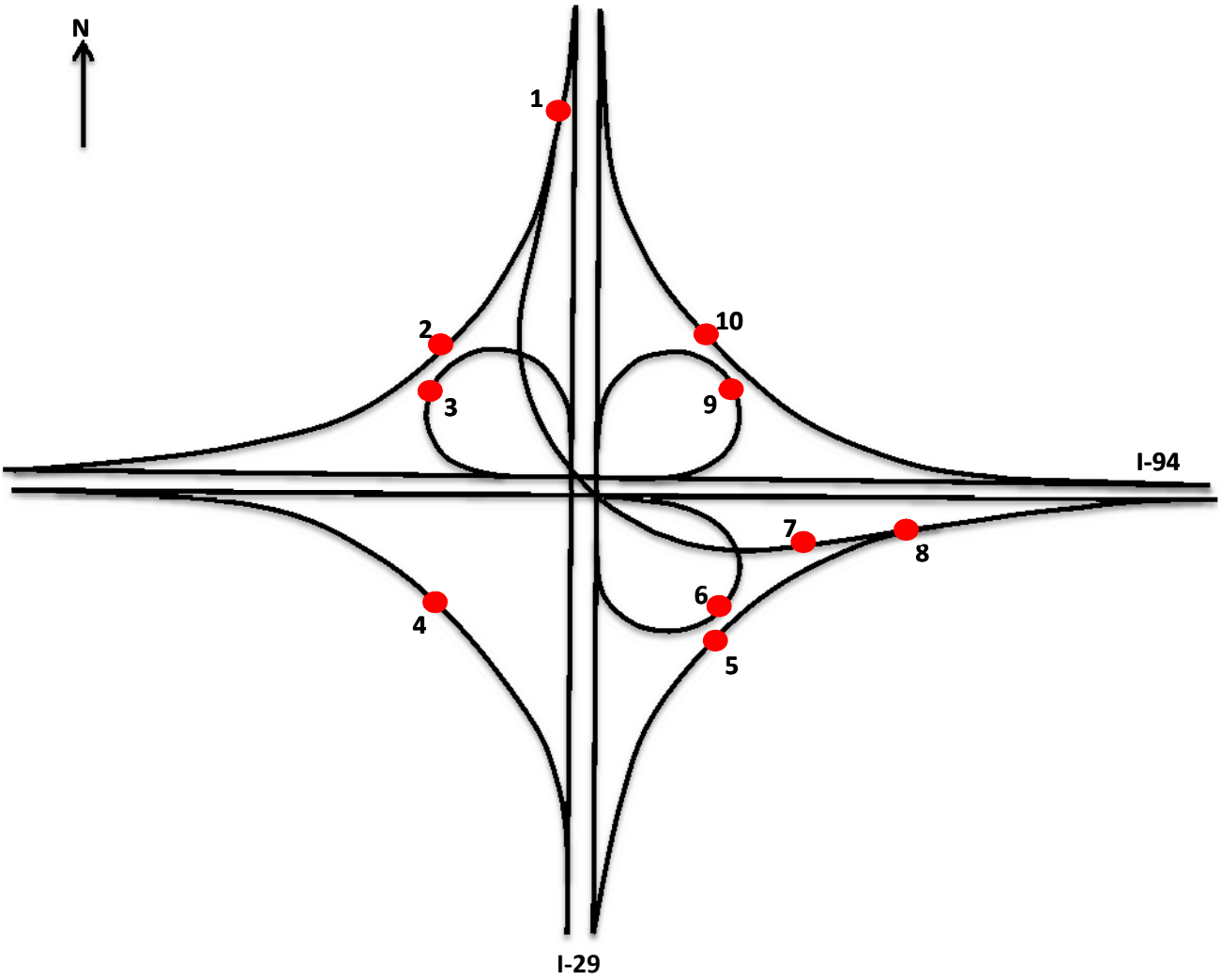
Westbound

Main Ave. | Sheyenne St. | 9th St. | 45th St. | I-29 | 25th St. | University Ave. | TH 75 | 20th St. | 34th St. | MN 336

Distance (ft.)	2815	1215	2850	390	9790	1035	835	1130	785	8105	730	3045	845	1395	825	1900	740	800	835	1490	440	535	945	650	1555	770	350	915	930	675	1930	700	470	490	505	1170	4225	525	1935	550	1880	970	6855	605	860	585	12850	965	2195	465	3270
2008 Vol. (vph)					661					-				939				1960							3362						3559						3736				2652		2198				1562				
2015 Sim. Vol. (vph)					767					853				1085				2237							3770						4064						4238				3010		2485				1765				
Volume % Difference					16%					-				16%				14%							12%						14%						13%				13%		13%				13%				
Speed (mph)					73.5					59				58.9				59.4							53.7						57.6						57.5				55.7		57.8				69.9				
# of Lanes					2					2				2				3							3						3						3				2		2				2				
Density (pc/mi/ln)					7					10				12				17							31						31						33				36		29				17				
Level of Service					A					A				B				B							D						D						D				E		D				B				

Note: Density values were adjusted using the following data:
Peak-hour factor = .78
Heavy vehicle percent = 5
This data increased the original density by 25%.

= Target Growth Percentage of 12%



2015 AM: Data Collection Points (I-29/I-94 Interchange)

	1	2	3	4	5	6	7	8	9	10
2008 Vol. (vph)	854	287	510	175	498	754	567	1065	183	1362
2015 Sim. Vol. (vph)	978	336	589	203	561	881	644	1204	282	1570
Volume % Difference	15%	17%	16%	16%	13%	17%	13%	13%	54%	15%
Speed (mph)	58	54	24	55	54	24	54	55	25	53
# of Lanes	2	1	1	1	1	1	1	1	1	1
Density (pc/mi/ln)	11	8	32	5	14	49	16	29	15	39

This data increased the original density by 25%.

= Target Growth Percentage of 12%

Appendix C: 2015 AM Simulation Output (Node Evaluations)

2015 AM Peak - Ramp Terminal Data

Node Location: I-94 & Sheyenne St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume			71			224	155	272			605	50
Delay Time/Veh. (s)			6.9			3.4	5.8	0.4			3.6	2.0
Max Queue (ft)			122			3	163	32			307	0
Avg. Queue (ft)			3			3	3	0			12	0
								Intersection Delay (sec/veh)				11.7

Node Location: I-94 & Sheyenne St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	9	0	33					417	170	424	252	
Delay Time/Veh. (s)	26.7	0	5.5					15.4	6.8	17.2	1.2	
Max Queue (ft)	111	0	111					540	131	458	124	
Avg. Queue (ft)	2	0	2					56	1	60	1	
								Intersection Delay (sec/veh)				11.7

Node Location: I-94 & 9th St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				118		229	44	332			498	66
Delay Time/Veh. (s)				35.9		5.8	40.0	2.9			5.8	2.4
Max Queue (ft)				171		163	145	145			199	0
Avg. Queue (ft)				24		15	13	13			11	0
								Intersection Delay (sec/veh)				6.6

Node Location: I-94 & 9th St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	27		76					348	532		381	237
Delay Time/Veh. (s)	35.5		4.3					2.1	3.4		2.5	0.8
Max Queue (ft)	118		128					137	0		160	237
Avg. Queue (ft)	6		5					3	0		4	5
								Intersection Delay (sec/veh)				2.6

Node Location: I-94 & 45th St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				308	0	1035		547	54		433	135
Delay Time/Veh. (s)				36.0	0	12.3		6.5	0.5		10.0	1.7
Max Queue (ft)				383	0	31		227	228		314	314
Avg. Queue (ft)				49	0	0		12	11		24	24
								Intersection Delay (sec/veh)				11.0

Node Location: I-94 & 45th St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	167	0	7					434	883		420	322
Delay Time/Veh. (s)	37.9	0	6.8					24.3	30.2		12.0	1.4
Max Queue (ft)	258	0	134					588	588		220	234
Avg. Queue (ft)	43	0	1					146	146		15	14
								Intersection Delay (sec/veh)				19.7

2015 AM Peak - Ramp Terminal Data

Node Location: I-94 & 25th St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				206	0	532		900	266		414	167
Delay Time/Veh. (s)				44.9	0	19.6		8.9	1.7		8.1	9.0
Max Queue (ft)				321	0	571		442	211		279	279
Avg. Queue (ft)				60	0	84		37	34		23	23
								Intersection Delay (sec/veh)				11.9

Node Location: I-94 & 25th St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	80	114	92	43	12	311	295	772	3	75	373	174
Delay Time/Veh. (s)	39.1	40.7	5.0	46.2	41.0	11.1	11.2	8.5	8.1	6.7	5.7	2.2
Max Queue (ft)	296	296	128	145	145	271	431	451	4	115	159	303
Avg. Queue (ft)	50	50	3	13	13	24	23	33	0	2	9	3
								Intersection Delay (sec/veh)				10.9

Node Location: I-94 & University Dr (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				362		450		1088	260		378	364
Delay Time/Veh. (s)				40.9		14.0		9.1	1.2		5.2	0.6
Max Queue (ft)				270		389		467	294		215	0
Avg. Queue (ft)				60		65		39	1		9	0
								Intersection Delay (sec/veh)				10.9

Node Location: I-94 & University Dr (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	634		308					724	315		562	173
Delay Time/Veh. (s)	41.5		8.2					7.0	0.5		4.3	0.5
Max Queue (ft)	415		213					249	0		245	205
Avg. Queue (ft)	104		24					19	0		9	15
								Intersection Delay (sec/veh)				13.1

Node Location: I-94 & 8th St/TH75 (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				52	0	239	675	1806			259	832
Delay Time/Veh. (s)				29.5	0	16.3	22.6	7.2			36.4	35.0
Max Queue (ft)				134	0	6	933	761			616	12
Avg. Queue (ft)				9	0	6	205	63			52	12
								Intersection Delay (sec/veh)				16.3

Node Location: I-94 & 8th St/TH75 (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	951		273					1528	173	97	214	
Delay Time/Veh. (s)	36.1		6.3					82.4	54.8	35.4	11.9	
Max Queue (ft)	1275		192					2611	176	223	193	
Avg. Queue (ft)	172		13					1052	6	14	10	
								Intersection Delay (sec/veh)				55.1

2015 AM Peak - Ramp Terminal Data

Node Location: I-94 & 20th St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				30	5	20	203	525	77	31	122	284
Delay Time/Veh. (s)				3.2	1.5	4.1	2.7	0.8	0.9	5.3	0.4	2.7
Max Queue (ft)				43	43	43	180	180	180	0	0	0
Avg. Queue (ft)				0	0	0	26	26	26	0	0	0
								Intersection Delay (sec/veh)				1.7

Node Location: I-94 & 20th St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	346		104					459			127	
Delay Time/Veh. (s)	12.9		4.6					9.9			16.0	
Max Queue (ft)	284		7					432			181	
Avg. Queue (ft)	31		7					37			13	
								Intersection Delay (sec/veh)				10.8

Node Location: I-94 & 34th St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				48		140		715	478	418	123	
Delay Time/Veh. (s)				21.4		6.6		6.5	29.7	1.5	8.2	
Max Queue (ft)				139		24		239	516	128	128	
Avg. Queue (ft)				9		0		56	89	0	5	
								Intersection Delay (sec/veh)				11.1

Node Location: I-94 & 34th St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				225		418		775	50	9	161	
Delay Time/Veh. (s)				60.3		10.9		8.7	2.0	71.6	7.3	
Max Queue (ft)				387		387		313	94	126	126	
Avg. Queue (ft)				77		77		26	1	7	7	
								Intersection Delay (sec/veh)				15.7

Node Location: I-94 & MN 336 (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				18	0	64	45	255			73	625
Delay Time/Veh. (s)				7.4	0	7.0	0.7	0.1			1.4	2.5
Max Queue (ft)				8	0	8	0	0			0	0
Avg. Queue (ft)				8	0	8	0	0			0	0
								Intersection Delay (sec/veh)				2.0

Node Location: I-94 & MN 336 (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				24		202		98	10	49	42	
Delay Time/Veh. (s)				8		1		0	1	1	0	
Max Queue (ft)				4		4		0	0	16	16	
Avg. Queue (ft)				0		0		0	0	0	0	
								Intersection Delay (sec/veh)				1.0

2015 AM Peak - Ramp Terminal Data

Node Location: I-29 & CR 20 (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		211	75	125	169					126		175
Delay Time/Veh. (s)		0.8	1.8	1.3	1.1					11.9		9.2
Max Queue (ft)		0	0	28	28					10		10
Avg. Queue (ft)		0	0	0	0					10		10
									Intersection Delay (sec/veh)			4.3

Node Location: I-29 & CR 20 (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	74	262			233	64	61		121			
Delay Time/Veh. (s)	1.1	0.9			0.6	1.4	11.2		9.3			
Max Queue (ft)	74	74			0	0	9		9			
Avg. Queue (ft)	0	0			0	0	9		9			
									Intersection Delay (sec/veh)			2.9

Node Location: I-29 & 19 Ave N (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	29	536			347	568				134		2
Delay Time/Veh. (s)	2.8	4.6			4.6	3.3				12.0		0.8
Max Queue (ft)	0	181			200	289				169		0
Avg. Queue (ft)	0	10			6	1				11		0
									Intersection Delay (sec/veh)			4.7

Node Location: I-29 & 19 Ave N (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		650	22		866	31	48		779			
Delay Time/Veh. (s)		9.2	0.3		9.3	0.9	22.7		10.1			
Max Queue (ft)		246	208		361	0	168		246			
Avg. Queue (ft)		22	5		42	0	7		43			
									Intersection Delay (sec/veh)			9.6

Node Location: I-29 & 12th Ave N (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		175	113		752	278				142		97
Delay Time/Veh. (s)		2.8	0.6		4.1	0.9				33.4		3.0
Max Queue (ft)		104	0		242	105				207		195
Avg. Queue (ft)		2	0		14	0				32		7
									Intersection Delay (sec/veh)			5.7

Node Location: I-29 & 12th Ave N (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		282	36		506	55	523		830			
Delay Time/Veh. (s)		3.9	0.2		8.8	0.6	26.7		9.6			
Max Queue (ft)		118	154		235	0	272		290			
Avg. Queue (ft)		4	0		19	0	59		58			
									Intersection Delay (sec/veh)			12.3

2015 AM Peak - Ramp Terminal Data

Node Location: I-29 & Main Ave (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		923	212		807	182				93	0	166
Delay Time/Veh. (s)		3.3	4.0		1.5	0.6				41.7	0.0	6.3
Max Queue (ft)		207	207		131	257				154	0	139
Avg. Queue (ft)		11	11		4	1				19	0	7
									Intersection Delay (sec/veh)			4.3

Node Location: I-29 & Main Ave (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		862	152		595	56	395	0	703			
Delay Time/Veh. (s)		4.9	0.4		5.7	6.8	38.2	0.0	9.6			
Max Queue (ft)		277	248		193	193	266	0	259			
Avg. Queue (ft)		15	1		12	12	60	0	48			
									Intersection Delay (sec/veh)			10.8

Node Location: I-29 & 38th St

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				303	0	27	0	99	166	105	26	
Delay Time/Veh. (s)				15.4	0	4.4	0.0	4.3	1.6	4.8	4.2	
Max Queue (ft)				174	0	112	0	117	110	132	132	
Avg. Queue (ft)				21	0	2	0	2	0	3	3	
									Intersection Delay (sec/veh)			8.3

Node Location: I-29 & 13th Ave S (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	67	848	170		909	256	270	260	541			
Delay Time/Veh. (s)	41.9	9.4	0.1		16.0	5.8	29.1	41.3	13.0			
Max Queue (ft)	156	292	149		370	0	412	411	416			
Avg. Queue (ft)	17	26	0		49	0	76	82	86			
									Intersection Delay (sec/veh)			15.8

Node Location: I-29 & 32nd Ave S (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		568	172	227	1000					347		453
Delay Time/Veh. (s)		13.6	2.5	48.8	8.4					40.0		10.8
Max Queue (ft)		292	0	507	523					298		312
Avg. Queue (ft)		32	0	77	35					59		50
									Intersection Delay (sec/veh)			16.8

Node Location: I-29 & 32nd Ave S (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		710	208		914	847	312		248			
Delay Time/Veh. (s)		6.3	1.3		15.6	8.3	38.3		12.6			
Max Queue (ft)		328	294		968	215	420		422			
Avg. Queue (ft)		18	15		109	28	87		59			
									Intersection Delay (sec/veh)			12.7

2015 AM Peak - Ramp Terminal Data

Node Location: I-29 & 52nd Ave S (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		841	106		1174	97				254		516
Delay Time/Veh. (s)		6.5	1.2		5.6	1.1				29.3		1.5
Max Queue (ft)		217	217		266	277				204		0
Avg. Queue (ft)		15	15		18	3				33		0
							Intersection Delay (sec/veh)					6.8

Node Location: I-29 & 52nd Ave S (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		573	521		1109	864	161		100			
Delay Time/Veh. (s)		3.1	3.4		6.3	4.4	35.8		1.7			
Max Queue (ft)		196	236		402	402	253		0			
Avg. Queue (ft)		5	13		33	33	39		0			
							Intersection Delay (sec/veh)					6.1

Appendix D: 2015 PM Simulation Output (Network Performance, Travel Time, Freeway Queues)

2015 PM Peak - Network MOE, Queue Length, Travel Time

Network Performance

Total Delay Time (hr)	494
Total Travel Time (hr)	4,189
Number of Active Vehicles	0
Number of Arrived Vehicles	48,262
Total Stopped Delay (hr)	164
Total Distance Traveled (mi)	201,592

Queue Measurement

Time	Tri-Level Merge			I-94 WB (45th St)		
	Avg.	Max.	Stop	Avg.	Max.	Stop
PM Peak	2,323	5,506	3,201	0	0	0

Travel Time (Network)

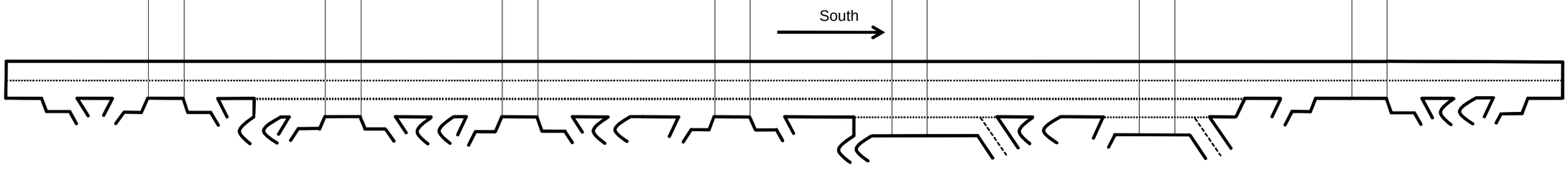
Origin		Destination					
		I-29 SB		I-94 EB		I-29 NB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-94 EB	1630-1645	12.3	3	15.3	10	15.8	3
	1645-1700	12.3	3	15.3	10	15.9	3
	1700-1715	12.4	3	15.3	11	15.8	3
	1715-1730	12.3	3	15.6	11	15.7	3
		I-29 SB		I-94 WB		I-29 NB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-94 WB	1630-1645	15.4	4	14.8	7	17.2	5
	1645-1700	15.4	4	14.9	7	17.2	5
	1700-1715	15.5	4	14.8	8	17.2	6
	1715-1730	15.4	4	14.8	8	17.1	6
		I-94 WB		I-29 NB		I-94 EB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-29 NB	1630-1645	13.1	3	14.7	7	15.0	3
	1645-1700	13.2	3	14.6	7	15.0	3
	1700-1715	13.1	3	14.6	8	15.3	3
	1715-1730	13.1	3	14.6	7	15.7	3
		I-94 WB		I-29 SB		I-94 EB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-29 SB	1630-1645	14.8	3	14.6	5	17.8	5
	1645-1700	14.7	3	14.6	6	17.9	6
	1700-1715	15.0	3	14.7	6	18.7	5
	1715-1730	15.2	3	14.7	6	20.8	6

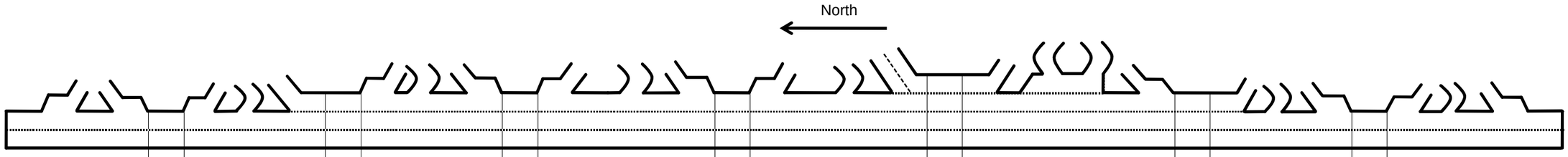
Appendix E: 2015 PM Simulation Output (Data Collection Points)

I-29 Data Collection: 2015 PM Peak Hour

Southbound

	CR20				19th Ave. N					12th Ave. N					Main Ave.						13th Ave. S						I-94								32nd Ave. S								52nd Ave. S					
Distance (ft.)	8050	650	1885	1150	7550	570	1015	1030	1040	1715	680	835	840	765	2240	455	735	230	1215	740	1230	945	840		3840			1300	640	1150	285	2325	285	950	1395	625	7200			620	670	960	510	1900
2008 Vol. (vph)					748					1317					2489						3411				3603							2037					1021							
2015 Sim. Vol. (vph)					864					1238					2322						3091				4045							2298					2068							
Volume % Difference					16%					-6%					-7%						-9%				12%							13%					103%							
Speed (mph)					74.6					59.5					58.4						54.1				55.1							58.8					72.7							
# of Lanes					2					3					3						3				4							4					2							
Density (pc/mi/ln)					7					8					16						22				22							11					17							
Level of Service					A					A					B						C				C							B					B							





Northbound

	CR 20				19th Ave. N					12th Ave. N					Main Ave.						13th Ave. S						I-94								32nd Ave. S								52nd Ave. S					
Distance (ft.)	8050	650	1885	1150	7140	1165	1045	1015	2520		830	921	765	580	2190	525	745	570	655	760	1930	685	755	665	1310	2100			910	505	485	1260	990	1495			1450	860	720	7100		760	775	595	800	1675
2008 Vol. (vph)					1155				1644						2025						2129					2763								1952					924							
2015 Sim. Vol. (vph)					1314				1345						1948						2244					3110								2177					1629							
Volume % Difference					14%				-18%						-4%						5%					13%								12%					76%							
Speed (mph)					74.1				59.1						58.1						58.2					58.8								58.5					73.5							
# of Lanes					2				3						3						3					4								3					2							
Density (pc/mi/ln)					10				9						13						15					16								15					13							
Level of Service					B				A						B						B					B								B					B							

Note: Density values were adjusted using the following data:
Peak-hour factor = .87
Heavy vehicle percent = 5
This data increased the original density by 15%.

= Target Growth Percentage of 12%

I-94 Data Collection: 2015 PM Peak Hour

Eastbound

Main Ave. Sheyenne St. 9th St. 45th St. I-29 25th St. University Dr. TH 75 20th St. 34th St. MN 336

Distance (ft.)	2660	575	1005	1440	11770	755	2050	1040	7520	765	1650	1800	835	1475	705	930	1450	615	1570	760	465	1345	1365	1415			795	930	990	2610		960	740	1050	1125	4225		520	2005	840	1740	455	5645	410	955	585	12850	710	1365	1080	2170
2008 Vol. (vph)					530				-					937					2297							3794				3678							3828				2297		1851				1092				
2015 Sim. Vol. (vph)					642				929					1233					2544							4154				4302							4273				2573		1595				1269				
Volume % Difference					21%				-					32%					11%							9%				17%							12%				12%		-14%				16%				
Speed (mph)					74.9				59.1					58.9					59							56.1				57.8							52.9				56.5		58.3				70				
# of Lanes					2				2					2					3							3				3							3				2		2				2				
Density (pc/mi/ln)					5				9					12					17							29				29							32				27		16				11				
Level of Service					A				A					B					B							D				D							D				C		B				B				

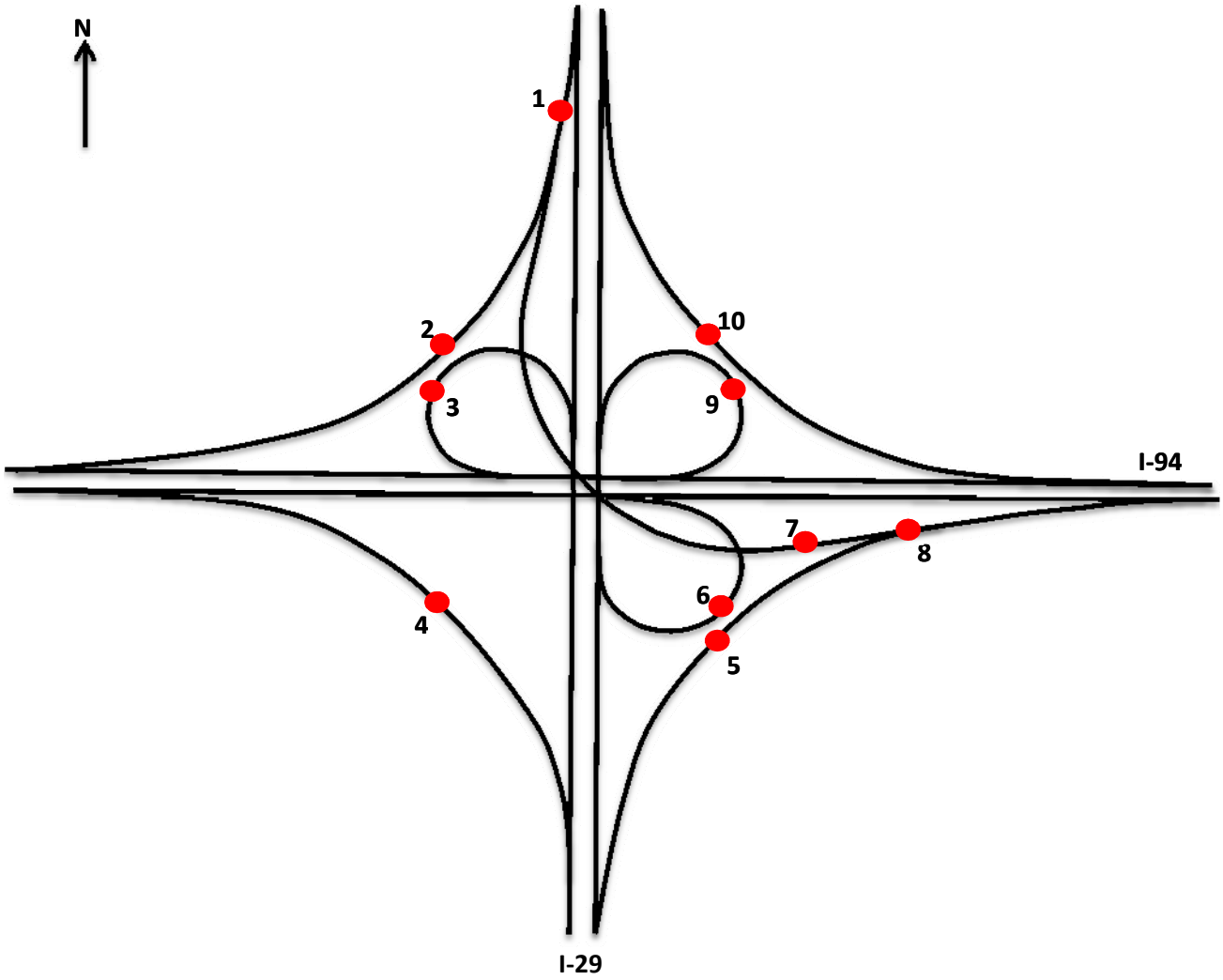
Westbound

Main Ave. Sheyenne St. 9th St. 45th St. I-29 25th St. University Dr. TH 75 20th St. 34th St. MN 336

Distance (ft.)	2815	1215	2850	390	9790	1035	835	1130	785	8105	730	3045	845	1395	825	1900	740	800	835	1490	440	535	945	650	1555	770	350	915	930	675	1930	700	470	490	505	1170	4225	525	1935	550	1880	970	6855	605	860	585	12850	965	2195	465	3270
2008 Vol. (vph)					256					-				1152				2292							3034						3023						2936				1825		1416				759				
2015 Sim. Vol. (vph)					340					736				1259				2542							3379						3239						3334				2187		1197				889				
Volume % Difference					33%					-				9%				11%							11%						7%						14%				20%		-15%				17%				
Speed (mph)					74					58.7				58.5				59.2							56.9						58.5						58.1				57.7		59.2				70				
# of Lanes					2					2				2				3							3						3						3				2		2				2				
Density (pc/mi/ln)					3					7				13				17							23						22						23				22		12				7				
Level of Service					A					A				B				B							C						C						C				C		B				A				

Note: Density values were adjusted using the following data:
Peak-hour factor = .87
Heavy vehicle percent = 5
This data increased the original density by 15%.

🟩 = Target Growth Percentage of 12%



2015 PM: Data Collection Points (I-29/I-94 Interchange)

	1	2	3	4	5	6	7	8	9	10
2008 Vol. (vph)	2139	604	390	203	471	354	1542	2013	154	1135
2015 Sim. Vol. (vph)	2408	666	433	230	533	387	1701	2226	298	1373
Volume % Difference	13%	10%	11%	13%	13%	9%	10%	11%	94%	21%
Speed (mph)	46	54	25	55	54	25	36	37	25	53
# of Lanes	2	1	1	1	1	1	1	1	1	1
Density (pc/mi/ln)	31	15	21	5	12	18	55	71	14	30

This data increased the original density by 25%.

= Target Growth Percentage of 12%

Appendix F: 2015 PM Simulation Output (Node Evaluations)

2015 PM Peak - Ramp Terminal Data

Node Location: I-94 & Sheyenne St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume			123			322	40	152			435	10
Delay Time/Veh. (s)			6.5			3.3	2.7	0.2			4.2	1.0
Max Queue (ft)			143			183	63	0			230	0
Avg. Queue (ft)			5			12	0	0			10	0
								Intersection Delay (sec/veh)				7.9

Node Location: I-94 & Sheyenne St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	28	0	79					163	95	297	262	
Delay Time/Veh. (s)	18.8	0.0	6.5					11.5	1.6	13.5	2.8	
Max Queue (ft)	146	0	146					200	0	284	154	
Avg. Queue (ft)	6	0	6					11	0	30	3	
								Intersection Delay (sec/veh)				7.9

Node Location: I-94 & 9th St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				161		419	33	222			443	23
Delay Time/Veh. (s)				34.4		8.8	39.7	3.2			6.4	2.4
Max Queue (ft)				233		232	134	134			176	0
Avg. Queue (ft)				42		37	10	10			11	0
								Intersection Delay (sec/veh)				8.7

Node Location: I-94 & 9th St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	39		95					215	206		374	231
Delay Time/Veh. (s)	36.6		4.3					2.2	1.4		3.7	0.8
Max Queue (ft)	126		132					108	0		180	247
Avg. Queue (ft)	9		6					2	0		5	6
								Intersection Delay (sec/veh)				2.7

Node Location: I-94 & 45th St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				644	0	849		227	26		1041	178
Delay Time/Veh. (s)				38.4	0.0	9.9		6.8	0.2		12.8	5.0
Max Queue (ft)				637	0	101		118	201		750	750
Avg. Queue (ft)				108	0	0		6	4		91	91
								Intersection Delay (sec/veh)				12.0

Node Location: I-94 & 45th St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	87	0	5					165	647		932	750
Delay Time/Veh. (s)	30.7	0.0	7.5					2.3	3.9		1.9	3.5
Max Queue (ft)	163	0	63					245	245		309	234
Avg. Queue (ft)	17	0	0					14	14		8	30
								Intersection Delay (sec/veh)				3.2

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Node Location: I-94 & 25th St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				150	0	199		436	266		1057	221
Delay Time/Veh. (s)				46.7	0.0	6.2		3.8	1.1		7.8	8.4
Max Queue (ft)				250	0	162		155	210		477	477
Avg. Queue (ft)				46	0	9		7	22		49	49
									Intersection Delay (sec/veh)			5.2

Node Location: I-94 & 25th St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	110	211	315	34	16	208	279	382	1	102	612	496
Delay Time/Veh. (s)	40.1	43.1	11.3	49.6	42.9	6.5	14.2	10.1	5.4	7.6	12.4	5.7
Max Queue (ft)	587	587	355	140	140	171	270	254	0	133	359	330
Avg. Queue (ft)	98	98	21	12	12	9	24	18	0	4	32	11
									Intersection Delay (sec/veh)			13.0

Node Location: I-94 & University Dr (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				482		479		712	300		857	554
Delay Time/Veh. (s)				39.3		12.4		4.4	0.9		8.2	2.8
Max Queue (ft)				336		347		285	218		559	0
Avg. Queue (ft)				75		66		12	0		44	0
									Intersection Delay (sec/veh)			8.8

Node Location: I-94 & University Dr (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	488		481					525	526		935	404
Delay Time/Veh. (s)	39.2		13.0					6.8	0.7		10.6	1.2
Max Queue (ft)	310		342					236	0		341	205
Avg. Queue (ft)	75		56					16	0		35	22
									Intersection Delay (sec/veh)			10.4

Node Location: I-94 & 8th St/TH75 (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				136	0	237	472	1278			821	1040
Delay Time/Veh. (s)				30.8	0.0	13.2	32.7	9.4			46.9	39.0
Max Queue (ft)				298	0	206	929	794			2000	2153
Avg. Queue (ft)				43	0	12	182	72			467	609
									Intersection Delay (sec/veh)			18.9

Node Location: I-94 & 8th St/TH75 (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	989		923					764	74	185	774	
Delay Time/Veh. (s)	31.1		58.9					49.7	4.8	48.1	23.7	
Max Queue (ft)	1878		5647					729	116	370	520	
Avg. Queue (ft)	379		2002					217	2	55	81	
									Intersection Delay (sec/veh)			41.6

2015 PM Peak - Ramp Terminal Data

Node Location: I-94 & 20th St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				123	10	15	334	541	65	14	230	533
Delay Time/Veh. (s)				6.5	1.7	4.9	9.0	1.0	1.1	12.1	6.5	15.5
Max Queue (ft)				118	118	118	180	180	180	193	193	193
Avg. Queue (ft)				0	0	0	32	32	32	6	6	6
							Intersection Delay (sec/veh)					7.0

Node Location: I-94 & 20th St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	472		502					466			241	
Delay Time/Veh. (s)	13.5		9.3					15.4			16.8	
Max Queue (ft)	527		369					501			303	
Avg. Queue (ft)	45		27					60			30	
							Intersection Delay (sec/veh)					15.9

Node Location: I-94 & 34th St (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				33		42		336	140	237	171	
Delay Time/Veh. (s)				14.4		5.4		0.3	6.8	1.2	4.4	
Max Queue (ft)				119		0		220	194	119	119	
Avg. Queue (ft)				3		0		22	5	0	3	
							Intersection Delay (sec/veh)					2.1

Node Location: I-94 & 34th St (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				187		243		233	77	24	180	
Delay Time/Veh. (s)				56.8		7.1		11.8	2.2	58.9	6.3	
Max Queue (ft)				284		284		168	107	130	130	
Avg. Queue (ft)				58		58		10	2	11	11	
							Intersection Delay (sec/veh)					17.6

Node Location: I-94 & MN 336 (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				23	0	59	30	446			121	292
Delay Time/Veh. (s)				7.9	0.0	7.2	0.6	0.2			0.7	1.5
Max Queue (ft)				119	0	119	0	0			0	0
Avg. Queue (ft)				3	0	3	0	0			0	0
							Intersection Delay (sec/veh)					1.2

Node Location: I-94 & MN 336 (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				25		413		63	11	82	62	
Delay Time/Veh. (s)				8.0		1.3		0.0	0.9	0.5	0.2	
Max Queue (ft)				8		8		0	0	16	16	
Avg. Queue (ft)				0		0		0	0	0	0	
							Intersection Delay (sec/veh)					1.2

2015 PM Peak - Ramp Terminal Data

Node Location: I-29 & CR 20 (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		301	70	113	145					104		93
Delay Time/Veh. (s)		0.8	1.7	1.4	1.1					10.3		6.8
Max Queue (ft)		0	0	40	40					141		141
Avg. Queue (ft)		0	0	0	0					1		1
									Intersection Delay (sec/veh)			2.9

Node Location: I-29 & CR 20 (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	182	222			174	122	84		156			
Delay Time/Veh. (s)	1.2	1.5			0.8	2.3	12.1		10.1			
Max Queue (ft)	44	44			0	0	199		199			
Avg. Queue (ft)	0	0			0	0	5		5			
									Intersection Delay (sec/veh)			3.8

Node Location: I-29 & 19 Ave N (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	47	334			477	509				182		3
Delay Time/Veh. (s)	2.8	5.0			5.5	2.0				12.3		1.3
Max Queue (ft)	0	150			196	253				186		0
Avg. Queue (ft)	0	7			10	1				15		0
									Intersection Delay (sec/veh)			5.0

Node Location: I-29 & 19 Ave N (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		513	3		935	330	51		314			
Delay Time/Veh. (s)		5.6	0.2		6.1	1.6	19.3		6.8			
Max Queue (ft)		167	194		279	0	127		148			
Avg. Queue (ft)		10	8		26	0	6		14			
									Intersection Delay (sec/veh)			5.7

Node Location: I-29 & 12th Ave N (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		286	559		451	667				112		31
Delay Time/Veh. (s)		2.5	1.8		2.1	2.1				33.5		1.5
Max Queue (ft)		135	0		175	190				179		133
Avg. Queue (ft)		3	0		4	1				25		1
									Intersection Delay (sec/veh)			3.7

Node Location: I-29 & 12th Ave N (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		352	46		818	158	299		509			
Delay Time/Veh. (s)		3.2	0.2		6.5	1.0	30.5		7.5			
Max Queue (ft)		133	135		302	0	214		224			
Avg. Queue (ft)		5	0		25	0	41		25			
									Intersection Delay (sec/veh)			9.0

2015 PM Peak - Ramp Terminal Data

Node Location: I-29 & Main Ave (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		586	493		851	611				149	0	186
Delay Time/Veh. (s)		3.4	4.9		2.4	2.1				42.0	0.0	6.1
Max Queue (ft)		245	245		156	239				175	0	157
Avg. Queue (ft)		14	14		6	0				30	0	9
									Intersection Delay (sec/veh)			5.2

Node Location: I-29 & Main Ave (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		634	107		1257	190	203	0	389			
Delay Time/Veh. (s)		2.2	0.3		4.3	6.0	42.7	0.0	6.7			
Max Queue (ft)		274	309		347	347	197	0	179			
Avg. Queue (ft)		7	3		26	26	37	0	16			
									Intersection Delay (sec/veh)			6.9

Node Location: I-29 & 38th St

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume				411	0	18	0	71	592	309	67	
Delay Time/Veh. (s)				15.2	0.0	4.3	0.0	5.2	6.2	7.8	4.9	
Max Queue (ft)				182	0	101	0	123	267	233	233	
Avg. Queue (ft)				27	0	1	0	2	2	15	15	
									Intersection Delay (sec/veh)			8.7

Node Location: I-29 & 13th Ave S (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	35	1048	304		960	279	419	238	453			
Delay Time/Veh. (s)	50.4	7.8	0.4		14.2	5.6	39.0	49.2	11.8			
Max Queue (ft)	126	298	165		393	0	353	352	356			
Avg. Queue (ft)	10	26	0		53	0	88	86	86			
									Intersection Delay (sec/veh)			15.7

Node Location: I-29 & 32nd Ave S (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		771	313	244	665					397		386
Delay Time/Veh. (s)		14.8	3.4	40.2	5.2					40.2		8.7
Max Queue (ft)		347	0	367	243					277		281
Avg. Queue (ft)		48	0	69	13					65		40
									Intersection Delay (sec/veh)			16.2

Node Location: I-29 & 32nd Ave S (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		955	219		735	800	167		310			
Delay Time/Veh. (s)		3.4	1.2		4.5	2.2	38.8		12.1			
Max Queue (ft)		296	293		232	0	299		309			
Avg. Queue (ft)		13	19		11	0	47		39			
									Intersection Delay (sec/veh)			5.9

2015 PM Peak - Ramp Terminal Data

Node Location: I-29 & 52nd Ave S (W. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		1052	186		613	89				579		543
Delay Time/Veh. (s)		9.4	1.7		7.9	0.7				26.7		1.7
Max Queue (ft)		254	254		186	266				299		14
Avg. Queue (ft)		29	29		14	2				64		0
							Intersection Delay (sec/veh)					10.3

Node Location: I-29 & 52nd Ave S (E. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume		1113	517		576	451	127		107			
Delay Time/Veh. (s)		2.7	4.0		3.4	1.3	37.3		2.2			
Max Queue (ft)		260	238		161	161	216		0			
Avg. Queue (ft)		7	28		7	7	32		0			
							Intersection Delay (sec/veh)					4.4