TO: Honorable Mayor and City Council

FROM: City Administrator Ron Johnson

SUBJECT: TH 52 Access Safety Study

DATE: January 30, 2015

BACKGROUND

MnDOT and the city of Cannon Falls commissioned the services of Short Elliott Hendrickson (SEH) to conduct a TH52 Access Safety Study.

Upon completion of the study report and after review with SEH, MnDOT staff and city staff on January 7, the city received a response letter regarding the report from MnDOT on January 27. The report and MnDOT letter are included with this memo.

Tom Sohrweide, SEH project engineer, will be present to provide the results of the study, and MnDOT will also have representatives present.

REQUESTED COUNCIL ACTION

No action being requested.

Attachment(s): SEH report; MnDOT letter

Minnesota Department of Transportation
District 6 Rochester
2900 48th St NW
Rochester, MN 55901

507-286-7501
jeff.vlaminck@state.mn.us

January 27, 2015

Ron Johnson
Cannon Falls City Administrator
Cannon Falls City Hall
918 River Road
Cannon Falls, MN 55009

Dear Mr. Johnson:

Thank you for the opportunity to meet with you and your staff to review and discuss the Cannon Falls Access Safety Study prepared by SEH. We had a good discussion at the meeting and I'm writing as follow up to your question regarding potential next steps for the City if they decide to pursue a project to add access to Highway 52.

As you probably know, opening new access on a newly created freeway segment is not a normal or frequent practice, so there isn't a standard process. The next steps are fairly general and will be dependent on decisions by the City and guidance from the Federal Highway Administration (FHWA). Following are some of the questions and potential steps that would need to be addressed.

First, as stated at the November 2013 council meeting, MnDOT does not support a new at grade access at Cannon Falls and the results of the study do not change that position. As we discussed at the meeting, it is the City's choice whether to pursue a project. The City would be responsible for developing and leading the proposed project and would be at 100 percent City cost. These project costs include development, planning, construction, right of way, utility, engineering and any other costs associated with the project. This is standard for any community in this type of circumstance.

The interchange project's purpose and need was based on the 2002 Highway 52 Corridor Study vision for a freeway corridor, between Rochester and the Twin Cities. Opening access on a new freeway segment is not consistent with this vision, so the Corridor Study should be updated to ensure future projects are developed in alignment with any new vision. This corridor study update should include all corridor stakeholders and be jointly funded by the state and the local government agencies along the corridor.

The interchange project was developed through the Federal Environmental Assessment process and includes future plans for a highway overpass in the same proximity of the proposed new access. Developing an access point in this location would be in conflict with developing a future overpass. One of the first questions that need to be addressed is, would the City plan on dropping plans for a future overpass if access was added in this location? The answer will affect the design and development of a potential future project.

Once the City identifies the proposed scope of the project, we would suggest meeting with the City and FHWA to discuss the proposed project and determine the appropriate environmental and public involvement process. FHWA must be involved in this discussion because of their oversight role on National Highway System routes like Highway 52 and the fact that the interchange project received federal funding and required use of the federal environmental process. The Stewardship Agreement executed between FHWA and MnDOT guides and directs this relationship.

Once a project is developed through the public involvement and environmental development process, the City would need to obtain a permit from MnDOT to construct the project. Since the current vision for Highway 52 is for a freeway corridor, new at grade accesses are considered temporary access, so time limits or other provisions and requirements could be included in the permit. MnDOT's top priority is to ensure a safe highway system and has the statutory obligation and authority to close the access immediately if safety issues develop. I'm sorry I'm unable to give a definitive timeline on how long it might take for this to unfold. It's uncertain how long these processes would take because much depends on whether the City seeks new access and the type of access.

This generally is the process depending on what the council decides. As part of your deliberations and discussions, here are some points to consider with the safety study and if additional access is pursued:

1) The safety study anticipates an average of 1.4 crashes per year (a 25 percent increase) at the temporary right-in/right-out location and would not occur if the access were not constructed. These crashes could involve vehicles traveling at relatively high speeds so the potential for injury and death are high. The projected crash rate is based on average rates from other similar locations; however, all locations are unique. Driver behavior is unpredictable; if a right-in/right-out is built here, the actual experienced crash rate may very well be higher than the 1.4 per year average. We remain seriously concerned for the safety of the citizens and visitors to Cannon Falls, as well as the through traffic on Highway 52, if a right-in/right-out is constructed.

2) The interchange was constructed as part of a conversion to a freeway type roadway. This is consistent with past corridor studies and agreements, which have concluded the vision for this corridor is a fully access controlled facility from Rochester to St. Paul. Other county and city governments have agreed with and cooperated to advance this freeway vision. If a right-in/right-out access is constructed here, it would conflict with the freeway vision.

3) The development of this interchange location and design was the culmination of years of studies and planning. Numerous location alternates were explored and the design specifics of the interchange were fully evaluated. Government and public input was regularly obtained, numerous public meetings were held and the City granted Municipal Consent for interchange construction. A right-in/right-out access was never considered or evaluated because it is inconsistent with the freeway vision.

4) Following the National Environmental Policy Act (NEPA) rules, an Environmental Assessment (EA), with subsequent Finding of No Significant Impact (FONSI) by the Federal Highway Administration (FHWA), was completed. This assessment studied and considered the various expected effects of the interchange project. The project was approved for final design and construction based on the EA. Construction of a right-in/right-out access was not considered within the EA and was not included as a basis for the FHWA FONSI. It's likely the EA will have to be amended, and a new FONSI may be necessary, if a right-in/right-out is proposed here.

5) This corridor has utilized federal funding for construction, and because the corridor is designated as a future freeway, we fully expect that the FHWA will not look favorably upon a proposed right-in/right-out here. We have heard from them informally and they've expressed concern; their views and input would have bearing on the eventual outcome.

6) If a right-in/right-out is allowed and constructed, this would eliminate or substantially affect the potential for a future overpass. One of the concerns expressed by City staff and by the concerned public is regarding the overpass that was not constructed with this interchange project. Even though this project, as presented for funding, did not include the overpass and the EA did include the overpass, the right-in/right-out would need to be removed if an overpass is constructed.

Also, a large number of signs were added to accommodate implementation of the Logo Sign Program here. The program, and its associated signs, is intended to inform motorists of specific gas, food, or lodging establishments available at the interchange. If a right-in/right-out is constructed, it is likely that a significant change in signs will be necessary. The Logo signs in place, which direct traffic to, and through, the interchange would likely not be appropriate and would be removed. Also, allowance of an at grade access within this access controlled segment, would jeopardize the critical justification for use of the Logo program at this interchange. The incorporation of Logo signs for this interchange was the first use of them on a roadway of this type in the state of Minnesota.

MnDOT cares about the city of Cannon Falls and its citizens, including its economic vitality and quality of life. I hope that this helps provide some information on issues that would need to be addressed in the next steps for developing a project. Defining an absolute process is difficult because there are project questions, as outlined above, that must be answered, which will influence the direction it will take. Again, thank you for our productive meeting. We will continue to work with you, the city of Cannon Falls and other stakeholders to resolve local questions and concerns.

Sincerely,

Jeffrey L. Vlaminck, PE
Transportation District Engineer
MnDOT District 6

SEH

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MEMORANDUM

TO: Mike Schweyen, PE, MnDOT District 6
Ron Johnson, City of Cannon Falls

FROM: Thomas A. Sohrweide, PE, PTOE

DATE: December 17, 2014

RE: TH 52 Access Safety Study
MnDOT Contract No. 05952
SEH No. MNT06 128314 Task 7.0

As a result of the construction of a new interchange on TH 52 in the City of Cannon Falls, the signalized at-grade intersection of TH 52/315th Street was removed. The City has requested that right-in/right-out access be allowed for 315th Street at TH 52. The City and MnDOT have agreed to jointly contribute to a study to evaluate the safety implications of this access.

The scope of this study included, the development of traffic forecasts, safety analysis, concept development, and traffic operational analysis. The detail of those components of the study are attached as individual memorandums. This memorandum serves as a summary of the findings.

Traffic Forecasts

AM and PM Peak Hour traffic volumes were developed and forecast to year 2015 and 2030 for the interchange area with and without right-in/right-out access at TH 52/315th Street. The basis for these traffic forecasts were the Traffic Forecasting (2007) and Traffic Operations Analysis (2008) memorandums completed for the interchange project.

Safety Analysis

Research by MnDOT found that for right-in/right-out intersections, crashes will increase as traffic volumes increase and crashes will increase as the ratio of the main roadway traffic volume to the side street traffic volume becomes more unbalanced.

Since vehicle crashes are generally quantified in rates, which generally indicates there will be more crashes with higher traffic volumes; and the traffic volumes will change at the area intersections with and without a right-in/right-out at 315th Street; in addition to the right-in/right-out, our analysis included the new roundabout ramp intersections and the intersection of 315th Street/65th Avenue. Specifically for the right-in/right-out, our analysis used a direct comparison of crashes at two existing right-in/right-out intersections in proximity to an interchange.

We have estimated that with 2015 estimated traffic volumes, the intersections described above will have 4.09 crashes per year without the right-in/right-out and 5.12 crashes per year with the right-in/right-out. The increase is comprised of 3.70 crashes per year at the three study intersections (reduced due to rerouting traffic) and 1.42 crashes per year at the right-in/right-out.

Concepts
Four concepts were developed that are capable of going to final design. The concepts include standard turn lanes, auxiliary lanes, and acceleration lanes. Each concept is shown as a complete right-in/right-out for both northbound and southbound. However, a right-in or a right-out could be considered separately for northbound or southbound with just that portion of the concept being used.

Traffic Operational Analysis
The 2030 AM and PM Peak Hour traffic forecasts were used to analyze the operation of vehicles entering and exiting TH 52 from the right-in/right-out and intermixing with the vehicles entering and exiting the interchange. This operational analysis reports reasonable peak hour traffic operating conditions.

Findings

1. Safety – It is estimated that a right-in/right-out will average 1.42 vehicle crashes per year.
2. Design – A right-in/right-out design is feasible that will meet trunk highway design standards.
3. Traffic Operations – A right-in/right-out is estimated to provide reasonable traffic operating conditions.

This study has been based on the best forecasts and estimates with the data available at this point in time. As development and access changes occur, the traffic flows may change from what has been forecast. Therefore, if a right-in/right-out access is constructed, consideration should be given to revisit the future safety and traffic operations of this access.

ts
Attachments
c: Dave Maroney, City of Cannon Falls
Greg Anderson, SEH

SEH

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MEMORANDUM

TO: Mike Schweyen, PE, MnDOT District 6
Ron Johnson, City of Cannon Falls

FROM: Thomas A. Sohrweide, PE, PTOE
Haifeng Xiao, PE

DATE: July 31, 2014

RE: US 52 Traffic Forecasts
MnDOT Contract No. 05952
SEH No. MNT06 128314 Task 3.0

INTRODUCTION

In the US 52 Cannon Falls Project completed in 2009 (the 2009 Project), a number of improvement alternatives were studied for the US 52 corridor and its adjacent and crossing roadways in the City of Cannon Falls. A travel demand model was developed to conduct traffic forecasts for different alternatives. Year 2030 daily and peak hour traffic forecasts were developed for the no-build and several build alternatives and they were documented in two memorandums: *Technical Memorandum Five – Traffic Forecasting,* dated June 2007 and *Technical Memorandum Six – Traffic Operations Analysis,* dated April 2008. The review of the documents indicates that the model had incorporated the latest land use plan for the city, including the relocation of the Hospital.

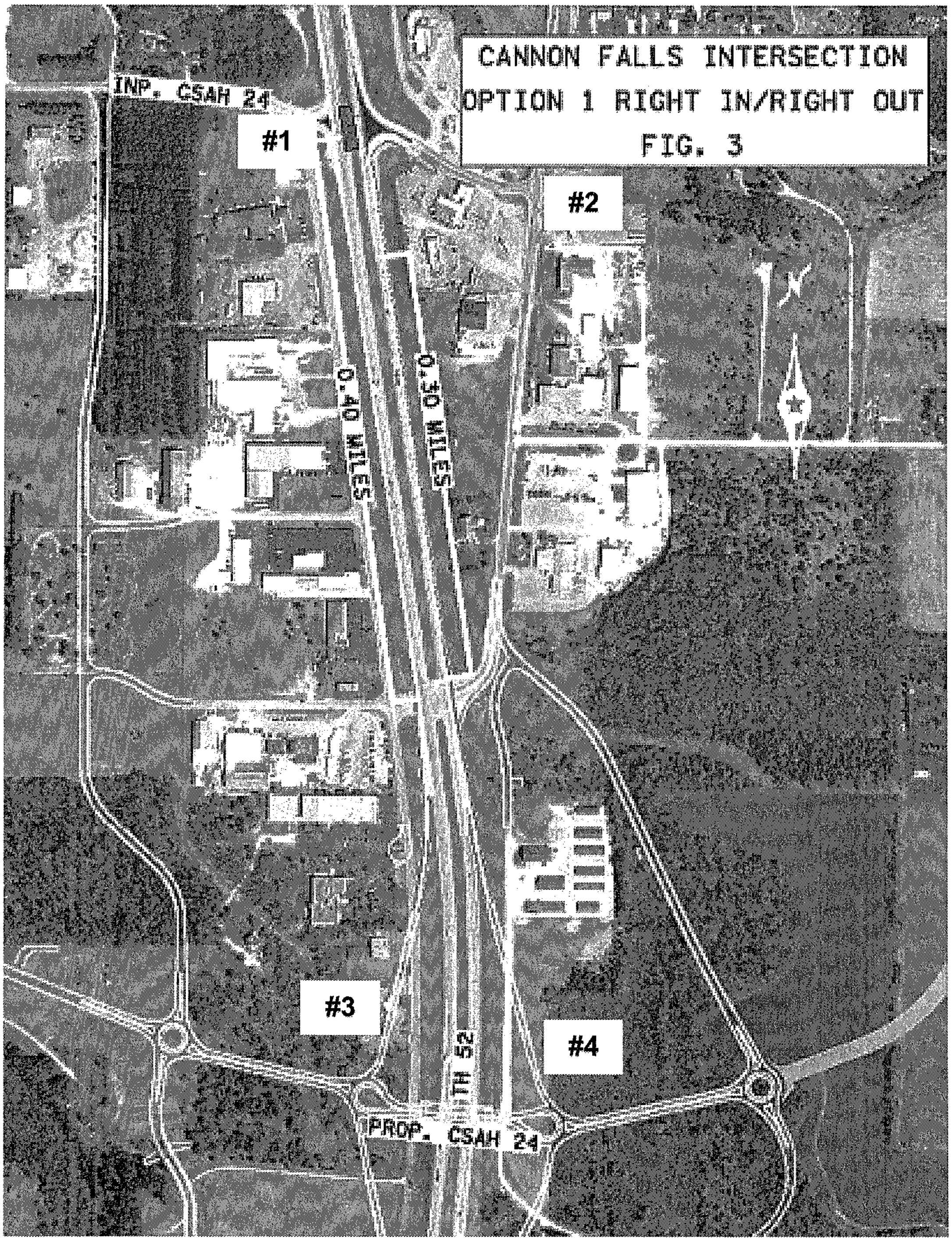
The Alternative 2 in the 2009 Project proposed the construction of a full access US 52 interchange near 324th Street with closure of all the local at-grade street accesses between the new interchange and the existing TH 19 interchange (Main Street) with two variations: with and without an overpass bridge at the existing CSAH 24/US 52 intersection. It is noted that year 2030 daily traffic forecasts were developed for both scenarios with and without the overpass while 2030 peak hour traffic forecasts for major intersections were available only for the scenario with the overpass.

In early 2014, several variations to the previous Alternative 2 in the 2009 Project were studied the Alternative with Right in/Right Out Access (shown in Figure 1) was selected for further operations and safety analysis. The alternative proposes constructing auxiliary lanes on US 52 to provide right in and right out access at the existing CSAH 24/US 52 intersection without an overpass. The US 52 Safety Study addresses the operations and safety concerns on the US 52 and four following major intersections (shown in **Figure 1**) due to the access change.

- #1: US 52/CSAH 24 Right In/Out Intersection
- #2: Old CSAH 24/65th Avenue Intersection
- #3: New CSAH 24/US 52 Interchange West Ramp
- #4: New CSAH 24/US 52 Interchange East Ramp

This memorandum documents the traffic forecast methodology and the results for the Right In/Out Alternative. The forecasts will be used for operations and safety analysis.

Figure 1
Right In/Right Out Alternative and Study Intersections



YEAR 2015 TRAFFIC FORECASTS

The year 2015 daily and peak hour traffic forecasts were developed based on the following steps.

1. The daily traffic forecasts for major roadway segments under 2015 No Build conditions were developed based on the historical trend analysis. (as shown in **Table 1**)
2. The daily growth factors were applied to 2006 peak hour turning movements from the 2009 Project to develop peak hour turning movement forecasts under 2015 No Build conditions
3. The 2015 traffic forecast under the No Build conditions were manually rerouted to develop the base 2015 build traffic forecasts to reflect the accessibility changes in the study area.
4. The new trips generated from the hospital were obtained from the traffic model for the 2009 Project and they were distributed to the four study intersections under build conditions to develop the final build forecasts. **Table 2** summarizes the hospital new trips and distributions via the study intersections. The assumptions on the directional distributions of the new trips using the four study intersections are as following:
    - The new trips going TH 52 North use the Right in/out while new trips from TH 52 North use the new interchange
    - The new trips from/to TH 52 South and West of TH 52 use the new interchange
    - The new trips from/to CSAH 24 North use the study intersection #2.

Table 1
Historical Daily Traffic Trend Analysis Summary

Segment	Historical ADT								2015 Forecast*	Total Growth 2007-2015
	2000	2002	2003	2004	2006	2007	2009	2011		
CSAH 24 North of 315th Street			6,700			6,300		6,000	6,100	
CSAH 24 South of 315th Street			4,300			4,350		4,400	4,600	6%
CSAH 24 East of TH 52			4,450			4,700		4,950	5,700	21%
CSAH 24 West of TH 52			1,650			1,650		1,950	1,900	15%
TH 52	18,400	18,900		17,800	17,900		18,800	18,400	19,600	9%

* Based on Historical Trend Analysis

Table 2
Hospital New Trips Generation and Distributions via Study Intersections

Daily Trips*		4,322		Distribution via study intersections				
				TH 52 north	TH 52 south	West of TH 52	CSAH 24 north	Other**
AM	% of daily	8%		30%	15%	10%	20%	25%
	In	69%	225	68	34	23	45	55
	Out	31%	101	30	15	10	20	26
PM	% of daily	9%		30%	15%	10%	20%	25%
	In	33%	108	32	16	11	22	27
	Out	67%	219	66	33	22	44	54

* The daily trips for the new Hospital is obtained from the traffic model (TAZ 28) for the 2009 Project.

** New trips don't use any of the study intersections

The 2015 daily and peak hour traffic forecasts for the Right In/Right Out Alternative are illustrated in the **Figure 2**.

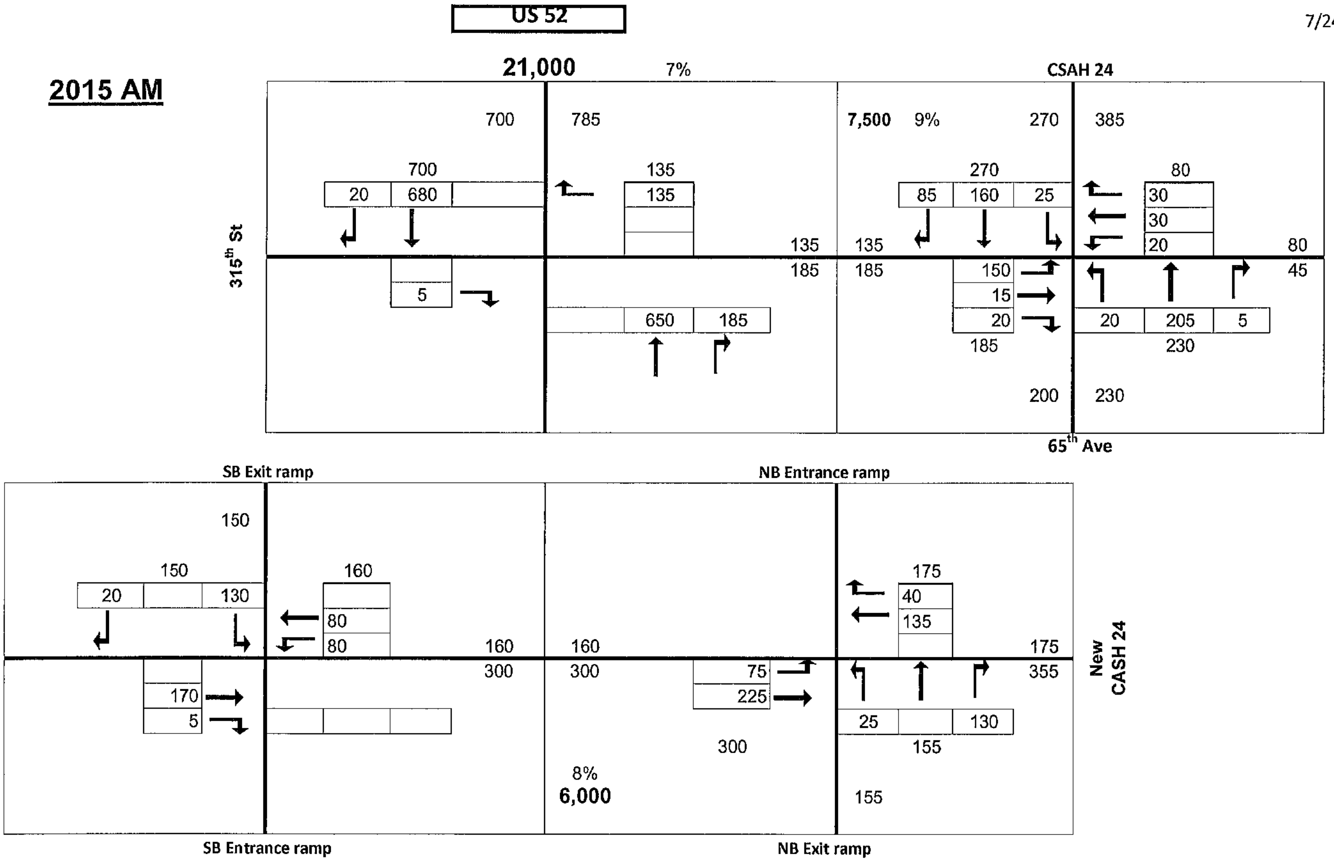
YEAR 2030 TRAFFIC FORECASTS

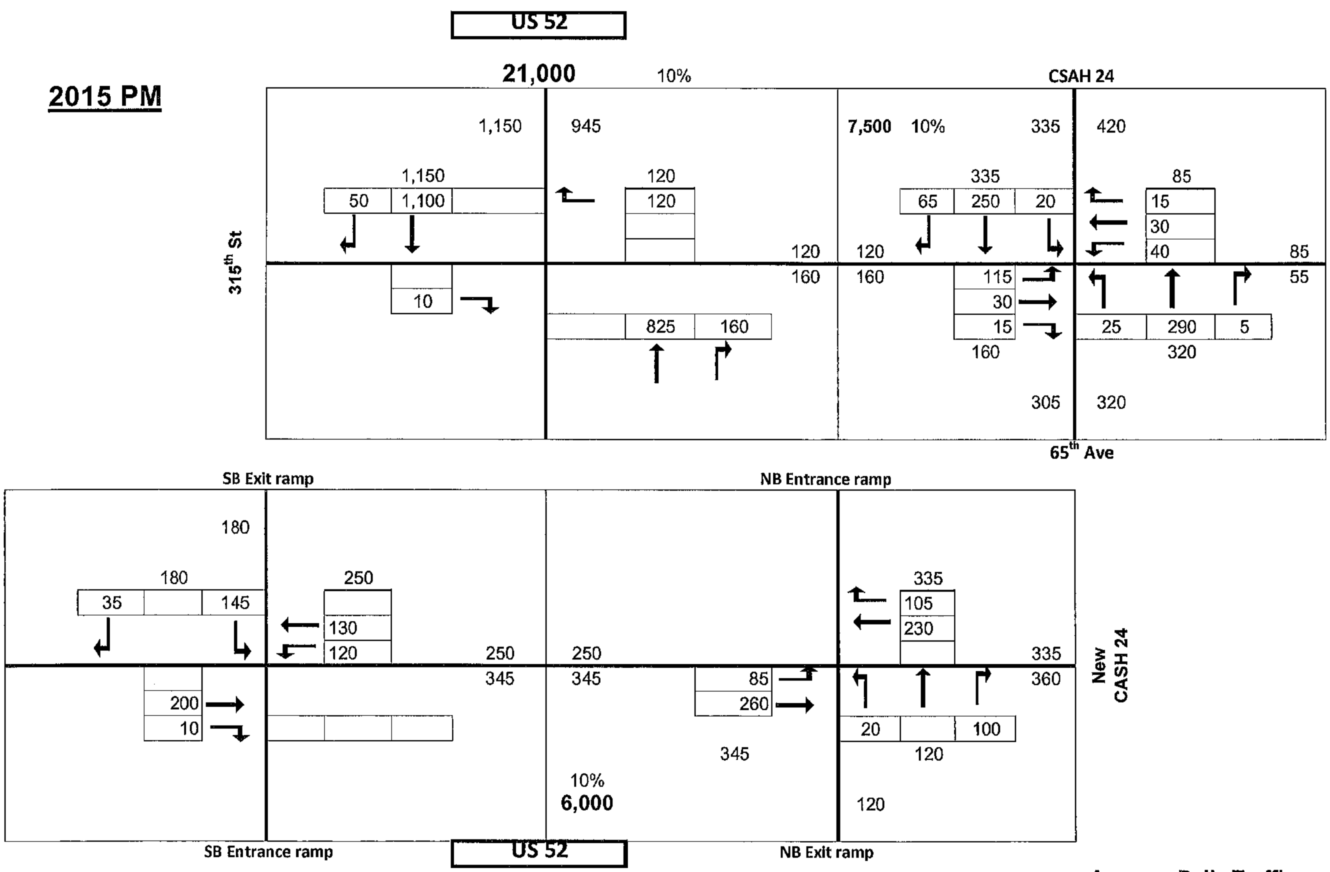
Due to the similarity, the year 2030 traffic forecasts for the Right In/Right Out Alternative were developed based on the analysis on the Alternative 2 in the 2009 Project. The 2030 daily traffic forecasts for the No Build and Alternative 2 from the 2009 Project are illustrated side by side in **Figure 3**. The figure shows that the forecasted 2030 daily traffic on the overpass is 6,200 in the Alternative 2 with Overpass. The traffic patterns change noticeably under the Alternative 2 without Overpass. Daily traffic increases 4,000 from 32,000 to 36,000 on the US 52 segment between the new CSAH 24 interchange and the TH 19 interchange while no changes on the segments to the south and north. It is also noted that daily traffic increases 6,100 from 3,600 to 9,700 on the west side of the new CSAH 24 while it increases only 2,900 from 8,900 to 11,800 on the east side of the new CSAH 24. These traffic volume changes indicate that a substantial amount of local trips (approximately 4,000 daily trips) between the east and west sides of US 52 would use the new CSAH 24 interchange, US 52 and the TH 19 interchange under the Alternative 2 without Overpass.

Based on the analysis, the 2030 daily and peak hour traffic forecasts for the for the Build Alternative 2 in the 2009 Project were manually rerouted to develop the traffic forecasts for the Right In/Right Out Alternative to reflect the removal of the overpass and accessibility changes. The forecast results are illustrated in the **Figure 4**.

Attachments
s:\ko\m\mnt06\128314\th 52 - rt in access\traffic forecasts\forecast memo\us 52 safety forecast memo.docx

7/24/2014



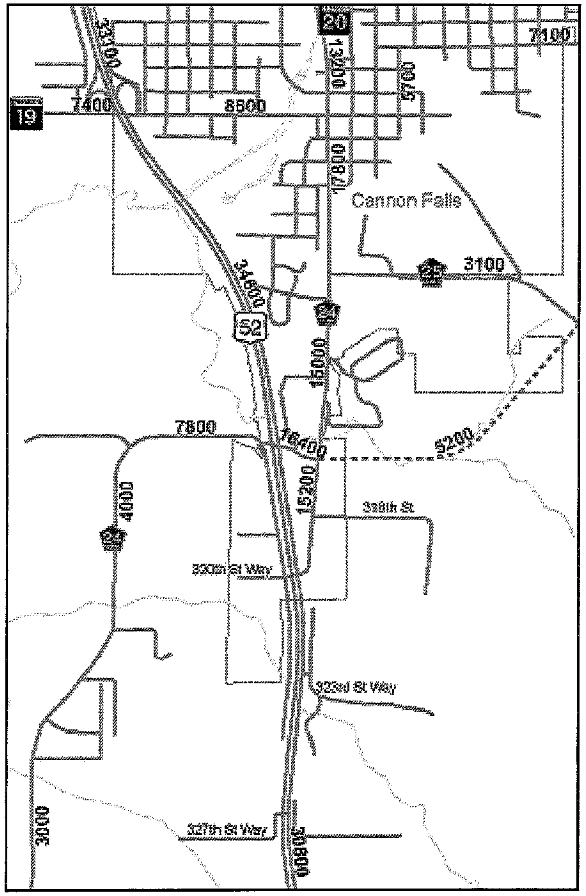


xx,xxx Average Daily Traffic

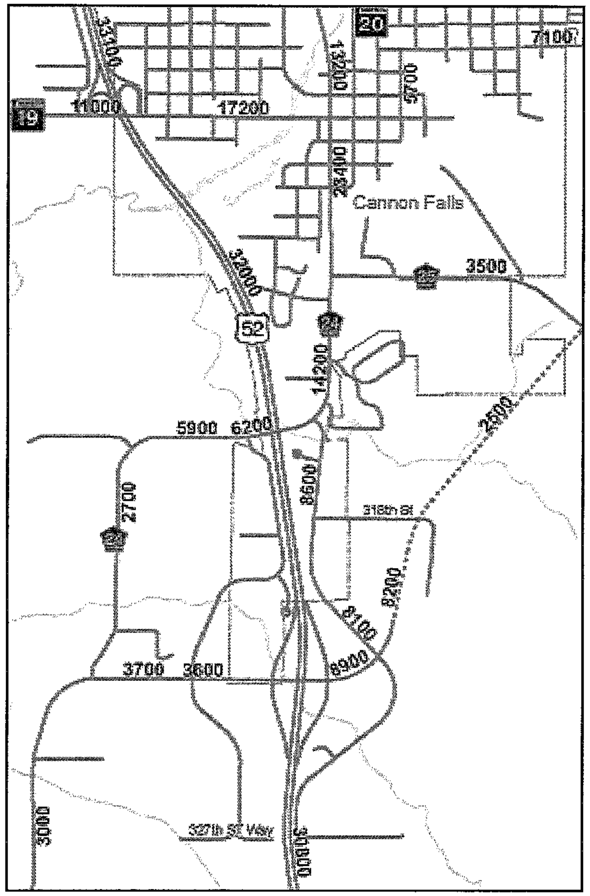
SEH

US 52 Safety Study
Cannon Falls, MN

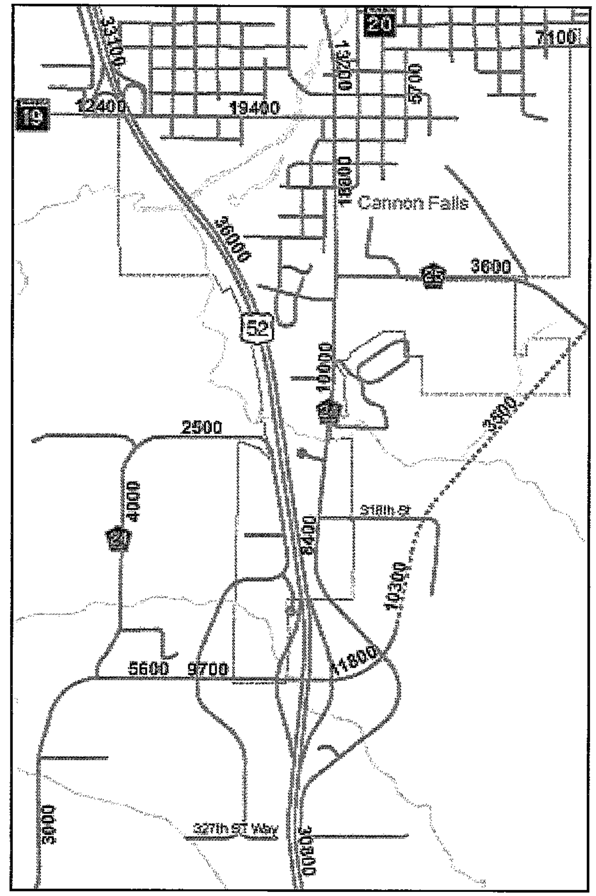
Figure 2
Build Alternative with RI/RO at US 52/315th Street
2015 AM and PM Peak Hours



No Build



Alternative 2 with Overpass in the 2009 Project

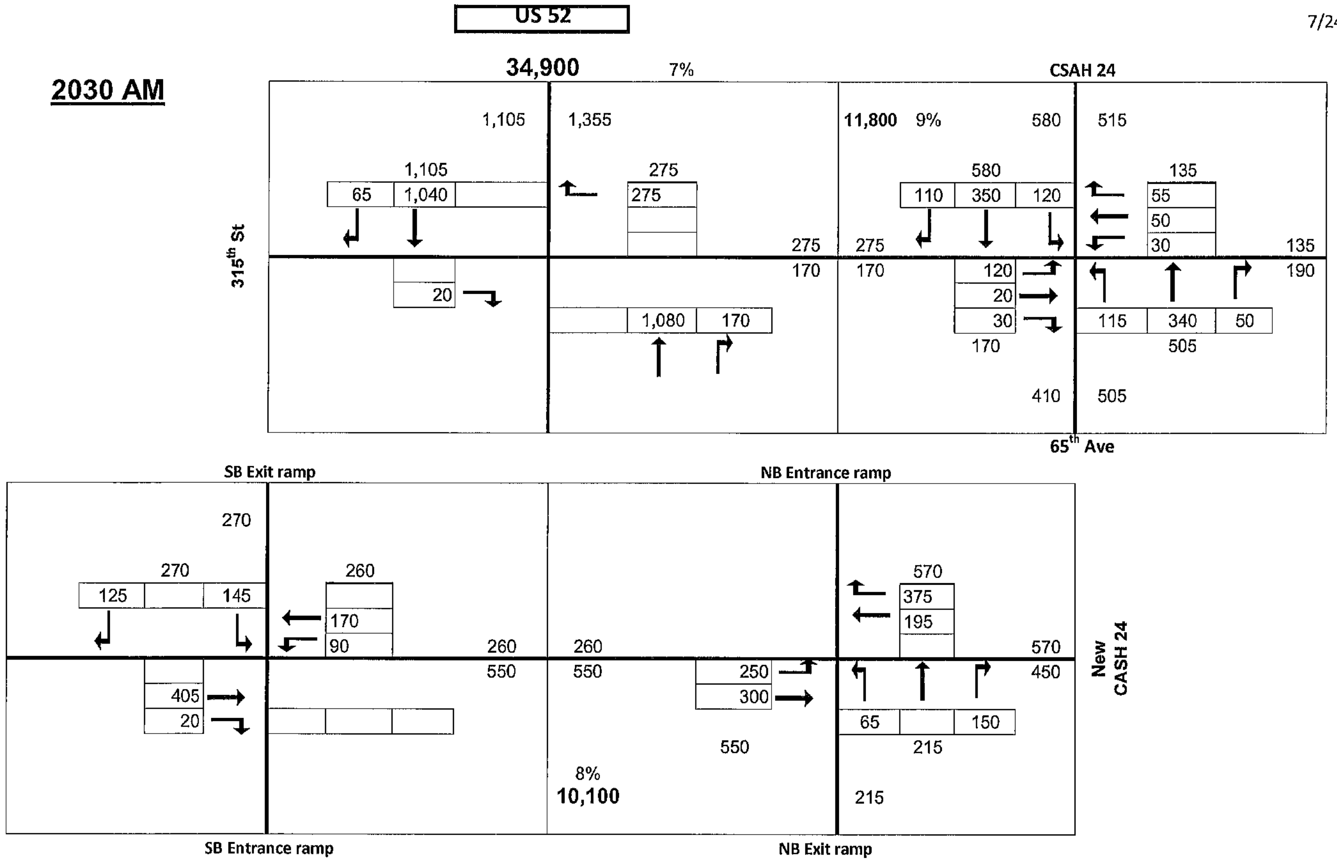


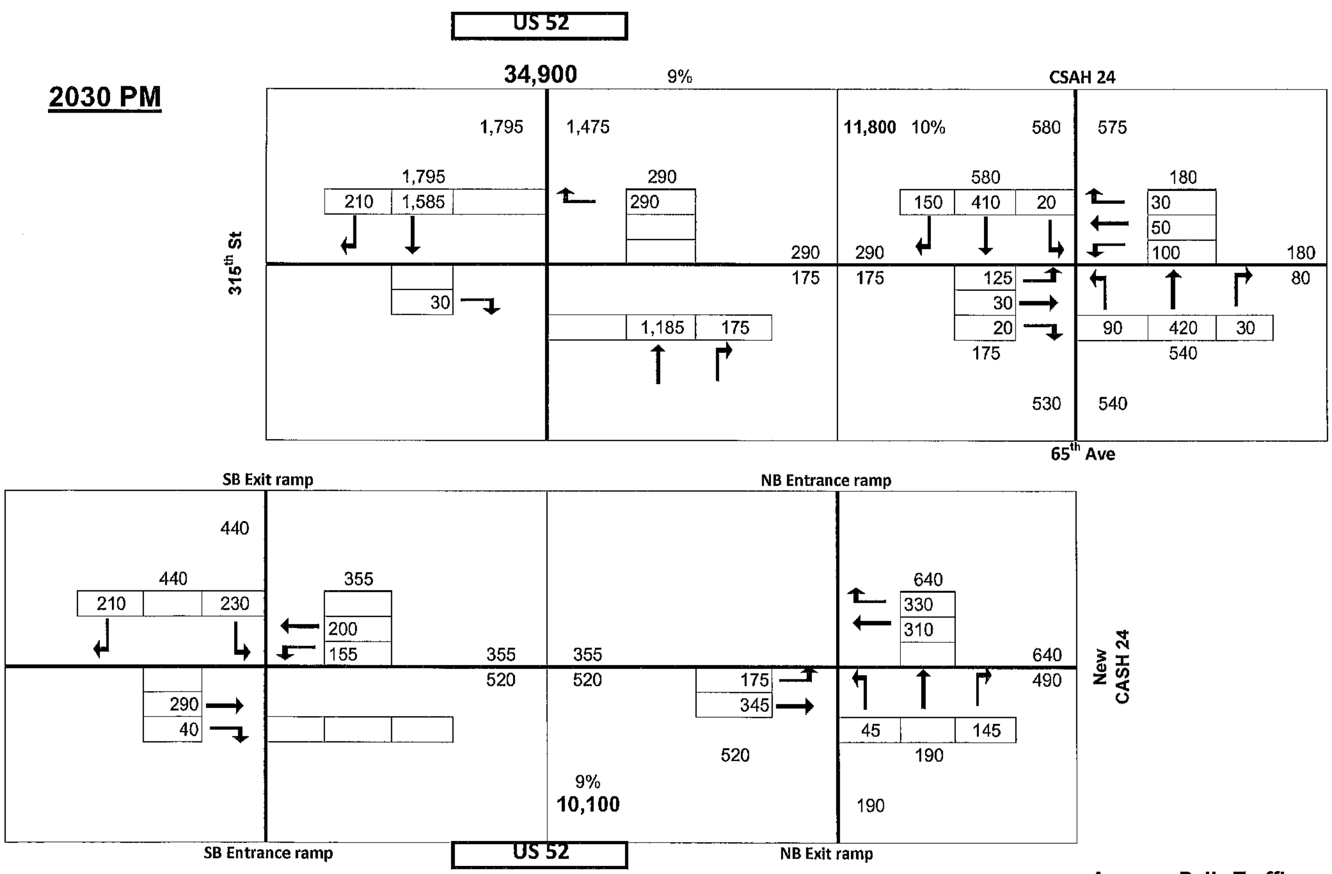
Alternative 2 without Overpass in the 2009 Project

Source: Figures 3, 4 & 5 in Technical Memorandum Five – Traffic Forecasting, TH 52 Cannon Falls

Path: C:\Hailang\SEH projects\KO\MNDOT_6\TH52_CannonFalls\GIS\Figure 3_ Forecasts 2009 project.mxd

SEH	N	3535 VADNAIS CENTER DR. ST. PAUL, MN 55110 PHONE: (651) 490-2000 FAX: (888) 908-8166 TF: (800) 325-2055 www.sehinc.com	Project: Mnt08 128314 Print Date: 7/23/2014 Map by: hxiao Projection: Source:	***2030 Daily Traffic Forecasts for No Build and Alternative 2 in the 2009 Project*** US 52 Safety Study In City of Cannon Falls District 6, MnDOT	Figure 3





xx,xxx Average Daily Traffic

SEH

US 52 Safety Study
Cannon Falls, MN

Figure 4
Build Alternative with RI/RO at US 52/315th Street
2030 AM and PM Peak Hours

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MEMORANDUM

TO: Mike Schweyen, PE, MnDOT District 6
Ron Johnson, City of Cannon Falls

FROM: Thomas A. Sohrweide PE, PTOE
Chad M. Jorgenson, EIT

DATE: December 17, 2014

RE: TH 52 Safety Analysis
MnDOT Contract No. 05952
SEH No. MNT06 128314 Task 4.0

We have conducted a safety analysis for a potential right-in/right-out access at the TH 52/315th Street intersection in Cannon Falls. Our analysis is based on an estimate of the number of future crashes for the following intersections both with and without the right-in/right-out access:

- 315th Street/65th Avenue
- The roundabout intersection ramps at proposed CSAH 24/TH 52.
- Right-in/right-out at TH 52/315th Street

The attached page "TH 52 Crash Comparisons" uses year 2015 forecast daily traffic volumes to calculate the estimated number of crashes both with and without the right-in/right-out. Crash rates for these calculations are from MnDOT's 2012 Intersection Crash Rates, MnDOT rates for comparable roundabouts, and from comparable right-in/right/out intersections. A rate of 0.18 crashes per million entering vehicles is the urban thru/stop rate and was used for the 315th Street/65th Avenue intersection, and a rate of 0.55 crashes per million entering vehicles was used for the roundabouts at the interchange ramps. Table 1 is crash and severity data from comparable right-in/right-out intersections identified by MnDOT. However, after review and discussion with MnDOT, it was agreed that two of the nine intersections analyzed better reflected the proposed location. Therefore, Table 2 is the data for the two intersections and provides a crash rate of 0.16 for the right-in/right-out.

As seen in Tables 1 and 2, the severity rate for the right-in/right-out is extremely small. In addition, our research did not reveal any usable severity rate data for roundabouts. Therefore severity rates were not estimated for the future conditions. However, it should be noted that due to the higher speed differentials between TH 52 thru traffic and the right-in/right-out traffic, the expected severity of crashes is likely to be higher for the right-in/right-out than at the roundabout interchange ramps.

In summary of the attached calculations, the three study intersections without the right-in/right-out access have an estimated 4.09 crashes per year. The three study intersections plus the right-in/right-out at TH 52 & 315th Street have an estimated 5.12 crashes per year. This is comprised of 3.70 crashes per year at the three study intersections (reduced due to rerouting traffic) and 1.42 crashes per year at the right-in/right-out.

The MnDOT Office of Traffic, Safety & Technology further researched crashes at right-in/right-out locations and found there to be statistical significance to an increase in crashes from an increase in traffic volume and an increase in crashes as ratio of the main roadway traffic volume to the side street traffic volume becomes more unbalanced. These findings are attached.

Attachment

Project: TH 52 CRASH Comparison's
Subject:
Date: 11/17/2014 By: CHAD M. JORGENSON SEH #: MNTO06 128314
Checked by: Date: Office: St. Paul File #:
Sheet No: 1 Of: 1

CRASHES W/ RI-RO

- 315TH @ 65TH — 2800 ADT for 315TH + 7500 ADT for CSAH 24 = 10,300 vpd
- URBAN THRU/STOP CRASH RATE = 0.18 (MNDOT GREEN SHEETS)

$$\text{NUMBER OF CRASHES} = \frac{(0.18)\cdot 365\text{ days}\cdot(10{,}300\text{ vpd})}{1{,}000{,}000\text{ vehicles entering}} = 0.68\text{ crashes/yr}$$

- ROUNDABOUTS

NB RAMP: 6000 ADT FOR CSAH 24 + 1200 ADT NB RAMP = 7200 vpd, 0.55 CRASH RATE for TH RABs Comparable to TH52 : Wentworth

$$\text{Number of CRASHES} = \frac{(0.55)\cdot(365\text{ days})\cdot(7200\text{ vpd})}{1{,}000{,}000\text{ vehicles entering}} = 1.45\text{ CRASHES/yr}$$

SB RAMP: 6000 ADT FOR CSAH 24 + 1800 ADT FOR SB RAMP = 7800 vpd, 0.55 CRASH RATE

$$\text{NUMBER OF CRASHES} = \frac{(0.55)\cdot(365\text{ days})\cdot(7800\text{ vpd})}{1{,}000{,}000\text{ vehicles entering}} = 1.57\text{ CRASHES/YR}$$

- RI/RO:

TOTAL CRASH RATE: 0.16 FROM COMPARABLE LOCATIONS SPREADSHEET

$$\text{NUMBER OF CRASHES} = \frac{(0.16)\cdot(365\text{ days})\cdot(21{,}000\text{ vpd} + 3400\text{ vpd})}{1{,}000{,}000\text{ vehicles entering}} = 1.42\text{ CRASHES/YR}$$

TOTAL # OF CRASHES: 5.12 CRASHES/YR

CRASHES W/O RI-RO

- 315TH @ 65TH — 7500 vpd for CSAH 24 + 2800 vpd for 315TH St - 400 vpd redist. trips = 9900 vpd
- URBAN THRU/STOP CRASH RATE = 0.18 (MNDOT GREEN SHEETS)

$$\text{NUMBER OF CRASHES} = \frac{(0.18)\cdot 365\text{ days}\cdot(9{,}900\text{ vpd})}{1{,}000{,}000\text{ vehicles entering}} = 0.65\text{ CRASHES/YR}$$

- ROUNDABOUTS

NB RAMP: 6000 ADT FOR CSAH 24 + 2800 ADT NB RAMP = 8,800 vpd, 0.55 CRASH RATE

$$\text{NUMBER OF CRASHES} = \frac{(0.55)\cdot(365\text{ days})\cdot 8{,}800\text{ vpd}}{1{,}000{,}000\text{ veh. entering}} = 1.77\text{ CRASHES/YR}$$

- SB RAMP: 6000 ADT FOR CSAH 24 + 2300 ADT SB RAMP = 8,300 vpd, 0.55 CRASH RATE

$$\text{NUMBER OF CRASHES} = \frac{(0.55)\cdot(365\text{ days})\cdot 8{,}300\text{ vpd}}{1{,}000{,}000\text{ veh. entering}} = 1.67\text{ CRASHES/YR}$$

TOTAL # OF CRASHES: 4.09 CRASHES/YR

RIGHT-IN / RIGHT-OUT INTERSECTIONS

2011 – 2013 Minnesota Crashes

1.0 Summary

- As volume increases, crashes increase.
  - ✓ +0.552 correlation
  - ✓ Statistically significant
  - ✓ Comparing two intersections, one with 1,000 additional vehicles would expect 1 additional crash every 15 years (0.07 more annually).
- As volume on legs becomes more unbalanced, crashes increase.
  - ✓ +0.608 correlation
  - ✓ Statistically significant

2.0 Analysis

Linear regression of total number of crashes per year. This is calculated by dividing the total number of crashes by the number of days included multiplied by 365.25 days per year.

33 similar intersections were identified: 7 in Greater Minnesota, 26 in Metro. Entering volumes averaged 26,400 vehicles, ranging from 9,350 to 45,300. The "unbalance ratio" of the legs is calculated by dividing the ADT from the highest volume leg by the entering volume.

3.0 Results

	Total Correlation	Part Correlation
Entering Volume (MEV)	+.552 (*p*=**.000**)	+.382
Unbalance Ratio	+.608 (*p*=**.000**)	+.362
Speed Limit	+.017 (*p*=.462)	-.272

The part correlation is the contribution of each variable towards total explained variance independent of the others.

Variable	Coefficient	Std. Error	Significance
[Constant]	-4.554	3.076	.150
Entering Volume (MEV)	66.638	22.322	**.006**
Unbalance Ratio	4.028	1.422	**.008**
Speed Limit	-0.065	.031	**.042**

$R^2 = 0.526$

There is a positive, significant correlation between entering volume and crashes. Similarly, as the volumes become more unequal, the number of crashes significantly increases.

Speed limits are also correlated to higher number of crashes. However, roads with higher volumes tend to have higher posted speeds. The part correlation controls for the part of speed limits independent of volume; here we see that increased speed limits has a negative correlation with crashes.

Table 1
TH 52 Right-in/Right-out Crash Comparison (500 Ft)

Intersection	Intersection Type	Adjacent Access Distance/Type	Main Road ADT	Side Road ADT	TOTAL Crash Severity					Crash Severity					Number of Entering Crashes					Number of Exiting Crashes					TOTAL CRASHES					Entering Crash Rate	Exiting Crash Rate	Total Crash Rate	RI/RO Severity Rate	TOTAL Severity Rate
					K	A	B	C	N	K	A	B	C	N	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013					
TH 169/CSAH 69 - Mankato	T, 3/4	Right-out = 1,600' downstream of exit; Right-in overlaps with downstream left side on	18,600	2,950	0	0	0	2	7	0	0	0	0	4	0	0	0	0	0	1	0	1	1	1	2	0	1	1	1	0.00	0.20	0.254	0.00	0.000000699
W Lake Street/TH 7	T	Right-out = 1200' upstream of signalized intersection, Right-in = 220' downstream of entrance ramp	37,000	3,850 *	0	0	0	2	4	0	0	0	1	2	0	1	0	1		0	1	0	0		0	2	0	4		0.07	0.03	0.201	0.00	0.000000268
TH 13/Valley Drive	T	Right-out = 600' upstream of entrance ramp, Right-in = 1625' down stream from signalized intersection.	56,000	1000 *	0	0	0	1	4	0	0	0	0	1	0	0	0	0		1	0	0	0		2	1	2	0		0.00	0.02	0.120	0.00	0.000000144
TH 13/Dupont Ave	T	Right-out = 1550' upstream of entrance ramp, Right-in = 1850' down stream from signalized intersection.	56,000	2000 *	0	0	0	1	1	0	0	0	0	1	0	1	0	0		0	0	0	0		0	2	0	0		0.02	0.00	0.047	0.00	0.000000071
TH 13/South Frontage Road	T	Right-out = 1320' upstream of entrance ramp, Right-in = 2330' down stream from signalized intersection.	56,000	1000 *	0	0	0	0	2	0	0	0	0	2	1	0	1	0		0	0	0	0		1	0	1	0		0.05	0.00	0.048	0.00	0.000000048
TH 52/Clayton Avenue	T	Right-out = 4200' downstream of entrance ramp, Right-in = 4400' up stream from intersection.	29,000	2000 *	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0.04	0.00	0.07	0.00	0.000000133
TH 52/170th Street	T	Right-out = 1584' upstream of exit ramp, Right-in = 3160' upstream from intersection.	29,000	500 *	0	0	0	1	6	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	2	2	0	1	2	0.07	0.00	0.26	0.00	0.000000371
TH 10/Ilama Street	T	Right-out = 1580' upstream of intersection	33,000	115	0	0	2	0	3	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	3	0	0	0	0.03	0.00	0.17	0.00	0.000000372
TH 10/Alpaca Street	T	Right-out = 1580' upstream of intersection	33,000	150 *	0	1	0	3	3	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0	1	3	0	0	2	0.07	0.00	0.198	0.00	0.000000537
Average # of Crashes															0.3					0.2					1.0					0.04	0.03	0.15	0.00	0.00000029

* Denotes estimated volume

Table 2
TH 52 Right-in/Right-out Crash Comparison - Similar Access Control (500 Ft)

Intersection	Intersection Type	Adjacent Access Distance/Type	Main Road ADT	Side Road ADT	Crash Severity TOTAL					Crash Severity					Number of Entering Crashes					Number of Exiting Crashes					TOTAL CRASHES					Entering Crash Rate	Exiting Crash Rate	Total Crash Rate	RI/RO Severity Rate	TOTAL Severity Rate
					K	A	B	C	N	K	A	B	C	N	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013					
W Lake Street/TH 7	T	Right-out = 1200' upstream of signalized intersection, Right-in = 220' downstream of entrance ramp	37,000	3,850 *	0	0	0	2	4	0	0	0	1	2	0	1	0	1		0	1	0	0		0	2	0	4		0.07	0.03	0.201	0.00	0.00000027
TH 13/Valley Drive	T	Right-out = 600' upstream of entrance ramp, Right-in = 1625' down stream from signalized intersection.	56,000	1000 *	0	0	0	1	4	0	0	0	0	1	0	0	0	0		1	0	0	0		2	1	2	0		0.00	0.02	0.120	0.00	0.00000014
Average # of Crashes															0.3					0.3					1.4					0.03	0.03	0.16	0.00	0.00000021

* Denotes estimated volume

SEH

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MEMORANDUM

TO: Mike Schweyen, PE, MnDOT District 6
Ron Johnson, City of Cannon Falls

FROM: Thomas A. Sohrweide, PE, PTOE
Scott Hotchkin, PE

DATE: December 4, 2014

RE: TH 52 Access Concepts
MnDOT Contract No. 05952
SEH No. MNT06 128314 Task 6.0

The attached Figures 1 – 4, depict four geometric concepts of a right-in/right-out access.

- Figure 1
    - Northbound
        - Right turn exit lane
        - Acceleration lane
    - Southbound
        - Right turn exit lane
        - Auxiliary lane
- Figure 2
    - Same as Figure 1, except the northbound right turn exit lane is replaced with an auxiliary lane
- Figure 3
    - Same as Figure 1, except the northbound right turn lane is separated from the exit to create an interchange type exit.
    - This in only shown for Northbound, but could also be used for southbound
- Figure 4
    - Same as Figure 3, except the Northbound right turn exit lane is replaced with an auxiliary lane

Due to the proximity of the southbound interchange exit to a southbound right-out from 315th Street, it is our recommendation that if developed, this movement should be designed as an auxiliary lane.

The concepts all show right-in/right-out access for both north and southbound. The concepts could be further modified to provide right-in or right-out only and could be different for north and southbound.

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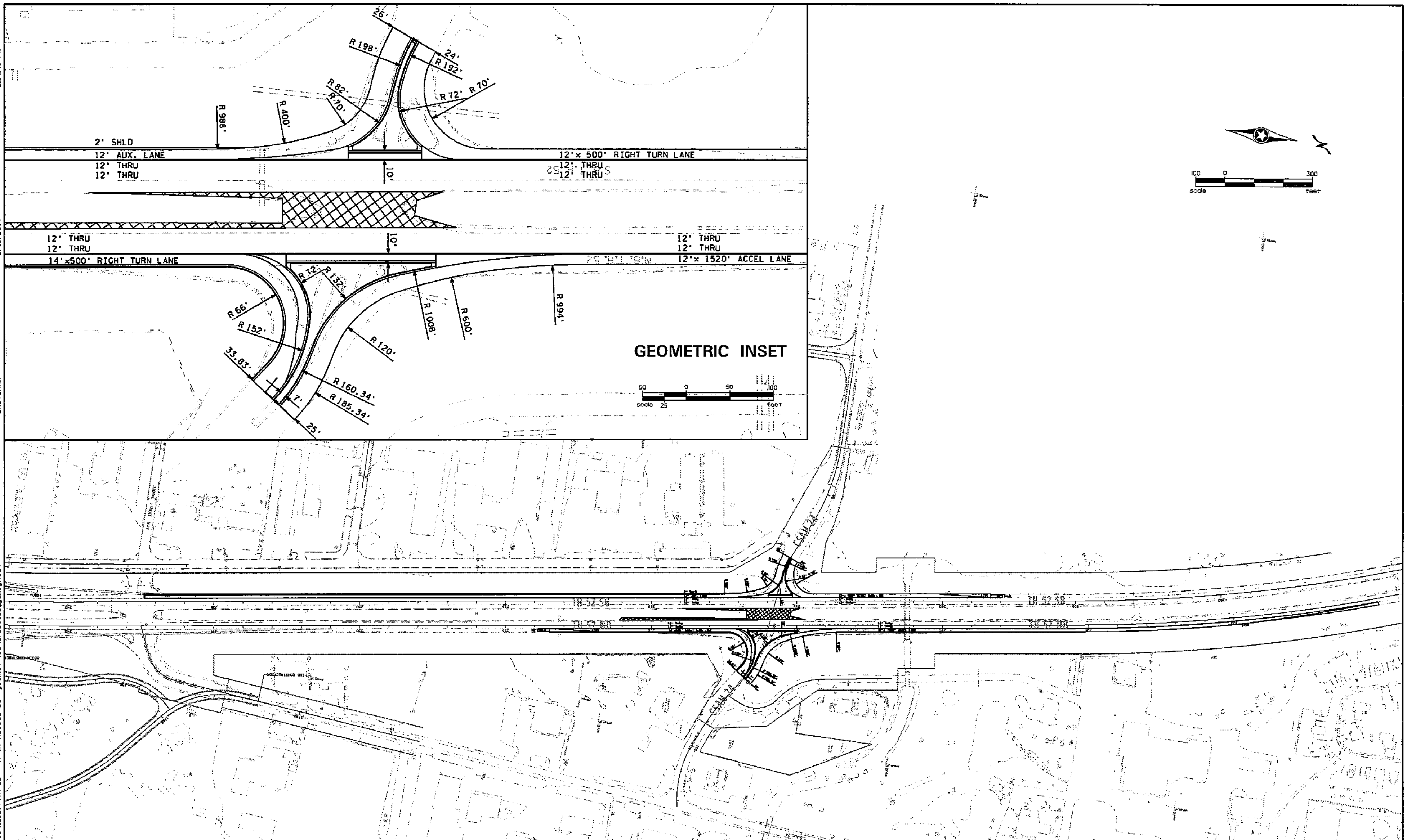
Attachments



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ST. PAUL, MN 55110

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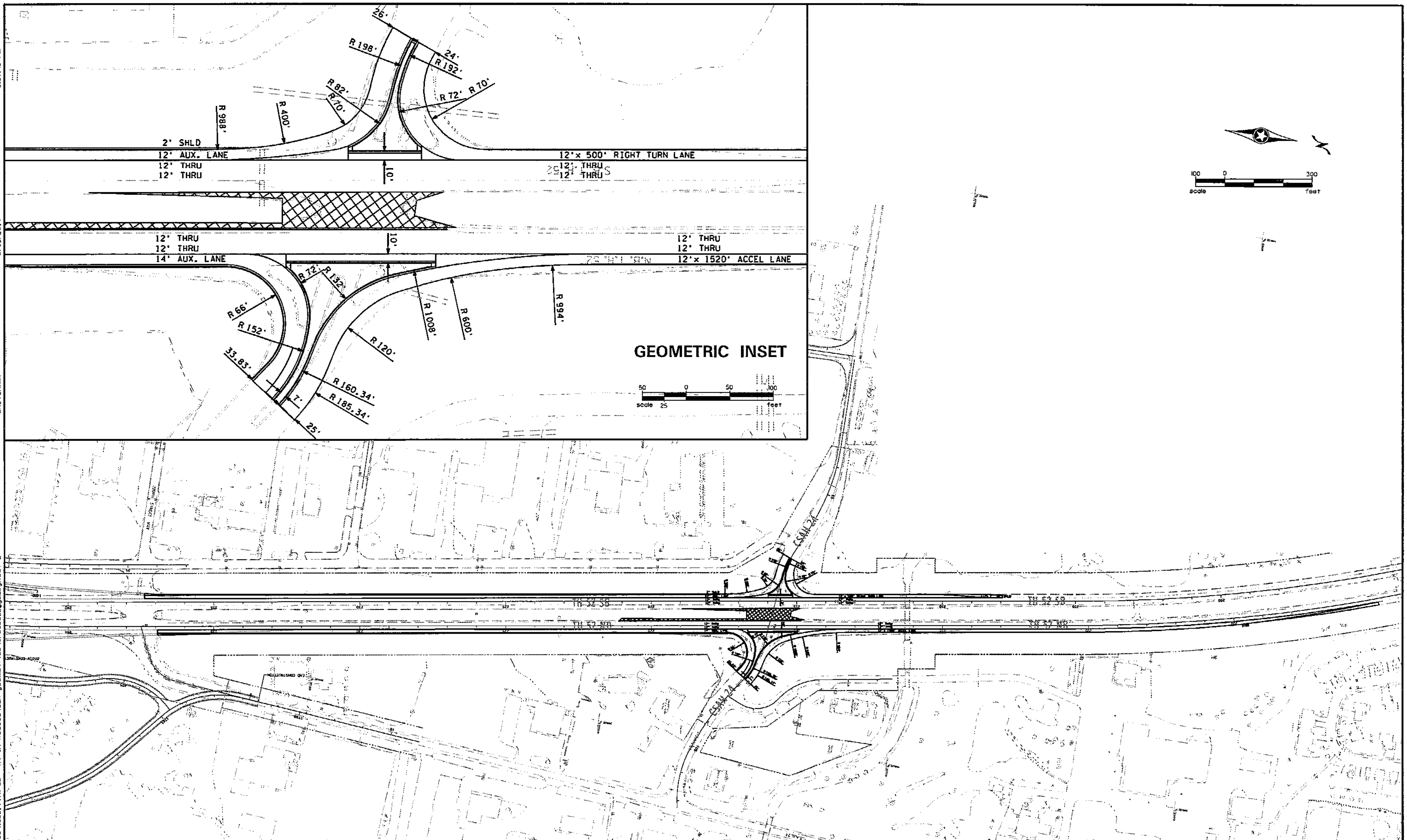
RI/RO WITH
SB AUX LANE

FIGURE
No. #1



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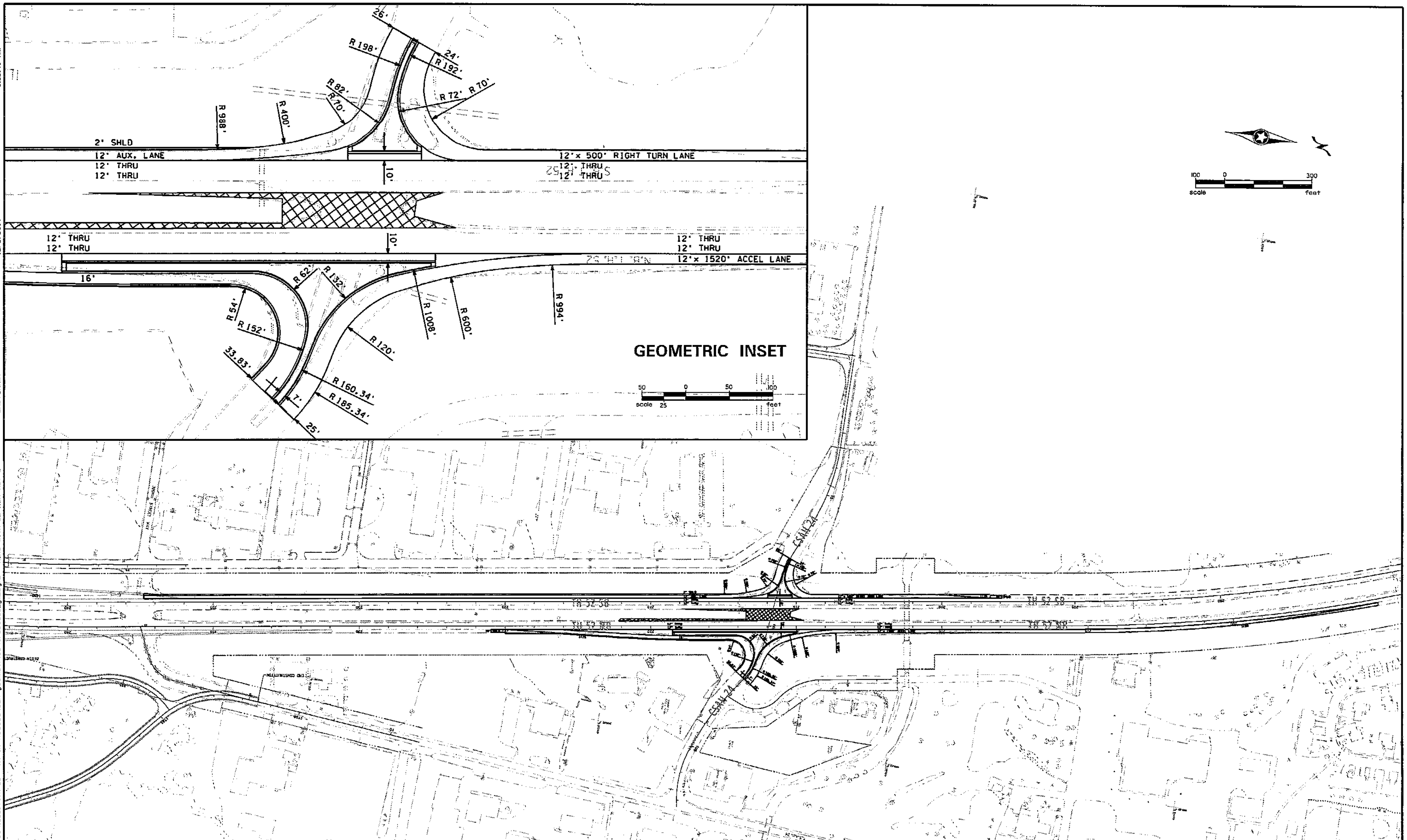
RI/RO WITH
NB & SB AUX LANES

FIGURE
No. #2



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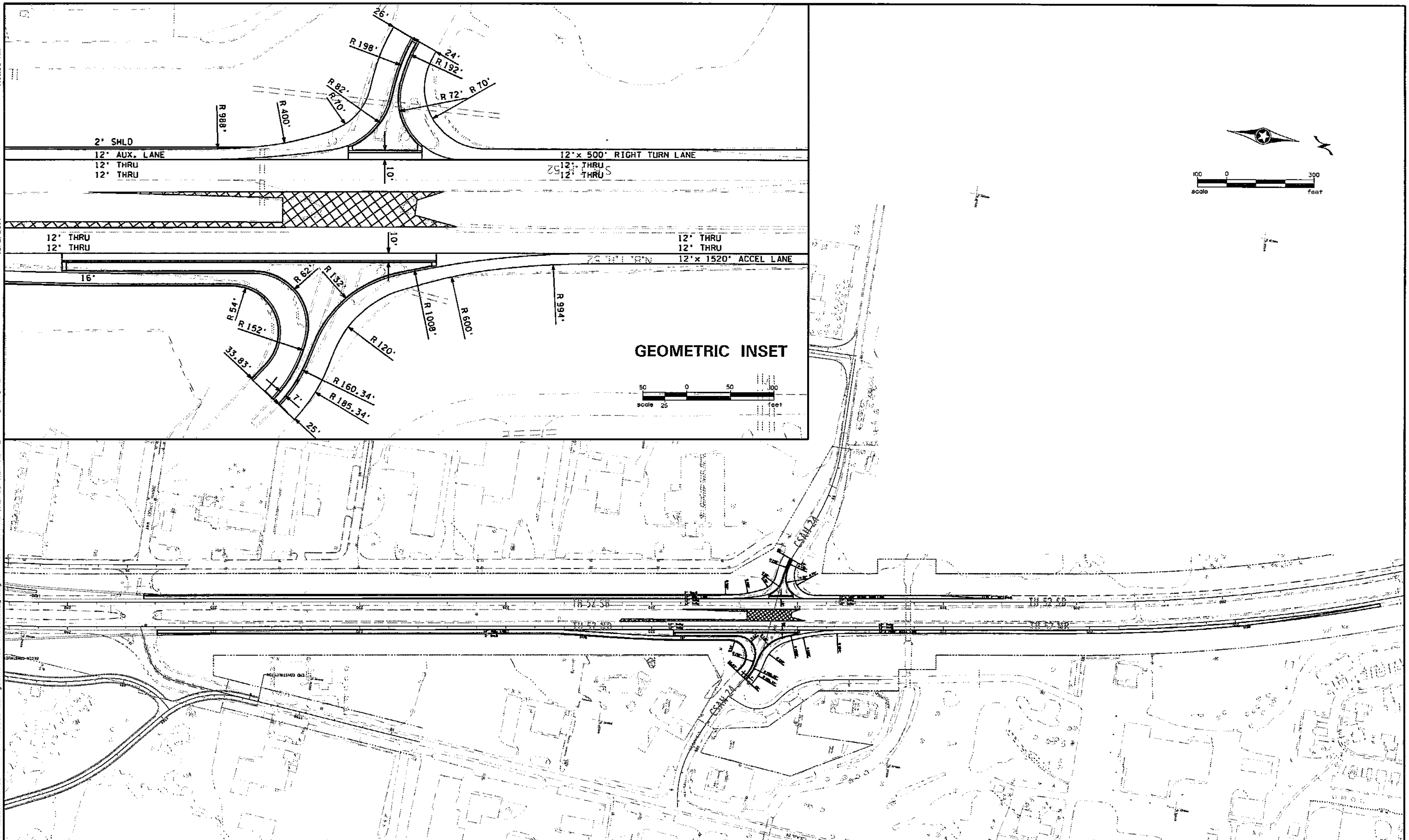
SEPARATED RI/RO WITH SB AUX LANE

FIGURE No. #3



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SEPARATED RI/RO WITH
NB & SB AUX LANES

FIGURE
No. #4

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SEH

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MEMORANDUM

TO: Mike Schweyen, PE, MnDOT District 6
Ron Johnson, City of Cannon Falls

FROM: Thomas A. Sohrweide, PE, PTOE
Graham Johnson, PE

DATE: December 17, 2014

RE: TH 52 Operational Analysis
MnDOT Contract No. 05952
SEH No. MNT06 128314 Task 6.0

This memorandum summarizes the traffic operational analysis conducted for the potential right-in/right-out access on TH 52 at 315th Street in Cannon Falls.

The Highway Capacity Manual (HCM) outlines procedures for evaluating the quality of traffic flow. The quality of traffic flow is expressed as a Level of Service (LOS) A – F, where LOS A represents the best operating conditions from the traveler's perspective and LOS F represents the worst.

Of concern with traffic operations at this location are:

- Traffic entering from a stop or yield condition onto a high speed roadway.
- Traffic exiting a high speed roadway.
- The proximity of an interchange to an at-grade access.

The original intent of the study was to analyze the concerns using HCM freeway type analysis, which consists of weaving (vehicles changing lanes), merging (vehicles entering from and interchange to the highway), and diverging (vehicles exiting the highway).

With the right-in/right-out condition being analyzed, these conditions don't totally cover the operation of the right-out traffic entering the highway. Therefore we also used Synchro/SimTraffic intersection modeling software to address the availability of gaps in traffic to accept the entering traffic.

The year 2030 AM and PM Peak Hour traffic forecasts were used for the operational analysis.

The attached Figures 1 – 3 report the results of the weaving, merge, and diverge analyses.

As noted on Figure 1, weaving analysis requires an auxiliary lane. The one-lane entrance ramp from the interchange followed by a one-lane exit and not connected by an auxiliary lane, is not considered as a weaving configuration, but as isolated merge and diverge configurations. Therefore, to analyze the weaving traffic for the conditions where there is not an auxiliary lane, as shown on the top of Figures 1 and 2, the analysis assumed one through lane on TH 52 and an auxiliary lane. While not depicting the geometry that would be present, this is a conservative analysis. This analysis indicates a LOS B for both directions and both peak hours.

The bottom of Figures 1 and 2, is the analysis with an auxiliary lane present. As indicated, this analysis found LOS A/B.

Figure 3 reports the results of the merge and diverge analyses. LOS B is reported for all merge and diverge levels of service.

As mentioned above, Synchro/SimTraffic was used as a tool address the ability of the entering traffic to access TH 52. This software was used for the ease of use, and is not the necessarily the most appropriate tool to use for freeway access. However, it was used to provide additional data on the availability of gaps along TH 52 to compliment the above described HCM analysis.

As reported in Tables 1 and 2, analysis was completed for three scenarios.

- Version 1 – Auxiliary lane between the interchange and the right-in/right-out; northbound acceleration lane.
- Version 2 – No auxiliary lanes; north and southbound acceleration lanes.
- Version 3 – No auxiliary lanes; no acceleration lanes.

As reported in the tables, all movements are LOS A, which assures there will be gaps in traffic for the right-out traffic to enter TH 52. Also attached is the detailed modeling results of this analysis.

The operational analysis reports reasonable peak hour traffic operating conditions.

ts
Attachments
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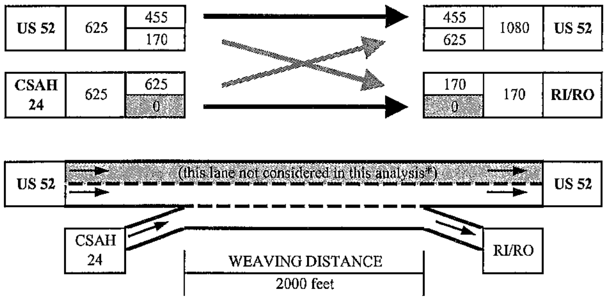
Figure 1
NORTHBOUND US 52
WEAVING ANALYSIS

ASSUMPTIONS:
10% Heavy Vehicle (2150/20300 HCAADT/AADT); 1% Recreational Vehicle.
Speed Limit 65 mph; PHF 0.9
100% Weaving Demands (worst case scenario)

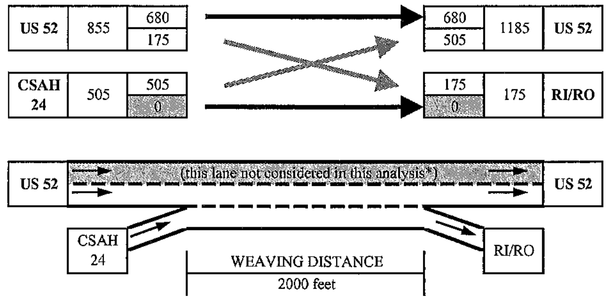
2030 WEAVING ANALYSIS - NO AUXILIARY LANES (see note)

AM PEAK HOUR ANALYSIS



Weaving Segment Data		
Flow Rate	1389	veh/hr
Capacity	3382	veh/hr
V/C Ratio	0.411	
LOS	**B**	

PM PEAK HOUR ANALYSIS

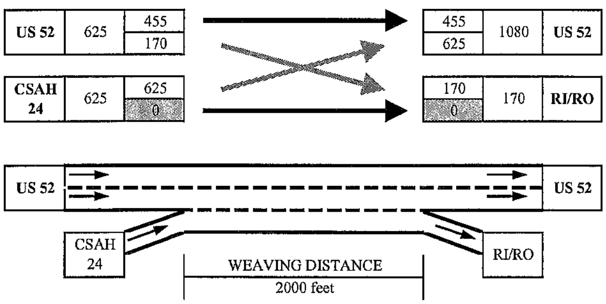


Weaving Segment Data		
Flow Rate	1512	veh/hr
Capacity	3620	veh/hr
V/C Ratio	0.417	
LOS	**B**	

*Weaving segments require auxiliary lanes (see note below); therefore for this analysis, 2 weaving lanes were used which assumes US 52 would only have a single freeway lane.

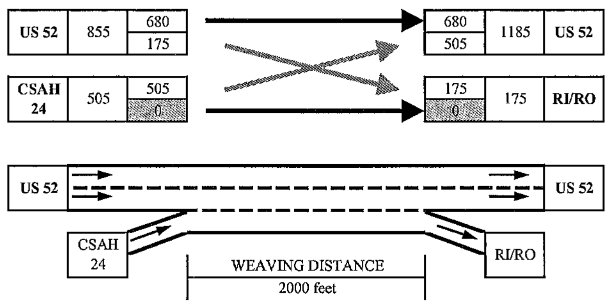
2030 WEAVING ANALYSIS - AUXILIARY LANES

AM PEAK HOUR ANALYSIS



Weaving Segment Data		
Flow Rate	1389	veh/hr
Capacity	3586	veh/hr
V/C Ratio	0.387	
LOS	**A**	

PM PEAK HOUR ANALYSIS



Weaving Segment Data		
Flow Rate	1512	veh/hr
Capacity	4563	veh/hr
V/C Ratio	0.331	
LOS	**A**	

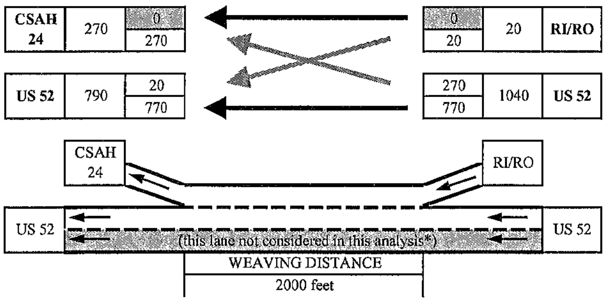
NOTE:
Weaving distance from entrance ramp painted gore to full 12' wide right turn lane beginning point.
Page 12-5 (2010 HCM): It is important to note that the case of a one-lane ramp closely followed by a one-lane off ramp, but not connected by a continuous freeway auxiliary lane, is not considered to be a weaving configuration. Such cases are treated as isolated merge and diverge segments by using methodology described in Chapter 13. The distance between the on ramp and off ramp is not a factor in this determination.

Figure 2
SOUTHBOUND US 52
WEAVING ANALYSIS

ASSUMPTIONS:
10% Heavy Vehicle (2150/20300 HCAADT/AADT); 1% Recreational Vehicle.
Speed Limit 65 mph; PHF 0.9
100% Weaving Demands (worst case scenario)

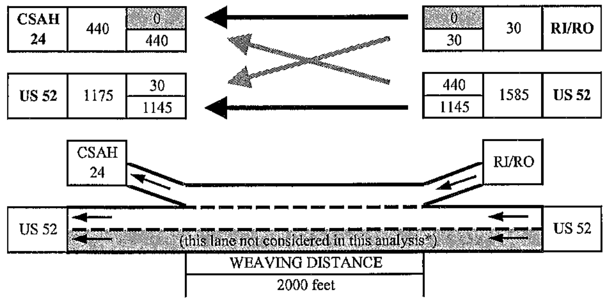
2030 WEAVING ANALYSIS - NO AUXILIARY LANES (see note)

AM PEAK HOUR ANALYSIS



Weaving Segment Data		
Flow Rate	1178	veh/hr
Capacity	4046	veh/hr
V/C Ratio	0.291	
LOS	**B**	

PM PEAK HOUR ANALYSIS

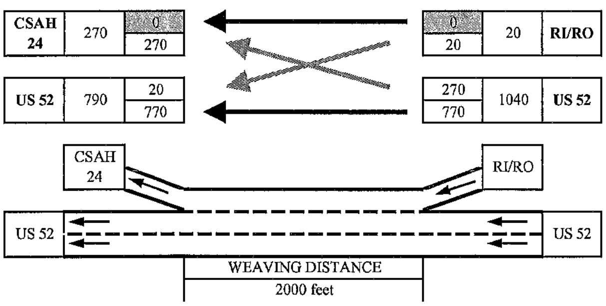


Weaving Segment Data		
Flow Rate	1795	veh/hr
Capacity	4019	veh/hr
V/C Ratio	0.446	
LOS	**B**	

*Weaving segments require auxiliary lanes (see note below); therefore for this analysis, 2 weaving lanes were used which assumes US 52 would only have a single freeway lane.

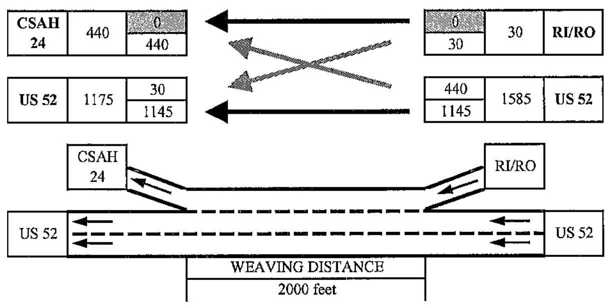
2030 WEAVING ANALYSIS - AUXILIARY LANES

AM PEAK HOUR ANALYSIS



Weaving Segment Data		
Flow Rate	1178	veh/hr
Capacity	5980	veh/hr
V/C Ratio	0.197	
LOS	**A**	

PM PEAK HOUR ANALYSIS



Weaving Segment Data		
Flow Rate	1795	veh/hr
Capacity	5940	veh/hr
V/C Ratio	0.302	
LOS	**B**	

NOTE:
Weaving distance assumes 500' acceleration length for the eastbound right turn to the southbound exit ramp painted gore.
Page 12-5 (2010 HCM): It is important to note that the case of a one-lane ramp closely followed by a one-lane off ramp, but not connected by a continuous freeway auxiliary lane, is not considered to be a weaving configuration. Such cases are treated as isolated merge and diverge segments by using methodology described in Chapter 13. The distance between the on ramp and off ramp is not a factor in this determination.

Figure 3
US 52
MERGE AND DIVERGE ANALYSIS

ASSUMPTIONS:

10% Heavy Vehicle (2150/20300 HCAADT/AADT); 1% Recreational Vehicle.
PHF 0.9
Speed Limit 65 mph

Southbound US 52
315th Exit

	Density	Speed	LOS
AM	10.2	58	B
PM	15.7	58	B

Northbound US 52
315th Entrance

	Density	Speed	LOS
AM	14.5	58	B
PM	15.6	58	B

Southbound US 52
315th Entrance

	Density	Speed	LOS
AM	12.2	58	B
PM	17.3	58	B

Northbound US 52
315th Exit

	Density	Speed	LOS
AM	10.6	58	B
PM	11.7	58	B

Southbound US 52
CSAH 24 Exit

	Density	Speed	LOS
AM	10.4	58	B
PM	16.0	57	B

Northbound US 52
CSAH 24 Entrance

	Density	Speed	LOS
AM	13.4	58	B
PM	14.5	58	B

Table 1
Cannon Falls, MN
2030 AM Peak Hour

	Intersection	Approach	Demand Volumes				Delay (s/veh)						LOS By Approach		LOS By Intersection		Queing Information (feet) Through			Left Turn			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Link Length	Avg.	Max	Storage	Avg.	Max	Storage	Avg.	Max
Ver. 1	US 52 at RI/RO	EB	0	0	20	20	0.0	A	0.0	A	0.8	A	0.8	A	1.1	A	500			0		0	500		
	EB and WB Rights are "Free Movements"	WB	0	0	275	275	0.0	A	0.0	A	1.5	A	1.5	A			500			0		0	500		
		NB	0	1080	170	1,250	0.0	A	1.5	A	2.4	A	1.6	A			2500			0		0	0		0
		SB	0	1040	65	1,105	0.0	A	0.4	A	2.2	A	0.5	A			2500			0		0	0		0

Version 1: Full Auxiliary Lanes between interchange ramps and RI/RO access.
WB Right onto northbound TH 52 includes 500' acceleration lane.

	Intersection	Approach	Demand Volumes				Delay (s/veh)						LOS By Approach		LOS By Intersection		Queing Information (feet) Through			Left Turn			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Link Length	Avg.	Max	Storage	Avg.	Max	Storage	Avg.	Max
Ver. 2	US 52 at RI/RO	EB	0	0	20	20	0.0	A	0.0	A	0.8	A	0.8	A	1.1	A	500			0		0	500		
	EB and WB Rights are "Free Movements"	WB	0	0	275	275	0.0	A	0.0	A	1.5	A	1.5	A			500			0		0	500		
		NB	0	1080	170	1,250	0.0	A	1.5	A	2.4	A	1.6	A			2500			0		0	0		0
		SB	0	1040	65	1,105	0.0	A	0.4	A	2.2	A	0.5	A			2500			0		0	0		0

Version 2: 500 foot acceleration lanes for RI/RO access in both directions; no auxiliary lanes.

	Intersection	Approach	Demand Volumes				Delay (s/veh)						LOS By Approach		LOS By Intersection		Queing Information (feet) Through			Left Turn			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Link Length	Avg.	Max	Storage	Avg.	Max	Storage	Avg.	Max
Ver. 3	US 52 at RI/RO	EB	0	0	20	20	0.0	A	0.0	A	1.9	A	1.9	A	1.4	A	500			0		0	500		
	EB and WB Rights are "Yield Movements"	WB	0	0	275	275	0.0	A	0.0	A	3.8	A	3.8	A			500			0		0	500	7	150
		NB	0	1080	170	1,250	0.0	A	1.6	A	2.4	A	1.7	A			2500			0		0	0		0
		SB	0	1040	65	1,105	0.0	A	0.4	A	2.2	A	0.5	A			2500			0		0	0		0

Version 3: No auxiliary lanes or acceleration lanes for RI/RO access in both directions; yield condition.

SimTraffic MOE Table

Table 2
Cannon Falls, MN
2030 PM Peak Hour

	Intersection	Approach	Demand Volumes				Delay (s/veh)						LOS By Approach		LOS By Intersection		Queing Information (feet)								
																	Through			Left Turn			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Link Length	Avg.	Max	Storage	Avg.	Max	Storage	Avg.	Max
Ver. 1	US 52 at RI/RO	EB	0	0	30	30	0.0	A	0.0	A	0.8	A	0.8	A	1.3	A	500			0		0	500		
		WB	0	0	290	290	0.0	A	0.0	A	1.5	A	1.5	A			500			0		0	500		
	EB and WB Rights are "Free Movements"	NB	0	1185	175	1,360	0.0	A	1.5	A	2.4	A	1.6	A			2500			0		0	0		0
		SB	0	1585	210	1,795	0.0	A	0.9	A	2.8	A	1.1	A			2500			0		0	0		0

Version 1: Full Auxiliary Lanes between interchange ramps and RI/RO access.
WB Right onto northbound TH 52 includes 500' acceleration lane.

	Intersection	Approach	Demand Volumes				Delay (s/veh)						LOS By Approach		LOS By Intersection		Queing Information (feet)								
																	Through			Left Turn			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Link Length	Avg.	Max	Storage	Avg.	Max	Storage	Avg.	Max
Ver. 2	US 52 at RI/RO	EB	0	0	30	30	0.0	A	0.0	A	0.8	A	0.8	A	1.3	A	500			0		0	500		
		WB	0	0	290	290	0.0	A	0.0	A	1.5	A	1.5	A			500			0		0	500		
	EB and WB Rights are "Free Movements"	NB	0	1185	175	1,360	0.0	A	1.5	A	2.3	A	1.6	A			2500			0		0	0		0
		SB	0	1585	210	1,795	0.0	A	0.9	A	2.8	A	1.1	A			2500			0		0	0		0

Version 2: 500 foot acceleration lanes for RI/RO access in both directions; no auxiliary lanes.

	Intersection	Approach	Demand Volumes				Delay (s/veh)						LOS By Approach		LOS By Intersection		Queing Information (feet)								
																	Through			Left Turn			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Link Length	Avg.	Max	Storage	Avg.	Max	Storage	Avg.	Max
Ver. 3	US 52 at RI/RO	EB	0	0	30	30	0.0	A	0.0	A	1.9	A	1.9	A	1.6	A	500			0		0	500		
		WB	0	0	290	290	0.0	A	0.0	A	4.4	A	4.4	A			500			0		0	500	15	200
	EB and WB Rights are "Yield Movements"	NB	0	1185	175	1,360	0.0	A	1.6	A	2.3	A	1.7	A			2500			0		0	0		0
		SB	0	1585	210	1,795	0.0	A	0.9	A	2.8	A	1.1	A			2500			0		0	0		0

Version 3: No auxiliary lanes or acceleration lanes for RI/RO access in both directions; yield condition.

3: Int Performance by lane

Lane	EB	WB	NB	NB	NB	SB	SB	SB	All
Movements Served	R	R	T	T	R	T	T	R	
Total Delay (hr)	0.0	0.1	0.1	0.4	0.1	0.1	0.3	0.2	1.3
Stop Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Stops	0	0	0	0	0	0	0	0	0
Travel Dist (mi)	3.6	30.0	42.9	87.9	16.5	69.9	103.3	14.1	368.2
Travel Time (hr)	0.1	0.9	0.7	1.9	0.6	1.1	2.0	0.7	8.1
Avg Speed (mph)	36	32	62	47	26	62	51	22	46
Fuel Used (gal)	0.0	0.5	1.8	2.3	0.2	2.4	3.9	0.2	11.4
Fuel Eff. (mpg)	86.6	56.3	23.3	38.8	100.1	28.7	26.4	91.5	32.4
HC Emissions (g)	1	9	34	34	2	47	71	1	199
CO Emissions (g)	28	411	1914	1341	40	2269	3595	18	9617
NOx Emissions (g)	1	19	108	133	2	159	243	1	667
Vehicles Entered	0	0	348	864	155	679	1130	0	3491
Vehicles Exited	30	285	428	767	172	640	945	223	3489
Hourly Exit Rate	30	285	428	767	172	640	945	223	3489
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0
Density (ft/veh)		724	832	309	895	493	270	762	584
Occupancy (veh)	0	1	1	2	1	1	2	1	8

6: Int Performance by lane

Lane	WB	NB	NB	SB	SB	SB	All
Movements Served	R	T	T	T	T	R	
Total Delay (hr)	0.1	0.0	0.1	0.0	0.1	0.0	0.4
Stop Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total Stops	0	0	1	0	0	0	1
Travel Dist (mi)	70.7	141.5	173.7	44.6	83.0	40.8	554.3
Travel Time (hr)	1.3	2.2	3.0	0.7	1.4	0.7	9.3
Avg Speed (mph)	54	65	59	66	59	59	60
Fuel Used (gal)	3.5	5.5	5.5	1.6	2.6	1.5	20.2
Fuel Eff. (mpg)	20.2	25.5	31.8	27.7	32.5	28.1	27.5
HC Emissions (g)	71	100	96	30	45	28	371
CO Emissions (g)	4312	5511	4186	1401	1708	1290	18411
NOx Emissions (g)	193	331	373	107	190	102	1296
Vehicles Entered	0	0	0	432	858	325	2981
Vehicles Exited	508	339	520	420	755	440	2982
Hourly Exit Rate	508	339	520	420	755	440	2982
Denied Entry Before	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0
Density (ft/veh)	558	884	651	812	391	801	676
Occupancy (veh)	1	2	3	1	1	1	9

Total Network Performance

Total Delay (hr)	9.0
Delay / Veh (s)	9.3
Stop Delay (hr)	0.4
St Del/Veh (s)	0.4
Total Stops	3
Stop/Veh	0.00
Travel Dist (mi)	5409.1
Travel Time (hr)	96.6
Avg Speed (mph)	56
Fuel Used (gal)	192.7
Fuel Eff. (mpg)	28.1
HC Emissions (g)	3485
CO Emissions (g)	164396
NOx Emissions (g)	12617
Vehicles Entered	3492
Vehicles Exited	3485
Hourly Exit Rate	3485
Input Volume	19146
% of Volume	18
Denied Entry Before	1
Denied Entry After	0
Density (ft/veh)	344
Occupancy (veh)	96

3: Int Performance by lane

Lane	EB	WB	NB	NB	NB	SB	SB	SB	All
Movements Served	R	R	T	T	R	T	T	R	
Total Delay (hr)	0.0	0.1	0.1	0.5	0.1	0.1	0.3	0.2	1.3
Stop Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Stops	0	0	0	0	0	0	0	0	0
Travel Dist (mi)	3.6	30.0	46.0	89.6	11.8	70.2	103.0	14.1	368.2
Travel Time (hr)	0.1	0.9	0.7	1.9	0.5	1.1	2.0	0.7	8.0
Avg Speed (mph)	36	32	64	46	23	63	51	22	46
Fuel Used (gal)	0.0	0.5	1.9	2.6	0.1	2.5	3.9	0.2	11.7
Fuel Eff. (mpg)	86.6	56.3	23.9	34.8	95.8	28.3	26.5	91.5	31.4
HC Emissions (g)	1	9	36	41	1	48	70	1	206
CO Emissions (g)	28	411	1994	1896	18	2277	3525	18	10168
NOx Emissions (g)	1	19	116	143	1	164	242	1	686
Vehicles Entered	0	0	393	973	0	680	1129	0	3490
Vehicles Exited	30	285	448	747	172	646	940	223	3489
Hourly Exit Rate	30	285	448	747	172	646	940	223	3489
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0
Density (ft/veh)		724	794	296	998	496	272	762	579
Occupancy (veh)	0	1	1	2	1	1	2	1	8

6: Int Performance by lane

Lane	WB	NB	NB	SB	SB	SB	All
Movements Served	R	T	T	T	T	R	
Total Delay (hr)	0.1	0.0	0.1	0.0	0.1	0.0	0.5
Stop Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total Stops	3	0	3	0	0	0	6
Travel Dist (mi)	70.7	141.4	173.8	48.7	91.2	28.5	554.4
Travel Time (hr)	1.4	2.2	3.0	0.8	1.6	0.5	9.5
Avg Speed (mph)	51	65	58	64	58	60	59
Fuel Used (gal)	3.4	5.6	5.4	1.8	3.2	1.2	20.6
Fuel Eff. (mpg)	21.1	25.4	32.3	26.4	28.1	23.2	26.9
HC Emissions (g)	68	100	94	37	59	24	383
CO Emissions (g)	4039	5548	4159	1788	2718	1316	19569
NOx Emissions (g)	184	330	360	122	222	76	1295
Vehicles Entered	0	0	0	482	1133	0	2981
Vehicles Exited	508	337	522	445	730	440	2983
Hourly Exit Rate	508	337	522	445	730	440	2983
Denied Entry Before	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0
Density (ft/veh)	531	884	642	727	353		661
Occupancy (veh)	1	2	3	1	2	0	9

Total Network Performance

Total Delay (hr)	9.7
Delay / Veh (s)	10.0
Stop Delay (hr)	0.4
St Del/Veh (s)	0.4
Total Stops	7
Stop/Veh	0.00
Travel Dist (mi)	5408.9
Travel Time (hr)	97.4
Avg Speed (mph)	56
Fuel Used (gal)	193.8
Fuel Eff. (mpg)	27.9
HC Emissions (g)	3507
CO Emissions (g)	165988
NOx Emissions (g)	12630
Vehicles Entered	3492
Vehicles Exited	3486
Hourly Exit Rate	3486
Input Volume	19146
% of Volume	18
Denied Entry Before	1
Denied Entry After	0
Density (ft/veh)	311
Occupancy (veh)	97

3: Int Performance by lane

Lane	EB	WB	NB	NB	NB	SB	SB	SB	All
Movements Served	R	R	T	T	R	T	T	R	
Total Delay (hr)	0.0	0.3	0.2	0.4	0.1	0.1	0.3	0.2	1.6
Stop Delay (hr)	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total Stops	0	19	0	0	0	0	0	0	19
Travel Dist (mi)	3.7	30.6	62.5	73.2	11.8	72.9	100.4	14.1	369.1
Travel Time (hr)	0.1	1.3	1.1	1.6	0.5	1.2	2.0	0.7	8.5
Avg Speed (mph)	29	24	57	45	23	62	50	22	43
Fuel Used (gal)	0.0	0.7	2.7	2.3	0.1	2.6	3.8	0.2	12.5
Fuel Eff. (mpg)	91.3	41.6	23.0	32.1	95.8	27.8	26.1	91.5	29.5
HC Emissions (g)	1	11	50	36	1	50	69	1	219
CO Emissions (g)	22	515	2891	1809	18	2433	3491	18	11198
NOx Emissions (g)	1	27	156	123	1	170	239	1	718
Vehicles Entered	0	0	393	973	0	681	1128	0	3490
Vehicles Exited	30	284	699	497	172	689	896	223	3489
Hourly Exit Rate	30	284	699	497	172	689	896	223	3489
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0
Density (ft/veh)		517	527	355	998	472	275	761	547
Occupancy (veh)	0	1	1	2	1	1	2	1	8

6: Int Performance by lane

Lane	WB	NB	NB	SB	SB	SB	All
Movements Served	R	T	T	T	T	R	
Total Delay (hr)	0.1	0.0	0.1	0.0	0.1	0.0	0.5
Stop Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total Stops	3	0	3	0	0	0	6
Travel Dist (mi)	70.7	141.4	173.8	49.2	90.7	28.5	554.4
Travel Time (hr)	1.4	2.2	3.0	0.8	1.5	0.5	9.5
Avg Speed (mph)	52	65	58	65	59	60	59
Fuel Used (gal)	3.4	5.6	5.4	1.9	3.2	1.2	20.6
Fuel Eff. (mpg)	21.1	25.4	32.2	26.5	28.1	23.4	26.9
HC Emissions (g)	68	100	95	36	60	24	383
CO Emissions (g)	4061	5536	4157	1776	2723	1298	19553
NOx Emissions (g)	186	330	361	121	223	75	1297
Vehicles Entered	0	0	0	488	1127	0	2981
Vehicles Exited	508	338	522	448	726	441	2984
Hourly Exit Rate	508	338	522	448	726	441	2984
Denied Entry Before	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0
Density (ft/veh)	534	884	642	722	355		662
Occupancy (veh)	1	2	3	1	2	0	9

Total Network Performance

Total Delay (hr)	11.6
Delay / Veh (s)	11.9
Stop Delay (hr)	1.9
St Del/Veh (s)	2.0
Total Stops	270
Stop/Veh	0.08
Travel Dist (mi)	5408.8
Travel Time (hr)	99.5
Avg Speed (mph)	55
Fuel Used (gal)	194.7
Fuel Eff. (mpg)	27.8
HC Emissions (g)	3524
CO Emissions (g)	167749
NOx Emissions (g)	12614
Vehicles Entered	3492
Vehicles Exited	3484
Hourly Exit Rate	3484
Input Volume	19146
% of Volume	18
Denied Entry Before	1
Denied Entry After	0
Density (ft/veh)	292
Occupancy (veh)	99

3: Int Performance by lane

Lane	EB	WB	NB	NB	NB	SB	SB	SB	All
Movements Served	R	R	T	T	R	T	T	R	
Total Delay (hr)	0.0	0.1	0.1	0.4	0.1	0.0	0.1	0.0	0.8
Stop Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Stops	0	0	0	0	0	0	0	0	0
Travel Dist (mi)	2.5	29.1	33.8	83.8	16.9	39.7	72.2	4.0	282.0
Travel Time (hr)	0.1	0.9	0.5	1.7	0.7	0.6	1.3	0.2	6.0
Avg Speed (mph)	36	33	62	48	26	66	57	22	47
Fuel Used (gal)	0.0	0.5	1.5	2.2	0.2	1.4	2.4	0.0	8.3
Fuel Eff. (mpg)	101.2	58.0	22.5	37.5	99.9	27.7	30.7	97.2	34.2
HC Emissions (g)	0	8	29	34	2	27	41	0	142
CO Emissions (g)	11	371	1629	1362	39	1273	1776	4	6465
NOx Emissions (g)	0	16	88	134	2	93	164	0	498
Vehicles Entered	0	0	266	823	159	382	729	0	2659
Vehicles Exited	21	277	345	728	176	370	678	64	2659
Hourly Exit Rate	21	277	345	728	176	370	678	64	2659
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0
Density (ft/veh)		747	1061	331	870	922	432		788
Occupancy (veh)	0	1	1	2	1	1	1	0	6

6: Int Performance by lane

Lane	WB	NB	NB	SB	SB	SB	All
Movements Served	R	T	T	T	T	R	
Total Delay (hr)	0.1	0.0	0.0	0.0	0.0	0.0	0.4
Stop Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total Stops	0	0	1	0	0	0	1
Travel Dist (mi)	88.2	99.0	126.8	26.7	60.0	24.5	425.2
Travel Time (hr)	1.6	1.5	2.2	0.4	1.0	0.4	7.2
Avg Speed (mph)	54	66	59	68	60	60	60
Fuel Used (gal)	4.2	3.9	3.9	1.0	1.8	0.9	15.7
Fuel Eff. (mpg)	21.1	25.6	32.3	27.0	33.3	28.4	27.1
HC Emissions (g)	76	79	78	18	30	16	297
CO Emissions (g)	4792	3989	3116	848	1115	733	14596
NOx Emissions (g)	217	248	290	64	135	59	1014
Vehicles Entered	0	0	0	259	619	189	2315
Vehicles Exited	634	231	384	252	546	269	2316
Hourly Exit Rate	634	231	384	252	546	269	2316
Denied Entry Before	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0
Density (ft/veh)	443	1283	896		548		878
Occupancy (veh)	2	2	2	0	1	0	7

Total Network Performance

Total Delay (hr)	5.4
Delay / Veh (s)	7.4
Stop Delay (hr)	0.2
St Del/Veh (s)	0.3
Total Stops	3
Stop/Veh	0.00
Travel Dist (mi)	4079.4
Travel Time (hr)	71.3
Avg Speed (mph)	57
Fuel Used (gal)	144.5
Fuel Eff. (mpg)	28.2
HC Emissions (g)	2602
CO Emissions (g)	120766
NOx Emissions (g)	9575
Vehicles Entered	2658
Vehicles Exited	2657
Hourly Exit Rate	2657
Input Volume	14691
% of Volume	18
Denied Entry Before	0
Denied Entry After	0
Density (ft/veh)	465
Occupancy (veh)	71

3: Int Performance by lane

Lane	EB	WB	NB	NB	NB	SB	SB	SB	All
Movements Served	R	R	T	T	R	T	T	R	
Total Delay (hr)	0.0	0.1	0.1	0.4	0.1	0.0	0.1	0.0	0.8
Stop Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Stops	0	0	0	0	0	0	0	0	0
Travel Dist (mi)	2.5	29.1	37.1	85.3	12.1	39.7	72.2	4.0	282.0
Travel Time (hr)	0.1	0.9	0.6	1.8	0.5	0.6	1.3	0.2	6.0
Avg Speed (mph)	36	33	64	47	23	66	56	22	47
Fuel Used (gal)	0.0	0.5	1.6	2.5	0.1	1.5	2.3	0.0	8.6
Fuel Eff. (mpg)	101.2	58.0	23.1	33.9	95.0	27.4	30.8	97.2	32.7
HC Emissions (g)	0	8	31	42	1	27	42	0	152
CO Emissions (g)	11	371	1735	1941	15	1287	1762	4	7126
NOx Emissions (g)	0	16	97	146	0	95	165	0	520
Vehicles Entered	0	0	310	937	0	383	729	0	2659
Vehicles Exited	21	277	366	707	176	370	678	64	2659
Hourly Exit Rate	21	277	366	707	176	370	678	64	2659
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0
Density (ft/veh)		747	986	315	971	923	432		778
Occupancy (veh)	0	1	1	2	1	1	1	0	6

6: Int Performance by lane

Lane	WB	NB	NB	SB	SB	SB	All
Movements Served	R	T	T	T	T	R	
Total Delay (hr)	0.1	0.0	0.1	0.0	0.1	0.0	0.4
Stop Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total Stops	2	0	4	0	0	0	6
Travel Dist (mi)	88.2	98.7	127.0	27.7	66.2	17.3	425.2
Travel Time (hr)	1.7	1.5	2.2	0.4	1.1	0.3	7.3
Avg Speed (mph)	52	66	58	67	60	61	59
Fuel Used (gal)	4.0	3.9	3.9	1.0	2.2	0.7	15.8
Fuel Eff. (mpg)	21.8	25.5	32.8	26.7	30.2	24.4	27.0
HC Emissions (g)	73	79	76	19	39	13	300
CO Emissions (g)	4561	4013	3059	925	1644	707	14911
NOx Emissions (g)	210	249	282	67	158	43	1008
Vehicles Entered	0	0	0	271	795	0	2315
Vehicles Exited	634	232	383	257	540	270	2316
Hourly Exit Rate	634	232	383	257	540	270	2316
Denied Entry Before	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0
Density (ft/veh)	431	1284	881		496		860
Occupancy (veh)	2	2	2	0	1	0	7

Total Network Performance

Total Delay (hr)	5.9
Delay / Veh (s)	8.0
Stop Delay (hr)	0.2
St Del/Veh (s)	0.3
Total Stops	7
Stop/Veh	0.00
Travel Dist (mi)	4079.1
Travel Time (hr)	71.8
Avg Speed (mph)	57
Fuel Used (gal)	145.3
Fuel Eff. (mpg)	28.1
HC Emissions (g)	2614
CO Emissions (g)	122024
NOx Emissions (g)	9581
Vehicles Entered	2658
Vehicles Exited	2656
Hourly Exit Rate	2656
Input Volume	14691
% of Volume	18
Denied Entry Before	0
Denied Entry After	0
Density (ft/veh)	422
Occupancy (veh)	72

3: Int Performance by lane

Lane	EB	WB	NB	NB	NB	SB	SB	SB	All
Movements Served	R	R	T	T	R	T	T	R	
Total Delay (hr)	0.0	0.3	0.1	0.3	0.1	0.0	0.1	0.0	1.1
Stop Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Stops	0	9	0	0	0	0	0	0	9
Travel Dist (mi)	2.6	29.7	53.3	69.2	12.1	40.9	71.1	4.0	282.8
Travel Time (hr)	0.1	1.2	0.9	1.5	0.5	0.6	1.3	0.2	6.4
Avg Speed (mph)	29	25	57	46	23	66	56	22	45
Fuel Used (gal)	0.0	0.7	2.4	2.2	0.1	1.5	2.3	0.0	9.3
Fuel Eff. (mpg)	107.8	43.7	22.6	31.8	95.0	27.2	30.3	97.1	30.5
HC Emissions (g)	0	9	46	37	1	28	42	0	163
CO Emissions (g)	5	461	2589	1809	16	1343	1785	4	8012
NOx Emissions (g)	0	23	139	123	1	98	165	0	549
Vehicles Entered	0	0	311	937	0	382	729	0	2660
Vehicles Exited	21	277	614	459	176	389	659	64	2660
Hourly Exit Rate	21	277	614	459	176	389	659	64	2660
Denied Entry Before	0	0	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0	0	0
Density (ft/veh)		552	616	381	971	893	437		732
Occupancy (veh)	0	1	1	2	1	1	1	0	6

6: Int Performance by lane

Lane	WB	NB	NB	SB	SB	SB	All
Movements Served	R	T	T	T	T	R	
Total Delay (hr)	0.1	0.0	0.1	0.0	0.0	0.0	0.4
Stop Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total Stops	1	0	4	0	0	0	5
Travel Dist (mi)	88.2	98.8	126.9	28.2	65.7	17.3	425.2
Travel Time (hr)	1.7	1.5	2.2	0.4	1.1	0.3	7.3
Avg Speed (mph)	52	66	58	67	60	61	59
Fuel Used (gal)	4.0	3.9	3.9	1.1	2.2	0.7	15.8
Fuel Eff. (mpg)	21.8	25.5	32.8	26.5	30.1	24.4	27.0
HC Emissions (g)	73	79	76	20	39	13	300
CO Emissions (g)	4560	4017	3057	949	1639	707	14932
NOx Emissions (g)	210	249	282	68	156	43	1009
Vehicles Entered	0	0	0	276	790	0	2315
Vehicles Exited	634	232	383	262	535	270	2316
Hourly Exit Rate	634	232	383	262	535	270	2316
Denied Entry Before	0	0	0	0	0	0	0
Denied Entry After	0	0	0	0	0	0	0
Density (ft/veh)	431	1284	882		499		860
Occupancy (veh)	2	2	2	0	1	0	7

Total Network Performance

Total Delay (hr)	7.2
Delay / Veh (s)	9.7
Stop Delay (hr)	1.2
St Del/Veh (s)	1.6
Total Stops	232
Stop/Veh	0.09
Travel Dist (mi)	4078.8
Travel Time (hr)	73.4
Avg Speed (mph)	56
Fuel Used (gal)	146.0
Fuel Eff. (mpg)	27.9
HC Emissions (g)	2626
CO Emissions (g)	123390
NOx Emissions (g)	9568
Vehicles Entered	2658
Vehicles Exited	2655
Hourly Exit Rate	2655
Input Volume	14691
% of Volume	18
Denied Entry Before	0
Denied Entry After	0
Density (ft/veh)	396
Occupancy (veh)	73