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Interstate Operations Study: Fargo-Moorhead Metropolitan Area

Simulation Base Case Calibration and 2008 Simulation Results

Technical Memorandum II

December 2008

Prepared for:
Fargo-Moorhead Council of Governments
(Metro COG)

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EXECUTIVE SUMMARY

This document provides the results of the 2008 simulation base cases for the Fargo-Moorhead Interstate Operations Study. The major sections of this document include an overview of the calibration procedures and the simulation results for both the 2008 AM and 2008 PM scenarios. The previous memorandum (Technical Memorandum I) discussed the simulation development process. The simulation analysis will produce numerical data and animation to evaluate the current freeway operations within the metropolitan 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. Nine interchanges exist with local roadways along the 15-mile portion of I-94 and 7 interchanges exist on I-29, which spans 9 miles. The original simulation network, which was constructed using PTV AG's VISSIM, was extended north and south to correlate with the external origin-destination (O-D) survey.

After error-checking was performed, the simulation base cases were calibrated to more accurately predict the traffic performance of the analysis area. Calibration is the process of adjusting the simulation model's parameters to reproduce local driver behavior and traffic performance characteristics. The primary calibration parameters of VISSIM relate to driver behavior, which is primarily governed by car-following and lane-changing models. This study focused on six parameters of the Weidemann 1999 car-following model (CC0 through CC5). The parameters that have the largest impact on driving behavior include CC0 (affects jam density and queue length), CC1 (affects saturation flow), and CC2 (affects following oscillation).

Several of VISSIM's lane-changing parameters were also adjusted during the calibration process. These parameters are related to both mandatory and discretionary lane changes. Adjusting the *Necessary lane change (route)*, *Safety distance reduction factor*, and *Maximum deceleration for cooperative braking* parameter sets were modified to more accurately model merge and weave areas. In addition, the *Look Ahead Distance* values were adjusted to more accurately reflect the starting point of mandatory lane changes. The values used for the parameters were based on previous research studies, as well as research performed as a part of this study.

A calibration methodology was developed based on the different operating conditions of various freeway sections. Once the critical sections were adjusted to replicate field observations, the calibration parameters were applied to the remaining links that exhibit similar operational conditions. On-ramp sections needed to be adjusted to allow accurate merging behavior with the freeway mainline, which modified car-following and lane changing parameters. When the critical on-ramp sections simulated traffic as observed in the field, the weave sections were addressed. The critical weave sections incorporated the on-ramp car-following parameters but required some additional modifications to the lane changing parameters. Next, the basic freeway sections were calibrated by adjusting car-following parameters and connector *Lane change* position values (primarily for the on- and off-ramps). Finally, the tri-level merge area was addressed, which encounters the most freeway congestion in the F-M area.

Once the 2008 AM and PM base cases were calibrated, the simulation results of these scenarios were produced. The AM peak period has significantly more traffic traveling westbound on I-94 and northbound on I-29. Density values for I-94 and I-29 ranged from 3 pc/mi/ln to 32 pc/mi/ln and 4 pc/mi/ln to 24 pc/mi/ln, respectively. The highest density values of the AM peak period were along the sections of I-94 from 20th St. (Moorhead, MN) to I-29, which exhibited densities between 27 pc/mi/ln and 32 pc/mi/ln (LOS C-D).

During the AM peak period, a few ramp terminals experienced congestion. The I-94 & Sheyenne St. Interchange experienced severe congestion due to the high number of vehicles making southbound left-turn and northbound through movements. The queues that developed for the southbound left-turn lane extended through the north ramp, which adversely affected traffic operations at that intersection.

The PM peak hour directional split was not as extreme as the AM peak hour; however, more traffic travels eastbound on I-94 and southbound on I-29 during the PM peak hour. Density values for I-94 and I-29 ranged from 2 pc/mi/ln to 26 pc/mi/ln and 6 pc/mi/ln to 27 pc/mi/ln, respectively. The sections of I-94 from 45th St. (Fargo, ND) to 20th St. (Moorhead, MN) provide density values ranging from 24 pc/mi/ln to 26 pc/mi/ln (LOS C).

During the PM peak period, the freeway system had a few weave/merge locations that experienced congestion. The westbound I-94 section between I-29 & 45th St. experienced congestion due to the traffic traveling from the north to the west from the I-29 & I-94 Interchange (northwest ramp) and merging with the westbound I-94 traffic. Since a significant number of vehicles traveling westbound on I-94 exit the freeway at 45th St., most vehicles are traveling in the right travel lane. Therefore, the vehicles traveling from I-29 (northwest ramp) had difficulty merging with the westbound I-94 traffic, causing average maximum queue lengths of approximately 450 ft.

The tri-level merge area (tri-level ramp and southeast ramp) experienced the most congestion during the PM peak period. Over 2,000 vehicles from two ramps merge into one lane during the PM peak hour, creating an average maximum queue length of over 2,000 ft to develop on the tri-level ramp.

Several ramp terminals also experienced congestion during the PM peak period. These ramp terminals include the I-94 & Sheyenne St. North Ramp (westbound vehicles from I-94 traveling south on Sheyenne St.), the I-94 & 45th St. South Ramp (southbound vehicles from 45th St. traveling east on I-94), and the I-94 & 8th St. (TH 75) South Ramp (eastbound vehicles from I-94 traveling north and south on 8th St.).

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OVERVIEW

This document provides the results of the 2008 Base Cases for the Fargo-Moorhead Interstate Operations Study (F-M IOS). The major sections of this document include an overview of the calibration procedures and the simulation results for both the 2008 AM and 2008 PM base cases. The previous memorandum (Technical Memorandum I) discussed the simulation development process.

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. Nine interchanges exist with local roadways along the 15 mile portion of I-94 and 7 exist on I-29, which spans 9 miles. The original simulation network, which was constructed using PTV AG's VISSIM 5.1, was extended north and south to correlate with the external origin-destination (O-D) survey (Figure 1). The simulation analysis will provide numerical data and animation that will provide guidance on locations suffering from capacity deficiencies resulting from continued traffic growth within the metropolitan area.

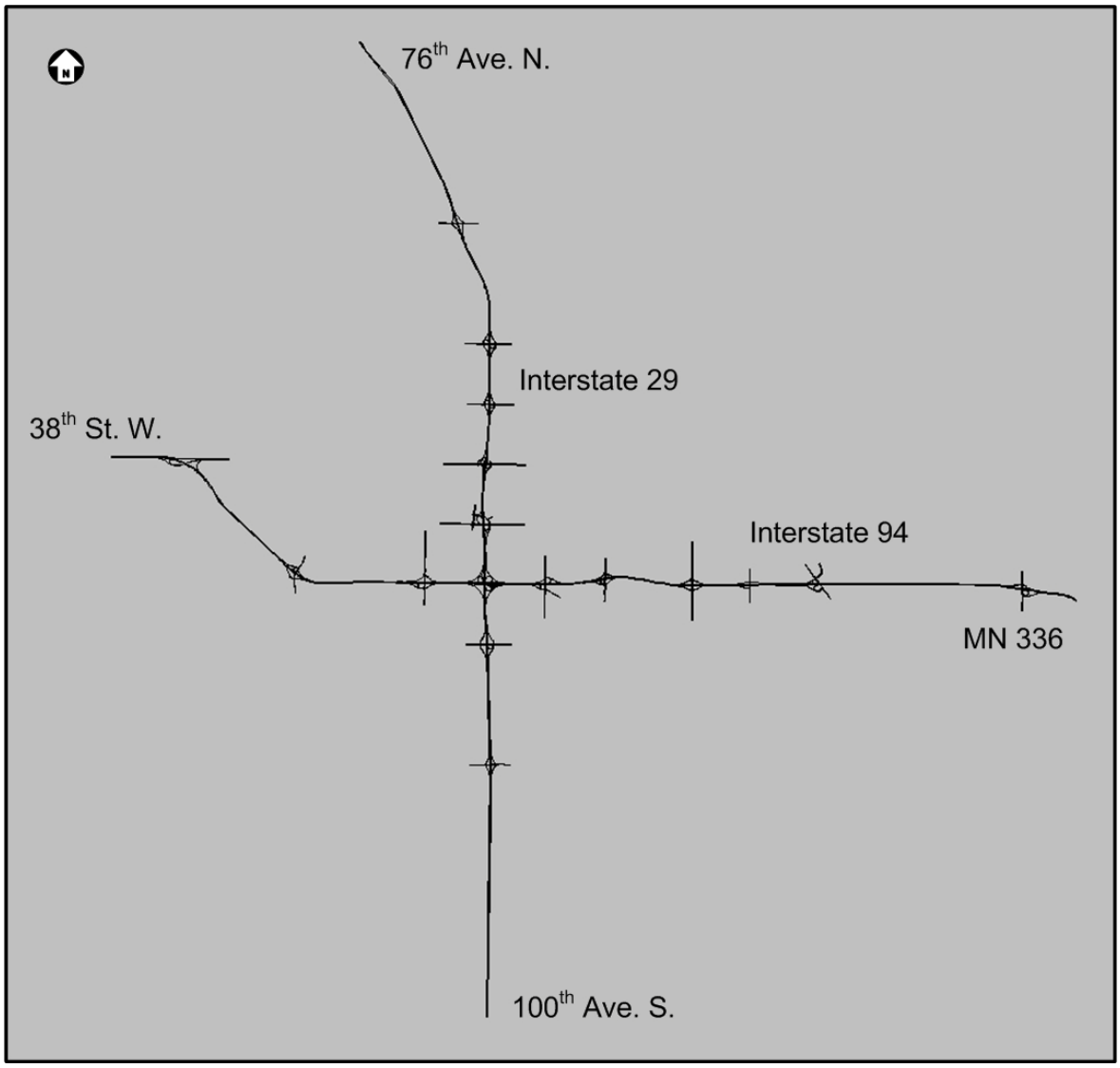

Figure 1. F-M IOS VISSIM network (2008)

SIMULATION CALIBRATION

After error-checking has been performed, the simulation base cases must be calibrated to more accurately predict the traffic performance of the analysis area. Calibration is the process of adjusting the simulation model's parameters to reproduce local driver behavior and traffic performance characteristics. Default values may be adequate for some instances; however, the user must calibrate the simulation network to ensure that local behavior is reflected in the model. In addition, users must be cautioned on adjusting only relevant parameters and realize the implications of adjusting such parameters.

The Federal Highway Administration (FHWA) has developed a toolbox for guiding traffic analysis projects. Volume III of the toolbox entitled "Guidelines for Applying Traffic Microsimulation Modeling Software" was consulted extensively during the Fargo-Moorhead Interstate Operations Study and Chapter 5 of the document specifically addresses simulation calibration (*1*).

Calibration is a systematic and iterative process, as shown in Figure 2. Users must be careful to avoid the never-ending circle of adjusting too many parameters and following a nonsequential manner. For example, a user may have a certain location (Site A) of the network calibrated but will have to reexamine this location after addressing an issue upstream (Site B), since the Site A modification could impact the downstream traffic.

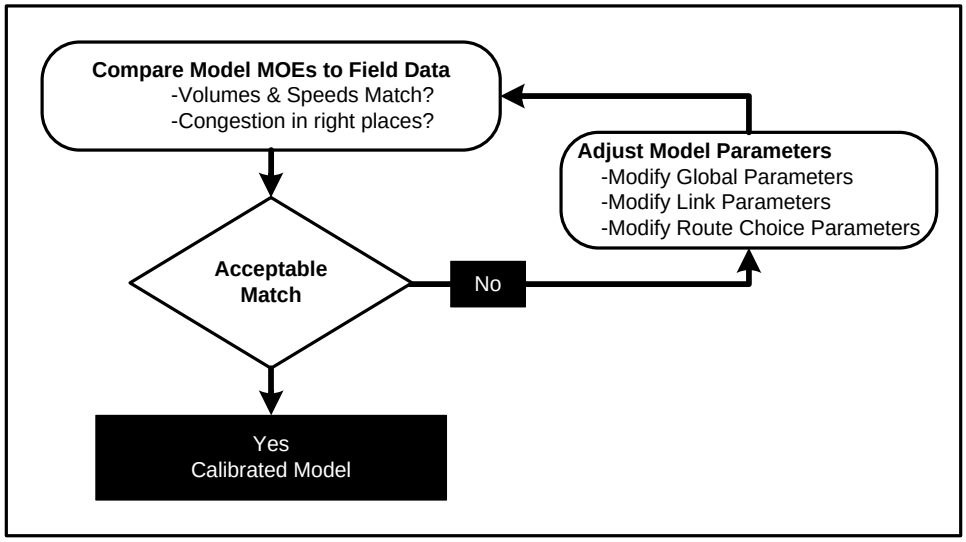

Figure 2. Microsimulation model calibration (*1*)

The Traffic Analysis Toolbox also recommends a three-step strategy for conducting simulation calibration, which includes capacity calibration, route choice calibration, and system performance calibration. The next section will discuss the main calibration parameters for the VISSIM simulation model and the procedures used for calibrating the 2008 AM Peak Hour and 2008 PM Peak Hour base cases.

VISSIM DRIVING BEHAVIOR

The driving behavior of VISSIM is primarily governed by both car-following and lane-changing models. Both models have numerous parameters to adjust and the user must use caution when making adjustments to these parameters. Early versions of VISSIM had one car following model (Wiedemann 74), while more recent versions also incorporate the Wiedemann 99 car following model, which is used for freeway applications.

The driving behavior is associated to various link types within the program, which include urban, freeway, footpath, etc. Users can modify the driving behavior of the default link types or create additional link types to be associated to the various roadway sections, e.g., basic freeway sections, on-ramp sections, weave sections, etc.

VISSIM Driver Behavior Calibration Parameters

The Weidemann 1999 car-following model has 10 parameters available for modifying. Users must use caution in adjusting these values since they can have a significant effect on the simulation output. Some key parameters include CC0 (affects jam density and queue length), CC1 (affects saturation flow), and CC2 (affects following oscillation). Several papers/projects have provided insight in adjusting the car-following parameters (*2, 3, 4*), which generally focus on the first five parameters, as described below (a complete explanation of the driving behavior parameters is provided in the VISSIM 5.1 User Manual (*5*):

- CC0: Desired distance (ft) between stopped cars.
- CC1: Headway time (sec.) that the driver wants to keep between vehicles.
- CC2: Following variation - controls longitudinal oscillation in the car-following process.
- CC3: Threshold for entering car-following - controls the start of the deceleration process
- CC4: Following threshold - controls the speed differences during closing in the following process.
- CC5: Following threshold - controls the speed differences during opening in the following process.

Several lane change parameters are available within the VISSIM simulation model for the user to modify. These parameters are related to both mandatory and discretionary lane changes. Adjusting the *Necessary lane change (route)*, *Safety distance reduction factor*, and *Maximum deceleration for cooperative braking* parameter sets may be required to more accurately model merge and weave areas. The *Waiting time before diffusion* parameter may be useful to reduce gridlock occurrences.

The VISSIM networks for the Fargo-Moorhead Interstate Operations Study incorporated eight different driving behavior parameter sets. Most of the parameters were identical among the parameter sets; however, each serves a specific facility/segment type that displayed unique driving behavior. The driving behavior sets were assigned to the appropriate link types and color coded to ensure proper assignment, as shown in Figure 3. The following driving behavior sets were used in the base cases:

- Urban (motorized): Urban links and off-ramps (dark blue)
- Freeway (free lane section): Basic freeway links (green)
- Sharp Curve: Loop ramp links (red)
- Trilevel Ramp: Tri-level ramp (orange)
- Onramp Merge: On-ramp merge sections (purple)
- Short Weave: Weave sections adjacent to I-29/I-94 interchange (cyan)
- Trilevel-SE Merge: Tri-level/SE Ramp merge area (yellow)
- Trilevel-SE Merge HV: Tri-level/SE Ramp merge area for trucks (yellow)

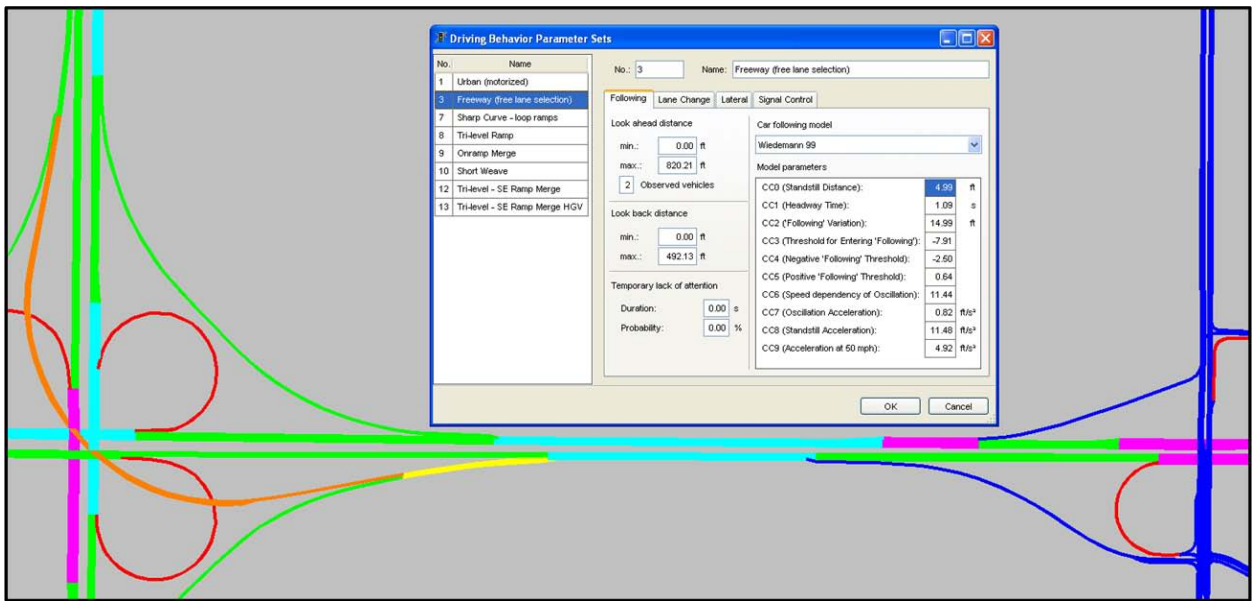

Figure 3. F-M IOS Driving behavior parameter sets

VISSIM CALIBRATION

The calibration of the 2008 AM Peak Hour and 2008 PM Peak Hour base cases occurred concurrently to ensure the driving behavior parameters would replicate traffic operations for both conditions. This study's calibration focused on calibrating the behavior of the freeway facility types/sections, which will be applied globally to all links in the network with that facility type.

Since the network is generally uncongested, except for the tri-level merge during a portion of the PM peak hour, field data cannot be used to calibrate network capacity. Therefore, maximum throughput tests were performed to estimate the capacity of the freeway sections. The simulated throughput from different link types ranged from approximately 2,100 vphpl to 2,300 vphpl. The capacity range is due to modifying the CC1 (Headway factor) parameter, which was performed for various link types to better replicate field conditions. In addition, modifications to lane changing parameters were made to merge and weave sections.

Calibration Methodology

Due to the different operating conditions of various freeway sections, a flowchart was used to calibrate the critical sections of the base cases (Figure 4). Once the critical sections were adjusted to replicate field observations, the calibration parameters were applied to the remaining links that exhibit similar operational conditions. On-ramp sections needed to be adjusted to allow accurate merging behavior with the freeway mainline, which included car-following and lane changing parameters. When the critical on-ramp sections simulated traffic as observed in the field, the weave sections were addressed. The critical weave sections incorporated the on-ramp car-following parameters but required some additional modifications to the lane changing parameters. Next, the basic freeway sections were calibrated by adjusting a few car-following parameters and connector *Lane change* position values, which are used to start the mandatory lane change for the on- and off-ramps. Finally, the tri-level merge area was addressed, which used similar car-following and lane changing parameters as the short weave behavior set. A tri-level merge heavy vehicle (HV) parameter set was used to create additional gaps for the merge area.

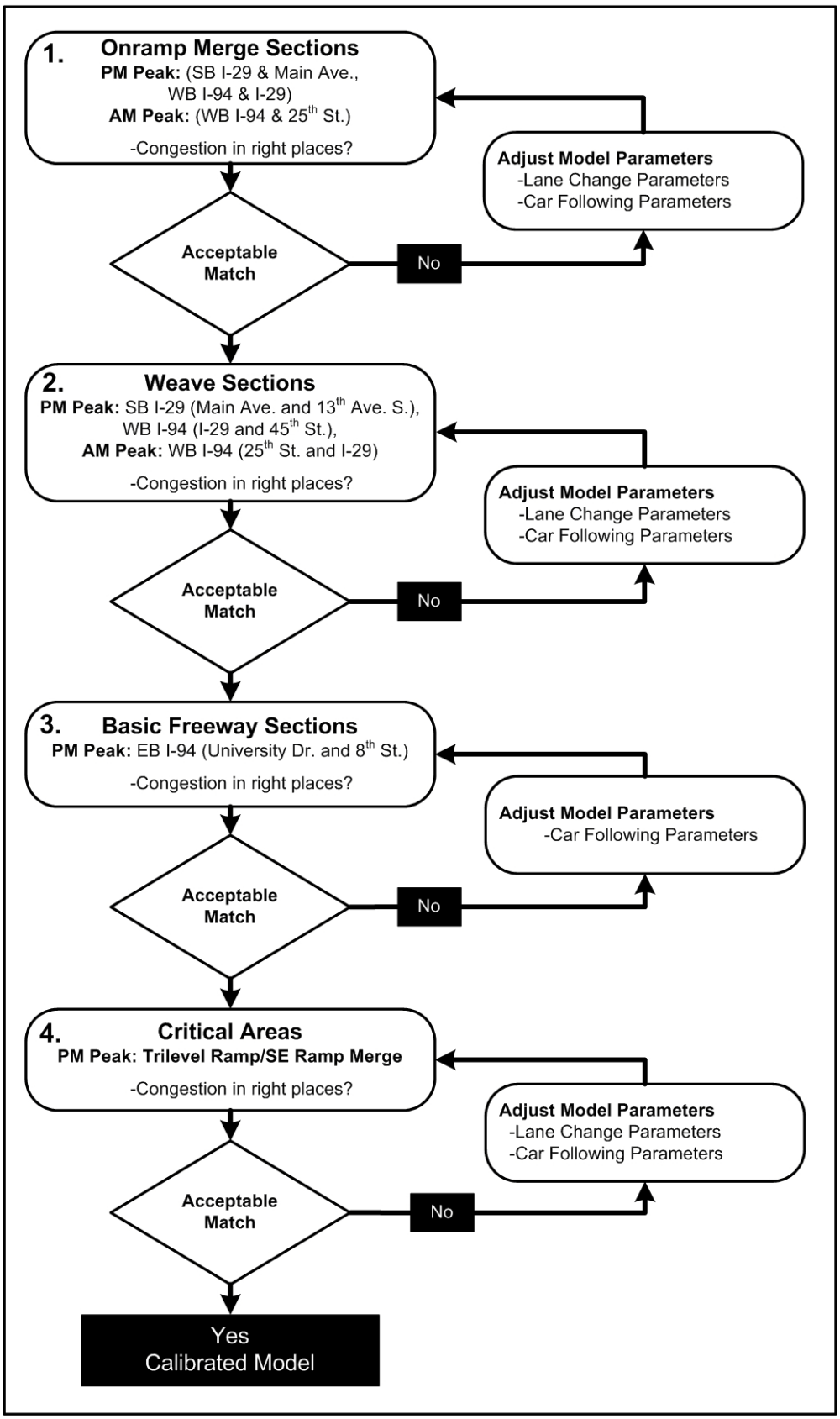

Figure 4. VISSIM calibration flowchart.

Base Case Calibration Parameters

As previously discussed, VISSIM has several parameters available for its car-following and lane changing models. ATAC consulted previous research and PTV America for using some of the calibration parameters. The initial car-following parameters (CC1-CC5) for this study were based on the research conducted by Sandeep et al. (*4*). Their research provided valuable information on some of the car following thresholds (CC3-CC5) and how it relates to the Next Generation Simulation (NGSIM) efforts. ATAC used these values for all freeway link types. However, modifications to CC1 and CC2 were required to replicate the observed conditions at the critical sections. A possible reason for these modifications are due to the characteristics of the US101 network (modeled by Sandeep et al.), which had freeway interchanges spaced every two miles or so. The Fargo-Moorhead network has interchanges spaced every mile and some weave sections are as short as 1,300 ft. It should be noted that different parameters could have been modified to produce similar output, however, ATAC performed several iterations of parameter modifications prior to deciding on the final calibration parameters. The calibration parameters used for the F-M IOS are shown in Tables 1-3.

Table 1. F-M IOS Car-Following Calibration Parameters.

Car-Following	CC0 (ft)	CC1 (sec)	CC2 (ft)	CC3	CC4	CC5
Default Values	4.92	.90	13.12	-8.00	-0.35	0.35
US101 – Speed-Flow*	N/A	1.09	34.74	-7.91	-2.50	0.64
Freeway (Basic)	5.0 ft	1.09	15.0	-7.91	-2.50	0.64
On-ramp Merge	5.0 ft	.80	15.0	-7.91	-2.50	0.64
Short Weave	5.0 ft	.80	15.0	-7.91	-2.50	0.64
Tri-level Ramp	5.0 ft	.90	15.0	-7.91	-2.50	0.64
Tri-level/SE Merge	5.0 ft	.80	15.0	-7.91	-2.50	0.64
Tri-level/SE Merge HV	30.0 ft	.80	15.0	-7.91	-2.50	0.64
Sharp Curve	5.0 ft	1.40	15.0	-7.91	-2.50	0.64

* Source: (*4*)

Table 2. F-M IOS Lane Change Calibration Parameters.

Lane Change: Necessary lane change	Max Decel. (own)	Max Decel. (trailing)	-1 fps^2 per dist. (own)	-1 fps^2 per dist. (trailing)	Accepted Decel. (own)	Accepted Decel. (trailing)
Default Values	-13.12	-9.84	200	200	-3.28	-1.64
Freeway	-13.12	-9.84	200	200	-3.28	-1.64
On-ramp Merge	-20.0	-20.0	50	25	-3.28	-3.28
Short Weave	-13.12	-9.84	200	200	-3.28	-1.64
Tri-level Ramp	-20.0	-20.0	50	25	-3.28	-3.28
Tri-level/SE Merge	-20.0	-20.0	50	25	-3.28	-3.28
Tri-level/SE Merge HV	-10.0	-20.0	50	25	-3.28	-3.28
Sharp Curve	-13.12	-9.84	200	200	-3.28	-1.64

Table 3. F-M IOS Lane Change Calibration Parameters.

Lane Change: Other key parameters	Wait time before diffusion (sec)	Safety distance reduction factor	Max. Decel. For coop. braking (fps^2)
Default Values	60	0.60	-9.84
Freeway	9,000	0.60	-9.84
On-ramp Merge	9,000	0.20	-16.0
Short Weave	9,000	0.10	-16.0
Tri-level Ramp	9,000	0.20	-16.0
Tri-level/SE Merge	9,000	0.10	-16.0
Tri-level/SE Merge HV	9,000	0.10	-16.0
Sharp Curve	9,000	0.60	-9.84

Note: The simulation duration is 9,000 sec.

Route Choice Calibration

This study incorporated O-D matrices from the F-M Metro COG travel demand model, which uses Citilab's Cube program. The balanced target values from the peak-hour counts were entered into the travel demand model, which generated O-D pairs to produce the desired link volumes in the network. The O-D matrices were used in VISSIM and assigned to the base cases using the dynamic assignment feature. However, since other logical routes (e.g., a parallel route to the freeway) are not available, route choice calibration was not required. As part of the error-checking procedures, ATAC used PTV's VISUM travel demand model to read/review the VISSIM O-D paths to ensure that invalid paths did not exist.

System Performance Calibration

This component allows the user to calibrate the model to the overall network performance. Several MOEs can be compared between the simulation output and field data, including volume, speed, travel time, delay time, and queue length. Visual audits were primarily used for the link type calibration, which are qualitative in nature. However, the following quantitative criteria was used for calibration (Table 4). It should be noted that the simulation output is based on 30 simulation runs.

Table 4. F-M IOS Calibration Criteria.

Criteria and Measures	Calibration Accepted Targets
Hourly Flows (Simulated vs. Observed)	
Individual Link Flows	
Within 15% Flow between 700 - 2,700 vph	> 85% of locations
Within 100 vph, Flow < 700 vph	> 85% of locations
Within 400 vph, Flow >2,700 vph	> 85% of locations
GEH Statistic for Sum of All Link Flows	< 4 for sum of all link counts
Travel Time (Simulated vs. Target)	
Within 15% (or 1 min., if higher)	>85% of Cases

Source: (*6*)

Simulation Runs

To determine if an adequate number of simulation runs were performed, a statistical test was performed for each base case using the network delay time performance measure, which is shown below:

$$n = \left\{ \frac{z_{\alpha/2} \times \sigma}{E \times \mu} \right\}^2$$

Where:

- n = required number of simulation runs
- $z_{\alpha/2}$ = 1.96 at a 95% confidence interval
- σ = standard deviation (sample size of 30 simulation runs)
- E = allowable percentage error (5%)
- μ = mean value (30 simulation runs)

Based on the statistical analysis for network delay time, the 2008 AM Peak Hour and 2008 PM Peak Hour scenarios require 3 and 1 runs, respectively (Table 5). These values represent the number of runs needed to be 95% confident that the actual delay time is within 5% of the average delay time from the 30 runs.

Table 5. Required Runs Based on Network Delay Time.

Base Case	μ (hr)	σ (hr)	# of Runs
PM Peak Hour	534.7	23.5	3.0
AM Peak Hour	369.6	9.2	1.0

Link Volume

The hourly traffic volume can be compared between modeled and observed based on individual links and the sum of the individual links. The basic freeway volumes from 14 Interstate-29 locations and 18 Intersate-94 locations were compared individually and as a whole. For the individual link volume comparison for the AM peak hour and PM peak hour differed from 0% to 3% and -1% to 2%, respectively (Tables 6 and 7). Therefore, 100% of the link counts meet accepted targets.

The GEH statistic is popular for traffic analysis applications, which accounts for the overall link flows between the simulated and observed conditions. The computed GEH value for the AM peak hour and PM peak hour were 3.1 and 1.1, respectively (Tables 8 and 9). Both of these values meet the criteria of less than 4.

$$GEH = \sqrt{\frac{(E-V)^2}{(E+V)/2}}$$

Where:

- E = Simulated estimated volume
- V = Field count (target volume)

Table 6. AM Peak Hour 2008: Freeway Volume Comparison

Interstate 29	**Southbound**			**Northbound**		
Freeway Mainline	Target Volume	Simulated Volume	% Difference	Target Volume	Simulated Volume	% Difference
CR 20 - 19th Ave. N	903	909	**1%**	497	505	**2%**
19th Ave. N - 12th Ave. N	1310	1320	**1%**	1176	1195	**2%**
12th Ave. N - Main Ave.	1450	1462	**1%**	2280	2320	**2%**
Main Ave. - 13th Ave. S	1592	1606	**1%**	3027	3073	**2%**
13th Ave. S - I-94	1711	1724	**1%**	3956	4005	**1%**
I-94 - 32nd Ave. S	1513	1535	**1%**	2512	2534	**1%**
32nd Ave. S - 52nd Ave. S	457	468	**2%**	1490	1507	**1%**
Interstate 94	**Eastbound**			**Westbound**		
Freeway Mainline	Target Volume	Simulated Volume	% Difference	Target Volume	Simulated Volume	% Difference
Main Ave. - Sheyenne St.	357	360	**1%**	672	686	**2%**
Sheyenne St. - 45th St.	1335	1345	**1%**	949	970	**2%**
45th St. - I-29	2321	2331	**0%**	1989	2026	**2%**
I-29 - 25th St.	2453	2476	**1%**	3368	3425	**2%**
25th St. - University Dr.	2638	2665	**1%**	3565	3615	**1%**
University Dr. - TH 75	2238	2260	**1%**	3734	3779	**1%**
TH 75 - 20th St.	1389	1418	**2%**	2650	2687	**1%**
20th St. - Main Ave.	982	1016	**3%**	2190	2219	**1%**
Main Ave. - MN 336	452	464	**3%**	1555	1558	**0%**

Table 7. AM Peak Hour 2008: GEH Statistic.

Total Link Volume (Target)	58,711
Total Link Volume (Simulated)	59,464
GEH Statistic	**3.1**

Table 8. PM Peak Hour 2008: Freeway Volume Comparison.

Interstate 29	**Southbound**			**Northbound**		
Freeway Mainline	Target Volume	Simulated Volume	% Difference	Target Volume	Simulated Volume	% Difference
CR 20 - 19th Ave. N	784	785	**0%**	1153	1168	**1%**
19th Ave. N - 12th Ave. N	1352	1358	**0%**	1641	1653	**1%**
12th Ave. N - Main Ave.	2457	2462	**0%**	2047	2060	**1%**
Main Ave. - 13th Ave. S	3406	3411	**0%**	2159	2174	**1%**
13th Ave. S - I-94	3607	3610	**0%**	2786	2789	**0%**
I-94 - 32nd Ave. S	2061	2060	**0%**	1922	1917	**0%**
32nd Ave. S - 52nd Ave. S	1047	1039	**-1%**	944	933	**-1%**
Interstate 94	**Eastbound**			**Westbound**		
Freeway Mainline	Target Volume	Simulated Volume	% Difference	Target Volume	Simulated Volume	% Difference
Main Ave. - Sheyenne St.	589	591	**0%**	313	313	**0%**
Sheyenne St. - 45th St.	1000	1008	**1%**	1216	1224	**1%**
45th St. - I-29	2411	2414	**0%**	2380	2399	**1%**
I-29 - 25th St.	3860	3871	**0%**	3147	3165	**1%**
25th St. - University Dr.	3609	3609	**0%**	3157	3177	**1%**
University Dr. - TH 75	3795	3803	**0%**	3028	3049	**1%**
TH 75 - 20th St.	2300	2321	**1%**	1876	1908	**2%**
20th St. - Main Ave.	1847	1878	**2%**	1458	1484	**2%**
Main Ave. - MN 336	1161	1168	**1%**	802	803	**0%**

Table 9. PM Peak Hour 2008 GEH Statistic

Total Link Volume (Target)	65,315
Total Link Volume (Simulated)	65,603
GEH Statistic	**1.1**

Travel Time

An external O-D study was performed by All Traffic Data during the AM and PM peak periods on September 10, 2008. The data collected from this study included pass-through trips and travel time for those trips, which assisted in this simulation study as well as the planning efforts using the regional travel demand model. The overall O-D capture rate was 87% (90% for cars and 60% for trucks). The sample sizes of the O-D trips during the peak periods ranged from 0 to 42. To get higher travel time samples from the simulation program, the larger O-D trip value from Cube or the O-D survey was used. If no trips were observed in the field between two O-D pairs, 10 trips were manual entered into the simulation matrices.

A few issues were noticed when processing the external O-D data. First, the time stamp for entering and exiting the study area did not include seconds (they were dropped). Therefore, the reported travel times from the survey could differ from the actual travel time by up to a minute. In addition, while comparing the simulating travel time to the survey travel time, significant differences were observed from one of the origins (SB I-29). Initially, we thought that it could be related to the simulation model (data collection locations or speed limits). However, after further

review, it appeared that the issue may be related to the time stamp of the field device(s) at this location. This seems the most logical since the average speed required to meet the reported travel time are unrealistic for the area (ranging from 75 to 84 mph). If the field travel times were subtracted by 3.5 minutes, the percent difference from the simulated travel time would range from -4% to 2% for both peaks. The travel time comparisons for the SB I-29 will not be included for the calibration criteria.

The O-D travel time between the survey and VISSIM were very similar. The travel time comparison for the AM peak hour and PM peak hour differed from -11% to 6% and -7% to -2%, respectively (Tables 10 and 11). These percent differences all meet the travel time calibration criteria.

Table 10. AM Peak Hour 2008: Travel Time Comparison

Origin	Destination	O-D Survey Travel Time		VISSIM Travel Time		Travel Time Comparison (%)
		Volume	Avg. (min)	Volume	Avg. (min)	
EB I-94	SB I-29	3	14.3	10	12.8	-11%
	NB I-29	0	0.0	10	15.3	N/A
	EB I-94	8	14.9	11	14.6	-2%
WB I-94	SB I-29	0	0.0	18	16.5	N/A
	NB I-29	7	18.0	32	17.2	-5%
	WB I-94	23	13.6	45	14.5	6%
NB I-29	NB I-29	9	16.6	38	15.7	-5%
	EB I-94	0	0.0	15	15.8	N/A
	WB I-94	5	13.6	10	13.9	2%
SB I-29	SB I-29	10	12.7	23	16.5	30%
	EB I-94	10	14.1	17	17.7	26%
	WB I-94	4	11.3	10	14.2	26%

Table 11. PM Peak Hour 2008: Travel Time Comparison

Origin	Destination	O-D Survey Travel Time		VISSIM Travel Time		Travel Time Comparison (%)
		Volume	Avg. (min)	Volume	Avg. (min)	
EB I-94	SB I-29	9	13.2	12	13.0	-2%
	NB I-29	5	15.8	6	15.0	-5%
	EB I-94	24	15.8	42	14.8	-6%
WB I-94	SB I-29	0	0.0	13	16.5	N/A
	NB I-29	22	17.7	43	17.0	-4%
	WB I-94	18	13.8	29	14.4	4%
NB I-29	NB I-29	10	16.9	72	15.8	-7%
	EB I-94	0	0.0	17	16.0	N/A
	WB I-94	9	14.6	11	13.8	-5%
SB I-29	SB I-29	17	13.1	23	16.5	26%
	EB I-94	16	14.8	22	18.2	23%
	WB I-94	4	11.5	8	14.7	27%

BASE CASE VISSIM OUTPUT

Several MOE were extracted from both the 2008 AM and 2008 PM base scenarios. The output from the 2008 AM scenario is located in Appendices A-C, while the 2008 PM data are provided in Appendices D-F. The output is based on 30 simulation runs for each base scenario using different seed numbers. The values reported for each measure of effectiveness (MOE) is the average value 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.

The 2008 PM scenarios typically had higher values for the various performance measures since the PM scenario has higher traffic volume. During the overall network data collection period (simulation time 1,800 to 9,000), the 2008 AM scenario generated 42,030 vehicles, while the 2008 PM scenario generated 52,959 vehicles. The 2008 PM scenario produced 535 hours of total delay time compared to 370 hours of total delay time for the 2008 AM scenario.

Freeway queue length was measured at the tri-level merge area and WB I-94 between 45th St. and I-29. The AM peak hour only exhibited one stop at each location, equating to maximum queue lengths of 98 ft (tri-level merge) and 31 ft (WB I-94). The PM peak hour had significant congestion at the tri-level merge during the peak period, which developed a maximum queue length of 2,027 ft and 454 stops. The WB I-94 section had an average queue length of 439 ft and 49 stops.

The freeway mainline section output illustrates a defined directional split between the AM and PM peak periods. The AM peak has significantly more traffic traveling westbound on I-94 and northbound on I-29. Density values, which are represented in passenger cars per mile per lane (pc/mi/ln), for I-94 and I-29 ranged from 3 pc/mi/ln to 32 pc/mi/ln and 4 pc/mi/ln to 24 pc/mi/ln, respectively (Table 12 illustrates density thresholds). The highest density values of the AM

peak period were along the sections of I-94 from 20th St. to I-29, which exhibited densities between 27 pc/mi/ln and 32 pc/mi/ln (LOS C-D).

The PM peak hour directional split is not as drastic as the AM peak hour; however, higher traffic volumes exist traveling eastbound on I-94 and southbound on I-29. Density values for I-94 and I-29 ranged from 2 pc/mi/ln to 26 pc/mi/ln and 6 pc/mi/ln to 27 pc/mi/ln, respectively. The sections of I-94 from 45th St. to 20th St. provide density values ranging from 24 pc/mi/ln to 26 pc/mi/ln (LOS C). The highest density value and most congested area for both the AM and PM peak periods occurs at the tri-level merge area. Over 2,000 vehicles from two ramps (tri-level and southeast ramps) merge into one lane during the PM peak hour, creating a density of 51 pc/mi/ln. The congestion at this area occurs for approximately 15 minutes during the PM peak.

Table 12. LOS CRITERIA for Freeway Segments

Level of Service	Density (pc/mi/ln)
LOS A	0-10
LOS B	>10-20
LOS C	>20-28
LOS D	>28-35
LOS E	>35-43
LOS F	>43

Source: HCM 2000, Exhibit 24-2. LOS Criteria for Weaving Segments (*7*)

Depending on the peak period, several ramp terminals experience congestion for at least one movement/approach. A list of these intersections and the time period that incurs congestion is as follows:

- I-94 & Sheyenne St. North Ramp: AM (caused by south ramp congestion) and PM peak periods
- I-94 & Sheyenne St. South Ramp: AM peak period
- I-94 & 45th St. North Ramp: PM peak period (caused by south ramp congestion)
- I-94 & 45th St. South Ramp: PM peak period
- I-94 & 8th St. (TH 75) South Ramp: PM peak period

SUMMARY

This document provided an overview of the calibration procedures and the simulation output for both the 2008 AM and 2008 PM base cases. The PM peak hour had significant congestion at the tri-level merge (max queue of 2,027 ft) and queuing also occurred on the westbound I-94 section west of the I-29 & I-94 Interchange (max queue of 439 ft).

The AM peak period has significantly more traffic traveling westbound on I-94 and northbound on I-29. Density values for I-94 and I-29 ranged from 3 pc/mi/ln to 32 pc/mi/ln and 4 pc/mi/ln to 24 pc/mi/ln, respectively. The highest density values of the AM peak period were along the sections of I-94 from 20th St. to I-29, which exhibited densities from 27 pc/mi/ln to 32 pc/mi/ln (LOS C-D).

The PM peak hour directional split is not as drastic as the AM peak hour; however, higher traffic volumes exist traveling eastbound on I-94 and southbound on I-29. Density values for I-94 and I-29 ranged from 2 pc/mi/ln to 26 pc/mi/ln and 6 pc/mi/ln to 27 pc/mi/ln, respectively. The sections of I-94 from 45th St. to 20th St. provide density values ranging from 24 pc/mi/ln to 26

pc/mi/ln (LOS C). The highest density value and most congested area for both the AM and PM peak periods occurs at the tri-level merge area. Over 2,000 vehicles from two ramps (tri-level and southeast ramps) merge into one lane during the PM peak hour, creating a density of 51 pc/mi/ln. The congestion at this area occurs for approximately 15 minutes during the PM peak.

Once the study's steering review committee (SRC) approves the calibrated models, two future scenarios (mid-term and long-term) will be constructed and simulated. The mid-term scenario will represent the 2015 planning horizon while the long-term scenario will represent the 2025 planning horizon.

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Appendix A: 2008 AM Simulation Output (Network Performance, Travel Time, Freeway Queues)

2008 AM Peak - Network MOE, Queue Length, Travel Time

Network Performance

Total Delay Time (hr)	370
Total Travel Time (hr)	3,382
Number of Active Vehicles	0
Number of Arrived Vehicles	42,030
Total Stopped Delay (hr)	155
Total Distance Traveled (mi)	159,465

Queue Measurement

Time	Tri-Level Merge			I-94 WB (45th St)		
	Avg.	Max.	Stop	Avg.	Max.	Stop
AM Peak	0	98	1	0	31	1

Travel Time (Network)

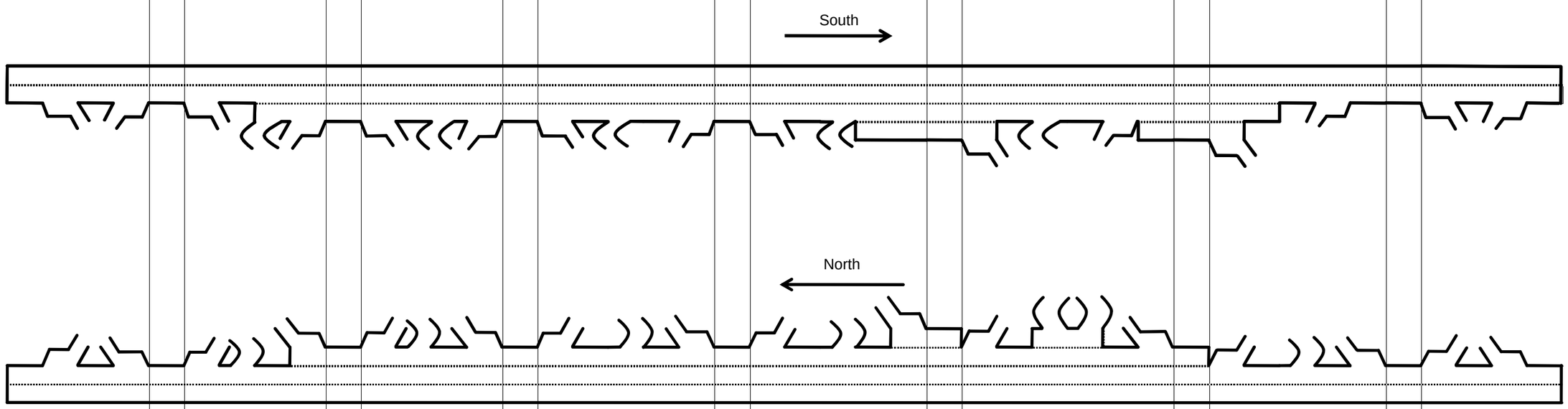
Origin		Destination					
		I-29 SB		I-94 EB		I-29 NB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-94 EB	0715-0730	12.5	2	14.6	3	15.2	2
	0730-0745	12.9	2	14.6	3	15.3	2
	0745-0800	12.8	3	14.6	3	15.3	3
	0800-0815	12.8	3	14.7	3	15.5	3
		I-29 SB		I-94 WB		I-29 NB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-94 WB	0715-0730	16.5	4	14.4	10	17.1	7
	0730-0745	16.5	4	14.3	10	17.0	7
	0745-0800	16.6	5	14.6	12	17.2	8
	0800-0815	16.5	6	14.5	13	17.3	10
		I-94 WB		I-29 NB		I-94 EB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-29 NB	0715-0730	13.8	2	15.7	8	15.8	3
	0730-0745	13.9	2	15.6	9	15.7	3
	0745-0800	14.0	3	15.8	10	15.9	4
	0800-0815	13.9	3	15.8	11	15.9	5
		I-94 WB		I-29 SB		I-94 EB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-29 SB	0715-0730	14.6	2	16.6	5	17.6	4
	0730-0745	12.6	2	16.5	5	17.7	4
	0745-0800	14.6	3	16.3	7	17.8	5
	0800-0815	14.6	3	16.5	6	17.8	5

Appendix B: 2008 AM Simulation Output (Data Collection Points)

I-29 Data Collection: 2008 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	550	230	3200		640	1300	640	1150	285	2325	285	950	1395	625	7200	770	1645	510	1900
Modeled Vol. (vph)					903					1310					1450						1592					1711						1513					457				
Simulated Vol. (vph)					909					1320					1462						1606					1724						1535					468				
Volume % Difference					1%					1%					1%						1%					1%						1%					2%				
Speed (mph)					74.6					56.6					57.1						56.2					57.8						58.6					58.9				
# of Lanes					2					3					3						3					4						4					2				
Density (pc/mi/ln)					8					10					11						13					10						9					5				
Level of Service					A					B					B						B					A						A					A				



Northbound

	CR 20				19th Ave. N					12th Ave. N					Main Ave.						13th Ave. S						I-94								32nd Ave. S					52nd Ave. S				
Distance (ft.)	8100	407	1980	775	7140	1165	1045	1015	665	1855	830	921	765	580	2190	525	745	570	655	760	1930	685	755	665	1310	380	1460	260	910	505	485	1260	990	1240	255	1145	305	860	720	7100	760	1635	800	1675
Modeled Vol. (vph)					497					1176					2280						3027						3956							2512						1490				
Simulated Vol. (vph)					505					1195					2320						3073						4005							2534						1507				
Volume % Difference					2%					2%					2%						2%						1%							1%						1%				
Speed (mph)					75					58.2					57						57.3						58							58.3						58.5				
# of Lanes					2					3					3						3						4							3						2				
Density (pc/mi/ln)					4					9					18						24						23							19						17				
Level of Service					A					A					B						C						C							B						B				

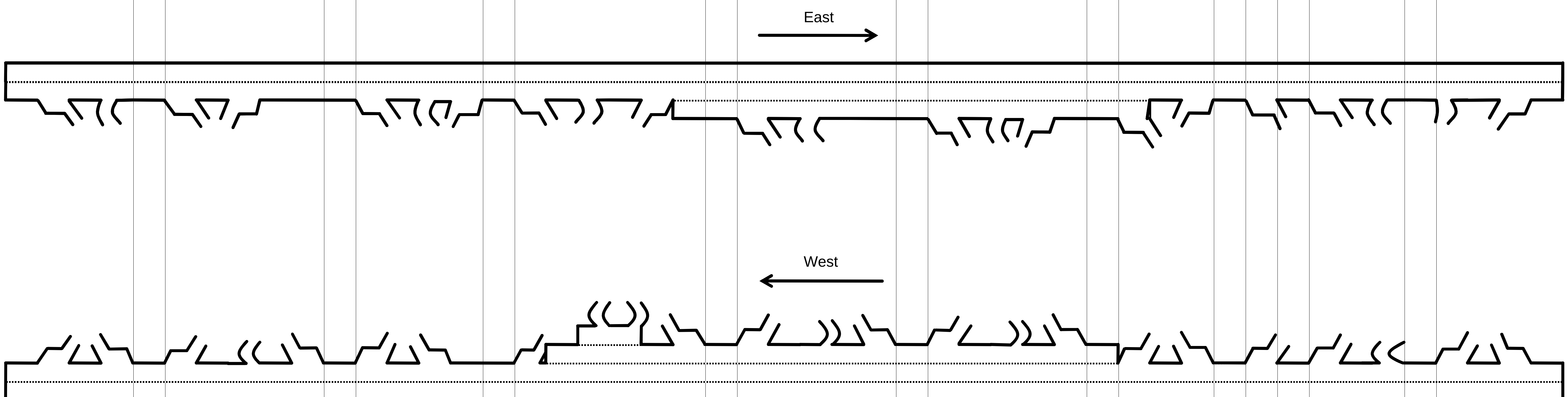
Note: Density values were adjusted using the following data:
Peak-hour factor = .78
Heavy vehicle percent = 5
This data increased the original density by 25%.

I-94 Data Collection: 2008 AM Peak Hour

Eastbound

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

Distance (ft.)	2660	575	1005	1440	11770	755	2050	1040	7520			705	930	1450	615	1570	760	465	1345	1365	405	1010		795	930	990	2610			960	740	1050	1125	4225		520	2005	840	1740	455	5645	285	1035	615	16635	710	1365	1080	2170
Modeled Vol. (vph)					357					1335						2321							2453						2638						2238				1389		982				452				
Simulated Vol. (vph)					360					1345						2331							2476						2665						2260				1418		1016				464				
Volume % Difference					1%					1%						0%							1%						1%						1%				2%		3%				3%				
Speed (mph)					75.2					74						57.1							59.1						58.4						58.5				58.5		59.3				70				
# of Lanes					2					2						2							3						3						3				2		2				2				
Density (pc/mi/ln)					3					12						27							19						20						17				16		11				4				
Level of Service					A					B						C							B						C						B				B		B				A				

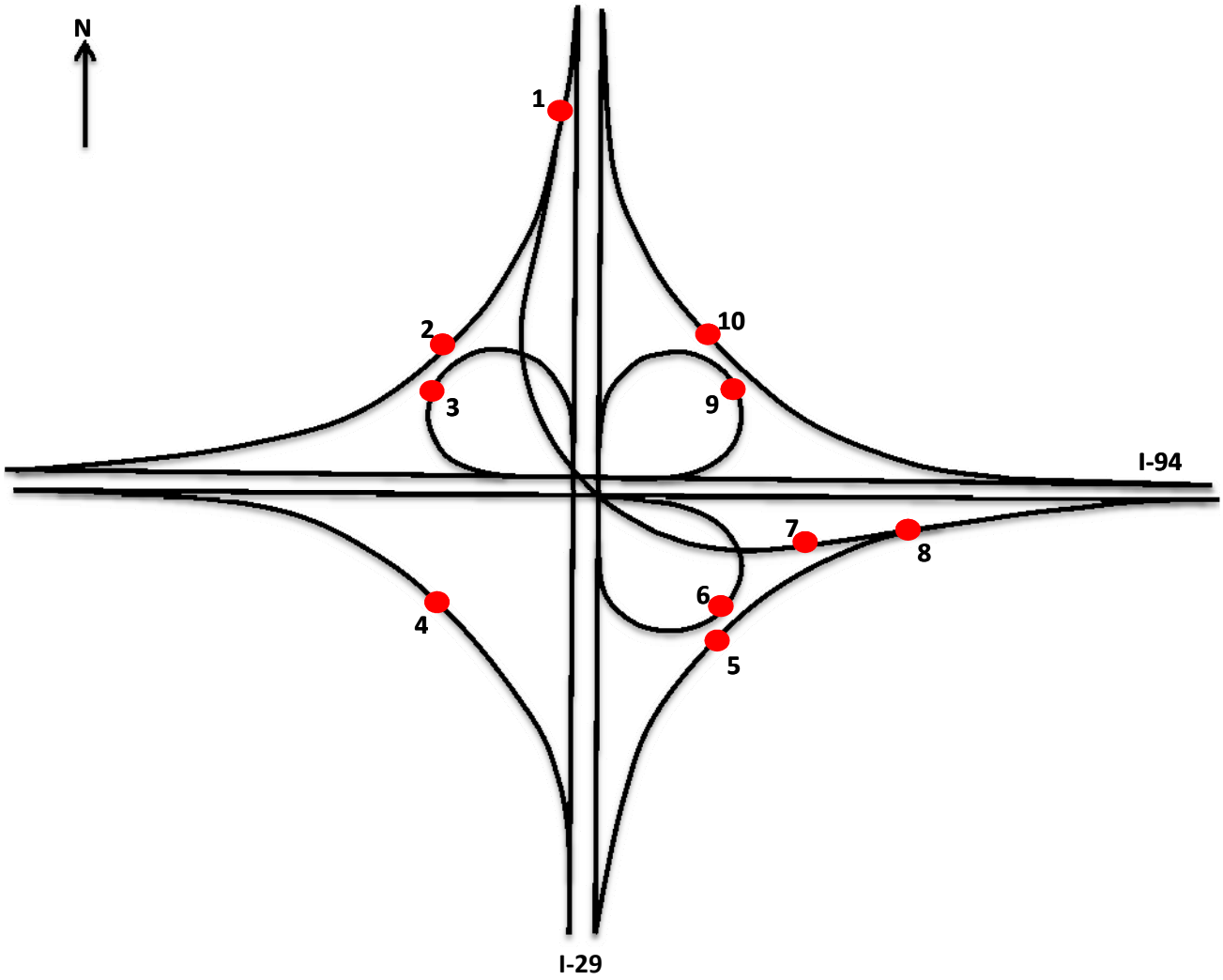


Westbound

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

Distance (ft.)	2815	1215	2850	390	9790	1035	835	870	260	785	8105	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	4835	810	700	630	15430	965	2195	465	3270
Modeled Vol. (vph)					672						949					1989							3368						3565						3734				2650		2190				1555				
Simulated Vol. (vph)					686						970					2026							3425						3615						3779				2687		2219				1558				
Volume % Difference					2%						2%					2%							2%						1%						1%				1%		1%				0%				
Speed (mph)					74.7						74.4					57.4							55.8						57.8						57.7				56.3		58.2				69.8				
# of Lanes					2						2					2							3						3						3				2		2				2				
Density (pc/mi/ln)					6						9					24							27						28						29				32		25				15				
Level of Service					A						A					C							C						C						D				D		C				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%.



2008 AM: Data Collection Points (I-29/I-94 Interchange)

	1	2	3	4	5	6	7	8	9	10
Modeled Vol. (vph)	877	301	502	177	497	765	577	1074	193	1370
Simulated Vol. (vph)	885	302	514	176	499	769	584	1084	196	1392
Volume % Difference	1%	0%	2%	-1%	0%	0%	1%	1%	1%	2%
Speed (mph)	57	54	25	55	54	24	54	55	25	53
# of Lanes	2	1	1	1	1	1	1	1	1	1
Density (pc/mi/ln)	10	7	28	4	12	42	14	26	10	35

This data increased the original density by 25%.

Appendix C: 2008 AM Simulation Output (Node Evaluations)

2008 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			102		0	262	53	669	0	0	696	29
Delay Time/Veh. (s)			264.6		0	7.8	11.6	0.5	0	0	58.2	36.1
Max Queue (ft)			798		0	327	0	0	0	0	655	655
Avg. Queue (ft)			202		0	17	0	0	0	0	169	169
										Intersection Delay (sec/veh)		39.5

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	4	0	23				0	716	613	395	404	0
Delay Time/Veh. (s)	13.9	0	6.7				0	8.4	7.8	72.4	1.7	0
Max Queue (ft)	56	0	56				0	819	819	2182	80	0
Avg. Queue (ft)	0	0	0				0	115	115	864	6	0
										Intersection Delay (sec/veh)		18.7

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				305	0	891	62	809	0	0	1181	70
Delay Time/Veh. (s)				41.1	0	10.7	33.5	7.9	0.0	0	11.8	6.7
Max Queue (ft)				329	0	521	152	246	0	0	746	173
Avg. Queue (ft)				51	0	41	13	21	0	0	71	2
										Intersection Delay (sec/veh)		13.5

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	188	0	86				0	684	623	0	853	632
Delay Time/Veh. (s)	39.2	0	4.7				0	5.8	10.9	0	3.9	8.5
Max Queue (ft)	267	0	108				0	417	417	0	68	327
Avg. Queue (ft)	51	0	1				0	50	50	0	0	29
										Intersection Delay (sec/veh)		8.9

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				275	0	396	0	996	327	0	832	146
Delay Time/Veh. (s)				57.1	0.0	15.2	0	9.2	2.0	0	10.6	11.5
Max Queue (ft)				507	507	399	0	458	148	0	435	435
Avg. Queue (ft)				111	111	41	0	38	1	0	48	48
										Intersection Delay (sec/veh)		14.2

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	72	92	75	15	33	404	155	834	24	190	687	235
Delay Time/Veh. (s)	38.7	43.1	5.7	41.4	37.1	15.1	14.4	14.0	12.1	13.3	8.1	3.0
Max Queue (ft)	263	263	118	128	128	393	438	511	0	236	270	177
Avg. Queue (ft)	42	42	2	10	10	44	14	56	0	15	22	1
										Intersection Delay (sec/veh)		13.6

2008 AM Peak - Ramp Terminal Data

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				391	0	341	0	1993	235	0	760	320
Delay Time/Veh. (s)				42.0	0	13.8	0.0	3.7	0.9	0	5.1	0.9
Max Queue (ft)				300	0	303	0	328	288	0	274	1080
Avg. Queue (ft)				67	0	44	0	23	1	0	14	177
								Intersection Delay (sec/veh)				8.1

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	609	0	228				0	1604	278	0	1009	156
Delay Time/Veh. (s)	47.1	0	8				0.0	15.1	1.1	0	11.7	0.4
Max Queue (ft)	962	0	182				0	577	0	0	361	290
Avg. Queue (ft)	245	0	15				0	82	0	0	39	17
								Intersection Delay (sec/veh)				17.2

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				126	0	145	612	1452	0	0	342	734
Delay Time/Veh. (s)				28.6	0	11.5	23.5	6.9	0	0	24.0	21.0
Max Queue (ft)				202	0	146	924	591	0	0	371	1080
Avg. Queue (ft)				23	0	5	156	41	0	0	34	177
								Intersection Delay (sec/veh)				15.6

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	314	0	786				0	1270	164	83	386	0
Delay Time/Veh. (s)	7.4	0	29.6				0	20.5	5.5	21.0	7.4	0
Max Queue (ft)	210	0	755				0	857	155	143	213	0
Avg. Queue (ft)	17	0	104				0	135	5	6	11	0
								Intersection Delay (sec/veh)				19.0

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				0	20	3	302	751	4	16	252	140
Delay Time/Veh. (s)				3.7	12.3	7.9	3.6	0.6	0.5	6.4	0.8	2.5
Max Queue (ft)				0	0	0	316	316	316	0	0	0
Avg. Queue (ft)				0	0	0	38	38	38	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	388	0	17				0	668	0	0	253	0
Delay Time/Veh. (s)	16.5	0	4.8				0	10.5	0	0	11.1	0.0
Max Queue (ft)	359	0	72				0	606	0	0	267	0
Avg. Queue (ft)	47	0	0				0	64	0	0	21	0
								Intersection Delay (sec/veh)				12.3

2008 AM Peak - Ramp Terminal Data

Node Location: I-94 & Main Ave (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	108	24	36	137	435	9	263	430	385	6	111	119
Delay Time/Veh. (s)	27.3	28.3	8.3	19.1	33.1	8.8	44.8	23.7	15.7	48.0	29.7	10.7
Max Queue (ft)	185	130	4	187	470	470	1020	973	489	64	182	0
Avg. Queue (ft)	18	5	0	15	99	99	148	121	30	2	20	0
							Intersection Delay (sec/veh)					26.1

Node Location: I-94 & Main Ave (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	444	0	148				0	628	0	0	249	35
Delay Time/Veh. (s)	22.5	0	8.1				0.0	21.6	0	0	17.0	8.5
Max Queue (ft)	598	0	157				0	634	0	0	301	33
Avg. Queue (ft)	73	0	5				0	84	0	0	27	0
							Intersection Delay (sec/veh)					19.5

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				2	0	43	14	219	0	0	47	591
Delay Time/Veh. (s)				5.8	0	7.0	0.6	0.1	0	0	1.2	2.3
Max Queue (ft)				0	0	115	0	0	0	0	0	0
Avg. Queue (ft)				0	0	2	0	0	0	0	0	0
							Intersection Delay (sec/veh)					1.9

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				17	0	193	0	41	5	37	11	0
Delay Time/Veh. (s)				7.5	0	0.7	0.0	0.0	0.9	0.5	0.1	0
Max Queue (ft)				0	0	0	0	0	0	0	0	0
Avg. Queue (ft)				0	0	0	0	0	0	0	0	0
							Intersection Delay (sec/veh)					0.9

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	0	83	86	198	45	0				26	0	7
Delay Time/Veh. (s)	0.0	0.6	2.2	1.1	1.2	0				6.9	0.0	5.3
Max Queue (ft)	0	0	0	0	0	0				52	0	52
Avg. Queue (ft)	0	0	0	0	0	0				0	0	0
							Intersection Delay (sec/veh)					1.6

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	9	100	0	0	228	23	14	0	91			
Delay Time/Veh. (s)	0.8	0.4	0	0	0.2	0.7	8.3	0	6.9			
Max Queue (ft)	12	12	0	0	0	0	95	0	95			
Avg. Queue (ft)	0	0	0	0	0	0	0	0	0			
							Intersection Delay (sec/veh)					1.8

2008 AM Peak - Ramp Terminal Data

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	0	220	27	0	229	499				91	0	29
Delay Time/Veh. (s)	0.0	3.6	2.3	0	4.5	2.6				9.6	0	1.5
Max Queue (ft)	0	135	0	0	144	271				143	0	0
Avg. Queue (ft)	0	4	0	0	4	1				6	0	0
							Intersection Delay (sec/veh)					3.7

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	0	292	20	0	693	27	32	0	707			
Delay Time/Veh. (s)	0.0	7.6	0.2	0	8.2	0.8	20.4	0.0	7.9			
Max Queue (ft)	0	149	171	0	292	0	135	0	214			
Avg. Queue (ft)	0	8	3	0	30	0	4	0	33			
							Intersection Delay (sec/veh)					8.0

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	0	327	103	0	832	247				86	0	127
Delay Time/Veh. (s)	0.0	2.3	0.6	0	3.6	0.7				32.9	0	3.2
Max Queue (ft)	0	120	0	0	269	112				160	0	144
Avg. Queue (ft)	0	3	0	0	12	0				18	0	5
							Intersection Delay (sec/veh)					4.2

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	0	381	32	0	562	50	514	0	696			
Delay Time/Veh. (s)	0.0	5.7	0.2	0	8.3	0.7	27.4	0	9.2			
Max Queue (ft)	0	149	130	0	250	0	279	0	298			
Avg. Queue (ft)	0	8	0	0	19	0	60	0	50			
							Intersection Delay (sec/veh)					12.2

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	0	1111	185	0	963	186				102	0	131
Delay Time/Veh. (s)	0.0	3.4	4.0	0	1.6	0.8				41.7	0	7.0
Max Queue (ft)	0	219	219	0	140	343				163	0	141
Avg. Queue (ft)	0	11	11	0	4	1				21	0	6
							Intersection Delay (sec/veh)					4.2

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	0	1075	133	0	641	48	519	0	435			
Delay Time/Veh. (s)	0	5.7	0.4	0.0	5.9	7.1	40.2	0	8.7			
Max Queue (ft)	0	308	210	0	208	208	332	0	325			
Avg. Queue (ft)	0	18	1	0	13	13	80	0	59			
							Intersection Delay (sec/veh)					12.3

2008 AM Peak - Ramp Terminal Data

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				201	0	87	0	146	202	153	75	0
Delay Time/Veh. (s)				15.4	0	5.2	0	3.9	2.2	5.3	3.8	0
Max Queue (ft)				155	0	145	0	122	128	156	156	0
Avg. Queue (ft)				15	0	6	0	3	0	5	5	0
							Intersection Delay (sec/veh)					6.5

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	45	822	151	0	974	140	352	304	509			
Delay Time/Veh. (s)	50.0	15.7	0.1	0	22.6	5.6	21.4	46.0	14.7			
Max Queue (ft)	146	288	122	0	375	0	506	505	510			
Avg. Queue (ft)	13	40	0	0	64	0	94	100	101			
							Intersection Delay (sec/veh)					20.3

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	0	1048	20	51	772	0				556	0	598
Delay Time/Veh. (s)	0	15.3	1.0	46.0	11.3	0				33.7	0.0	14.6
Max Queue (ft)	0	528	0	137	378	0				436	0	450
Avg. Queue (ft)	0	71	0	15	35	0				93	0	96
							Intersection Delay (sec/veh)					17.9

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	0	1250	350	0	758	882	69	0	146			
Delay Time/Veh. (s)	0	3.7	2.0	0	5.0	3.9	35.1	0	9.0			
Max Queue (ft)	0	428	294	0	231	51	153	0	161			
Avg. Queue (ft)	0	17	26	0	6	1	15	0	9			
							Intersection Delay (sec/veh)					4.7

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	0	217	8	13	83	0				76	0	28
Delay Time/Veh. (s)	0	3.6	2.2	4.1	2.9	0				33.2	0	1.1
Max Queue (ft)	0	149	0	98	98	0				172	0	73
Avg. Queue (ft)	0	4	0	1	1	0				17	0	0
							Intersection Delay (sec/veh)					8.6

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	159	135	0	0	71	288	25	0	17			
Delay Time/Veh. (s)	2.5	3.5	0	0	2.4	3.6	28.8	0	1.0			
Max Queue (ft)	197	197	0	0	83	152	110	0	28			
Avg. Queue (ft)	4	4	0	0	1	2	4	0	0			
							Intersection Delay (sec/veh)					4.1

Appendix D: 2008 PM Simulation Output (Network Performance, Travel Time, Freeway Queues)

2008 PM Peak - Network MOE, Queue Length, Travel Time

Network Performance

Total Delay Time (hr)	535
Total Travel Time (hr)	4,223
Number of Active Vehicles	0
Number of Arrived Vehicles	52,959
Total Stopped Delay (hr)	190
Total Distance Traveled (mi)	193,612

Queue Measurement

Time	Tri-Level Merge			I-94 WB (45th St)		
	Avg.	Max.	Stop	Avg.	Max.	Stop
PM Peak	184	2,027	454	19	439	49

Travel Time (Network)

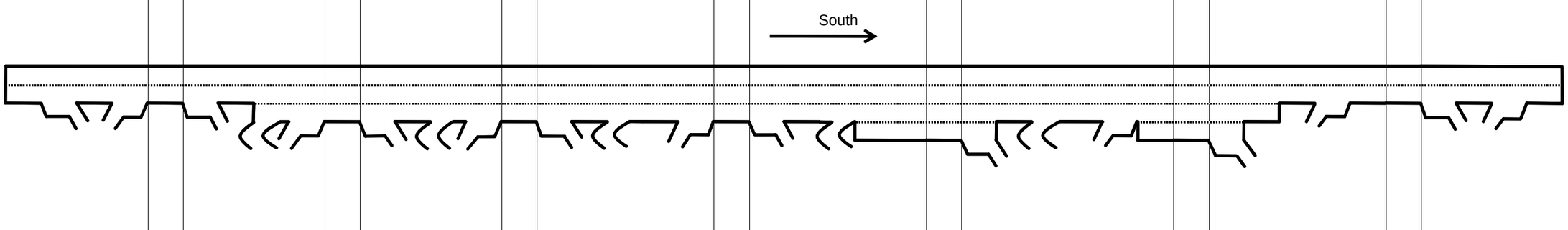
Origin		Destination					
		I-29 SB		I-94 EB		I-29 NB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-94 EB	1630-1645	13.0	3	14.8	10	15.5	2
	1645-1700	13.1	3	14.8	10	14.1	1
	1700-1715	13.0	3	14.9	11	14.9	2
	1715-1730	13.0	3	14.8	10	15.6	2
		I-29 SB		I-94 WB		I-29 NB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-94 WB	1630-1645	16.4	3	14.4	7	17.0	10
	1645-1700	16.4	3	14.3	7	17.0	10
	1700-1715	16.5	3	14.4	8	17.1	11
	1715-1730	16.5	4	14.3	8	17.1	11
		I-94 WB		I-29 NB		I-94 EB	
	Time	TT (sec)	Vol	TT (sec)	Vol	TT (sec)	Vol
I-29 NB	1630-1645	13.7	3	15.8	17	15.9	4
	1645-1700	13.7	3	15.8	17	15.9	4
	1700-1715	13.8	3	15.7	19	16.1	4
	1715-1730	13.9	3	15.7	19	16.1	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	14.8	2	16.5	6	17.9	5
	1645-1700	14.2	2	16.4	5	18.0	5
	1700-1715	14.7	2	16.5	6	18.3	6
	1715-1730	14.9	2	16.5	6	18.4	6

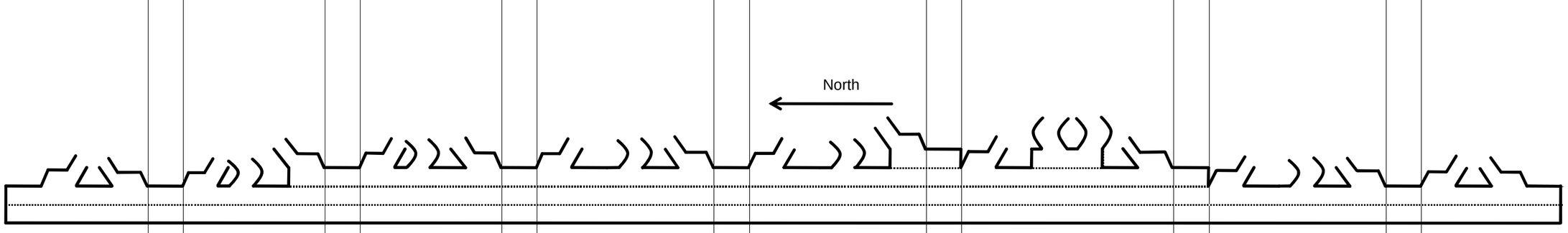
Appendix E: 2008 PM Simulation Output (Data Collection Points)

I-29 Data Collection: 2008 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	550	230	3200		3607	640	1300	640	1150	285	2325	285	950	1395	625	7200	770	1645	510	1900
Modeled Vol. (vph)					784					1352					2457						3406												2061					1047				
Simulated Vol. (vph)					785					1358					2462						3411						3610						2060					1039				
Volume % Difference					0%					0%					0%						0%						0%						0%					-1%				
Speed (mph)					74.6					57					57.2						50.2						57.3						58.4					58.3				
# of Lanes					2					3					3						3						4						4					2				
Density (pc/mi/ln)					6					9					17						27						19						10					10				
Level of Service					A					A					B						C						B						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	665	1855	830	921	765	580	2190	525	745	570	655	760	1930	685	755	665	1310	380	1460	260	910	505	485	1260	990	1240	255	1145	305	860	720	7100	760	1635	800	1675
Modeled Vol. (vph)					1153					1641					2047						2159						2786							1922						944				
Simulated Vol. (vph)					1168					1653					2060						2174						2789							1917						933				
Volume % Difference					1%					1%					1%						1%						0%							0%						-1%				
Speed (mph)					74.4					58.6					58.4						58.5						58.9							58.7						59.2				
# of Lanes					2					3					3						3						4							3						2				
Density (pc/mi/ln)					9					11					14						15						14							13						9				
Level of Service					A					B					B						B						B							B						A				

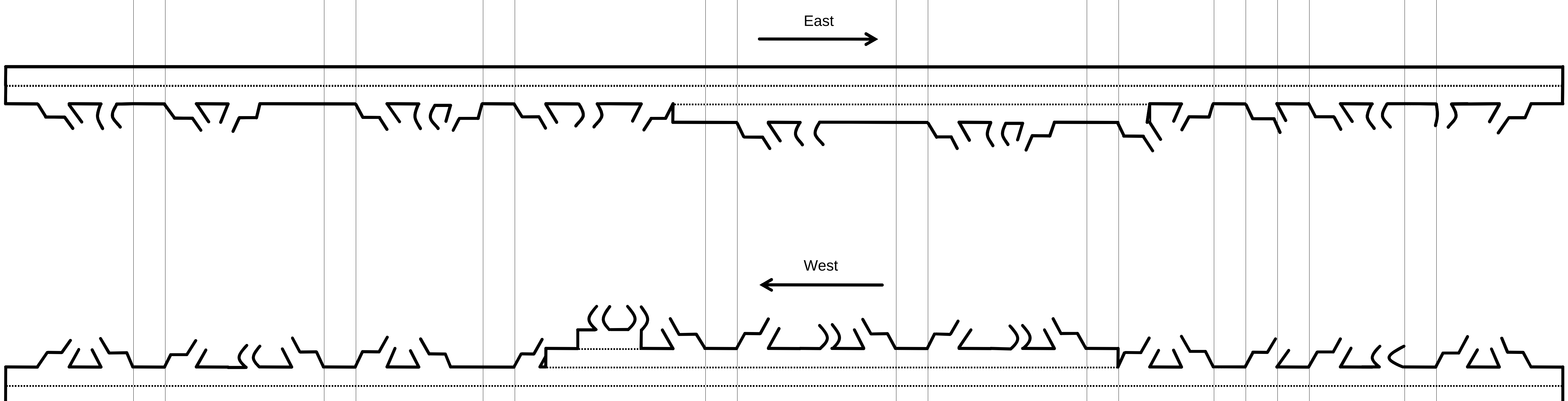
Note: Density values were adjusted using the following data:
Peak-hour factor = .87
Heavy vehicle percent = 5
This data increased the original density by 15%.

I-94 Data Collection: 2008 PM Peak Hour

Eastbound

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

Distance (ft.)	2660	575	1005	1440	11770	755	2050	1040	7520	705	930	1450	615	1570	760	465	1345	1365	405	1010	795	930	990	2610	960	740	1050	1125	4225	520	2005	840	1740	455	5645	285	1035	615	16635	710	1365	1080	2170
Modeled Vol. (vph)					589				1000					2411						3860				3609					3795				2300		1847				1161				
Simulated Vol. (vph)					591				1008					2414						3871				3609					3803				2321		1878				1168				
Volume % Difference					0%				1%					0%						0%				0%					0%				1%		2%				1%				
Speed (mph)					74.9				74.4					57.9						57.4				58.2					57				57.1		59				70				
# of Lanes					2				2					2						3				3					3				2		2				2				
Density (pc/mi/ln)					5				8					25						26				24					26				24		19				10				
Level of Service					A				A					C						C				C					C				C		B				A				

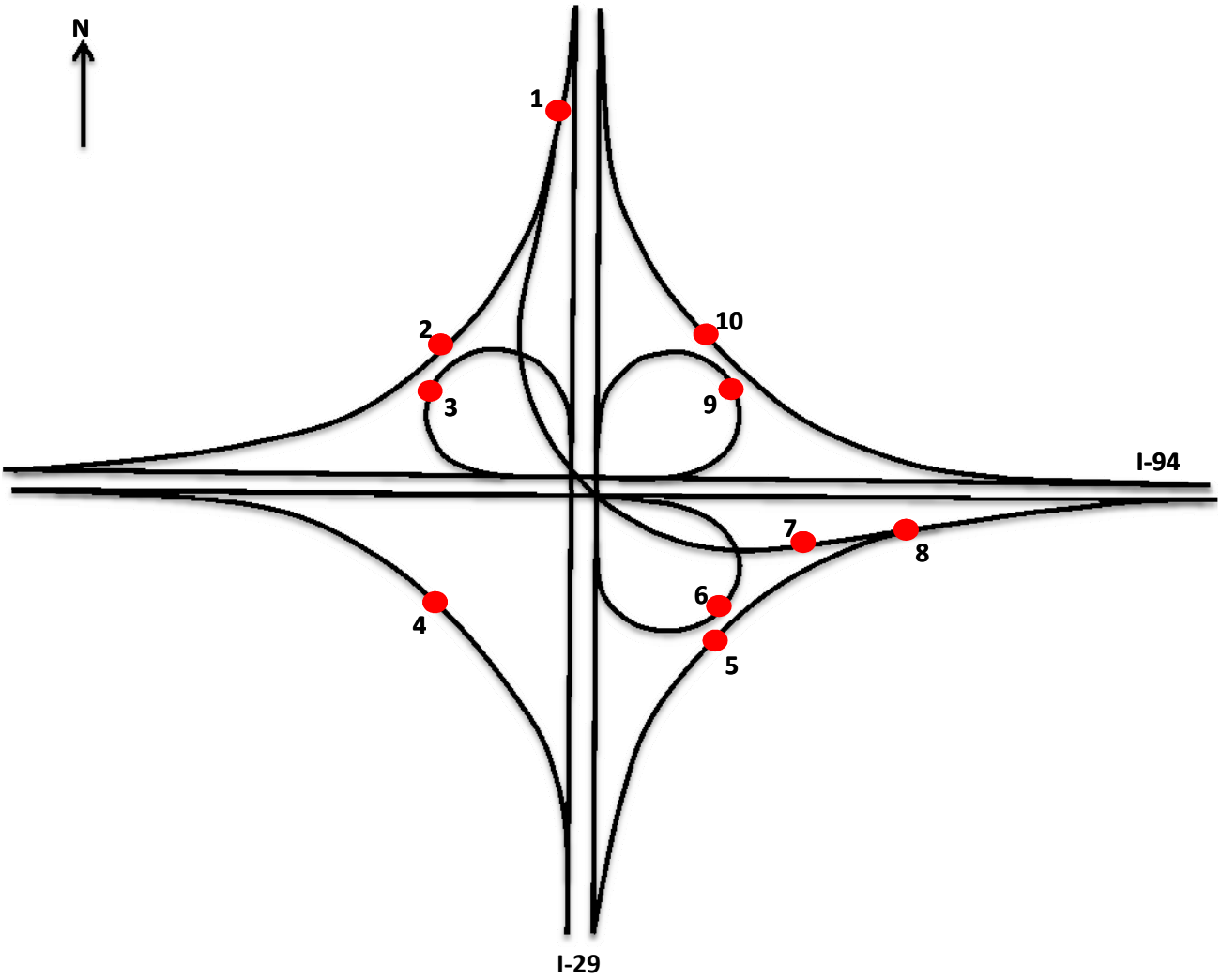


Westbound

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

Distance (ft.)	2815	1215	2850	390	9790	1035	835	870	260	785	8105	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	4835	810	700	630	15430	965	2195	465	3270
Modeled Vol. (vph)					313						1216				2380							3147						3157						3028				1876		1458				802				
Simulated Vol. (vph)					313						1224				2399							3165						3177						3049				1908		1484				803				
Volume % Difference					0%						1%				1%							1%						1%						1%				2%		2%				0%				
Speed (mph)					75.1						74.1				55.2							57.6						58.4						58.3				57.9		59				69.9				
# of Lanes					2						2				2							3						3						3				2		2				2				
Density (pc/mi/ln)					2						10				26							22						21						20				19		15				7				
Level of Service					A						A				C							C						C						C				B		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%.



2008 PM: Data Collection Points (I-29/I-94 Interchange)

	1	2	3	4	5	6	7	8	9	10
Modeled Vol. (vph)	2139	604	390	203	471	354	1542	2013	154	1135
Simulated Vol. (vph)	2147	607	392	202	472	357	1541	2014	156	1143
Volume % Difference	0%	1%	1%	0%	0%	1%	0%	0%	1%	1%
Speed (mph)	56	54	25	55	54	25	50	47	25	53
# of Lanes	2	1	1	1	1	1	1	1	1	1
Density (pc/mi/ln)	23	13	19	4	10	17	36	51	7	25

This data increased the original density by 15%.

Appendix F: 2008 PM Simulation Output (Node Evaluations)

2008 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			473		0	526	27	389	0	0	830	59
Delay Time/Veh. (s)			19.4		0	7.2	5.5	0.4	0	0	1.7	1.0
Max Queue (ft)			563		0	483	0	0	0	0	0	0
Avg. Queue (ft)			106		0	42	0	0	0	0	0	0
									Intersection Delay (sec/veh)			6.4

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	20	0	57				0	396	220	271	1032	0
Delay Time/Veh. (s)	23.2	0	14.4				0.0	1.2	1.3	4.8	0.4	0
Max Queue (ft)	91	0	91				0	0	0	227	75	0
Avg. Queue (ft)	0	0	0				0	0	0	10	0	0
									Intersection Delay (sec/veh)			1.9

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				472	0	1055	92	1079	0	0	2046	247
Delay Time/Veh. (s)				50.3	0	15.6	40.1	20.0	0	0	84.1	123.2
Max Queue (ft)				1663	0	1839	190	474	0	0	3472	3476
Avg. Queue (ft)				172	0	155	24	77	0	0	2920	2604
									Intersection Delay (sec/veh)			53.7

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	145	0	64				0	1035	426	0	1337	1193
Delay Time/Veh. (s)	46.5	0	5.7				0	4.4	6.0	0	11.7	8.1
Max Queue (ft)	243	0	109				0	327	327	0	630	1115
Avg. Queue (ft)	46	0	1				0	25	25	0	49	204
									Intersection Delay (sec/veh)			9.4

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				263	0	226	0	948	330	0	1413	144
Delay Time/Veh. (s)				47.6	0.0	8.3	0.0	9.5	1.8	0	14.3	13.9
Max Queue (ft)				389	389	170	0	345	114	0	773	773
Avg. Queue (ft)				85	85	11	0	36	0	0	111	111
									Intersection Delay (sec/veh)			13.9

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	144	276	351	57	50	331	183	808	45	341	1052	288
Delay Time/Veh. (s)	49.1	55.2	26.0	46.6	43.6	11.2	27.1	21.7	19.6	23.7	14.7	4.0
Max Queue (ft)	965	965	807	200	200	262	495	526	0	379	613	377
Avg. Queue (ft)	200	200	63	27	27	23	37	87	0	54	64	8
									Intersection Delay (sec/veh)			22.4

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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				353	0	186	0	1098	283	0	1639	379
Delay Time/Veh. (s)				44.7	0	6.8	0	2.8	0.8	0	5.6	2.9
Max Queue (ft)				268	0	175	0	189	166	0	498	1351
Avg. Queue (ft)				64	0	17	0	10	0	0	40	200
									Intersection Delay (sec/veh)			7.7

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	344	0	327				0	1041	541	0	1673	313
Delay Time/Veh. (s)	41.5	0	11.2				0	7.9	0.9	0	9.7	0.7
Max Queue (ft)	467	0	242				0	294	0	0	480	290
Avg. Queue (ft)	103	0	29				0	28	0	0	56	18
									Intersection Delay (sec/veh)			10.2

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				127	0	96	449	1443	0	0	904	910
Delay Time/Veh. (s)				30.6	0	10.3	25.9	6.0	0	0	24.0	15.4
Max Queue (ft)				203	0	126	666	616	0	0	1063	1351
Avg. Queue (ft)				25	0	3	104	35	0	0	126	200
									Intersection Delay (sec/veh)			15.5

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	935	0	799				0	954	114	136	895	0
Delay Time/Veh. (s)	24.7	0	47.9				0	25.3	4.2	23.8	12.0	0
Max Queue (ft)	548	0	2387				0	532	129	209	409	0
Avg. Queue (ft)	90	0	0				0	115	3	16	43	0
									Intersection Delay (sec/veh)			26.1

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				7	7	13	106	600	20	12	318	310
Delay Time/Veh. (s)				7.3	9.8	8.7	2.3	0.7	0.5	4.7	1.1	1.8
Max Queue (ft)				0	0	0	306	306	306	0	0	0
Avg. Queue (ft)				0	0	0	21	21	21	0	0	0
									Intersection Delay (sec/veh)			1.3

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	312	0	132				0	413	0	0	326	0
Delay Time/Veh. (s)	12.8	0	5.7				0	10.0	0	0	11.8	0
Max Queue (ft)	273	0	133				0	329	0	0	306	0
Avg. Queue (ft)	28	0	3				0	32	0	0	29	0
									Intersection Delay (sec/veh)			10.7

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Node Location: I-94 & Main Ave (N. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	37	13	17	175	325	26	179	313	595	33	321	241
Delay Time/Veh. (s)	36.6	40.5	10.4	28.5	36.4	7.1	46.9	25.0	17.9	48.1	23.5	8.7
Max Queue (ft)	121	113	0	243	385	385	661	932	434	110	326	0
Avg. Queue (ft)	8	3	0	30	80	80	66	116	10	9	47	0
							Intersection Delay (sec/veh)					25.1

Node Location: I-94 & Main Ave (S. Side)

	EB Approach			WB Approach			NB Approach			SB Approach		
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume	658	0	165				0	429	0	0	400	112
Delay Time/Veh. (s)	25.3	0	13.0				0	20.8	0	0	23.7	14.6
Max Queue (ft)	981	0	174				0	434	0	0	535	229
Avg. Queue (ft)	154	0	6				0	54	0	0	83	2
							Intersection Delay (sec/veh)					22.0

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				1	0	13	25	532	0	0	78	283
Delay Time/Veh. (s)				5.2	0	7.1	0.6	0.2	0	0	0.7	1.5
Max Queue (ft)				0	0	78	0	0	0	0	0	0
Avg. Queue (ft)				0	0	1	0	0	0	0	0	0
							Intersection Delay (sec/veh)					0.8

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				17	0	506	0	51	2	68	11	0
Delay Time/Veh. (s)				8.1	0.0	1.3	0	0.0	0.4	0.6	0.1	0
Max Queue (ft)				60	0	60	0	0	0	0	0	0
Avg. Queue (ft)				0	0	0	0	0	0	0	0	0
							Intersection Delay (sec/veh)					1.3

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	0	165	37	4	50	0				79	0	187
Delay Time/Veh. (s)	0	0.3	0.7	0.7	0.5	0				8.3	0	8.0
Max Queue (ft)	0	0	0	12	12	0				161	0	161
Avg. Queue (ft)	0	0	0	0	0	0				3	0	3
							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	127	117	0	0	33	17	21	0	12			
Delay Time/Veh. (s)	0.7	1.1	0	0	0.1	1.2	7.5	0	6.1			
Max Queue (ft)	32	32	0	0	0	0	62	0	62			
Avg. Queue (ft)	0	0	0	0	0	0	0	0	0			
							Intersection Delay (sec/veh)					1.5

2008 PM Peak - Ramp Terminal Data

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	0	322	33	0	243	615				56	0	24
Delay Time/Veh. (s)	0	2.5	1.9	0	3.2	3.0				9.0	0	1.5
Max Queue (ft)	0	143	0	0	140	292				116	0	0
Avg. Queue (ft)	0	4	0	0	3	1				3	0	0
							Intersection Delay (sec/veh)					3.1

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	0	325	54	0	843	77	15	0	606			
Delay Time/Veh. (s)	0	6.5	0.3	0	7.6	1.0	22.7	0	7.5			
Max Queue (ft)	0	151	158	0	319	0	95	0	196			
Avg. Queue (ft)	0	8	2	0	34	0	2	0	27			
							Intersection Delay (sec/veh)					7.0

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	0	490	642	0	396	564				58	0	45
Delay Time/Veh. (s)	0	2.1	2.2	0	1.9	1.5				30.4	0	1.5
Max Queue (ft)	0	145	0	0	144	120				138	0	106
Avg. Queue (ft)	0	3	0	0	3	0				11	0	1
							Intersection Delay (sec/veh)					2.7

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	0	445	103	0	791	149	169	0	494			
Delay Time/Veh. (s)	0	3.5	0.2	0	5.0	1.0	31.3	0.0	8.1			
Max Queue (ft)	0	150	112	0	276	4	167	0	184			
Avg. Queue (ft)	0	5	0	0	18	0	26	0	22			
							Intersection Delay (sec/veh)					7.0

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	0	1114	415	0	1358	788				88	0	169
Delay Time/Veh. (s)	0	3.4	5.0	0	3.0	3.3				41.3	0	7.2
Max Queue (ft)	0	254	254	0	214	289				148	0	132
Avg. Queue (ft)	0	17	17	0	11	1				19	0	7
							Intersection Delay (sec/veh)					4.4

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	0	1001	208	0	1925	127	220	0	227			
Delay Time/Veh. (s)	0	2.8	0.5	0	4.5	6.3	43.4	0	7.0			
Max Queue (ft)	0	217	196	0	407	407	204	0	185			
Avg. Queue (ft)	0	8	1	0	34	34	41	0	12			
							Intersection Delay (sec/veh)					6.3

2008 PM Peak - Ramp Terminal Data

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				865	0	137	0	217	526	446	194	0
Delay Time/Veh. (s)				15.1	0	5.9	0	7.7	7.7	18.5	7.4	0
Max Queue (ft)				273	0	202	0	190	250	348	348	0
Avg. Queue (ft)				52	0	10	0	8	2	55	55	0
									Intersection Delay (sec/veh)			12.3

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	51	1209	268	0	1521	255	371	177	240			
Delay Time/Veh. (s)	55.2	8.6	0.3	0	16.0	5.9	37.8	52.7	8.0			
Max Queue (ft)	151	332	218	0	524	0	297	296	300			
Avg. Queue (ft)	17	33	1	0	79	0	71	65	50			
									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	0	1148	49	98	750	0				801	0	375
Delay Time/Veh. (s)	0	17.8	1.3	47.7	9.1	0				36.7	0	8.4
Max Queue (ft)	0	540	0	202	286	0				470	0	481
Avg. Queue (ft)	0	92	0	30	27	0				121	0	83
									Intersection Delay (sec/veh)			20.0

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	0	1660	282	0	803	820	48	0	75			
Delay Time/Veh. (s)	0	2.4	1.5	0	2.3	2.4	36.6	0	9.4			
Max Queue (ft)	0	344	295	0	184	0	133	0	121			
Avg. Queue (ft)	0	10	41	0	4	0	11	0	4			
									Intersection Delay (sec/veh)			2.9

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	0	95	22	6	70	0				221	0	110
Delay Time/Veh. (s)	0	5.1	2.2	4.1	4.3	0				37.1	0	2.1
Max Queue (ft)	0	123	0	103	103	0				323	0	112
Avg. Queue (ft)	0	2	0	1	1	0				59	0	1
									Intersection Delay (sec/veh)			17.7

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	84	232	0	0	60	129	16	0	29			
Delay Time/Veh. (s)	2.2	4.3	0	0	2.1	2.4	27.0	0	1.4			
Max Queue (ft)	283	283	0	0	88	106	84	0	47			
Avg. Queue (ft)	6	6	0	0	1	1	3	0	0			
									Intersection Delay (sec/veh)			3.8