APPENDIX C

TECHNICAL MEMORANDA

- Traffic Study (March 5, 2009)
- Safety and Operations Analysis Memorandum (October 16, 2008)

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SRF No. 0076461

MEMORANDUM

TO: Michael Turner, PE, Principal

FROM: Marie Cote, PE, Principal
Carla Stueve, PE, PTOE, Associate

DATE: March 5, 2009

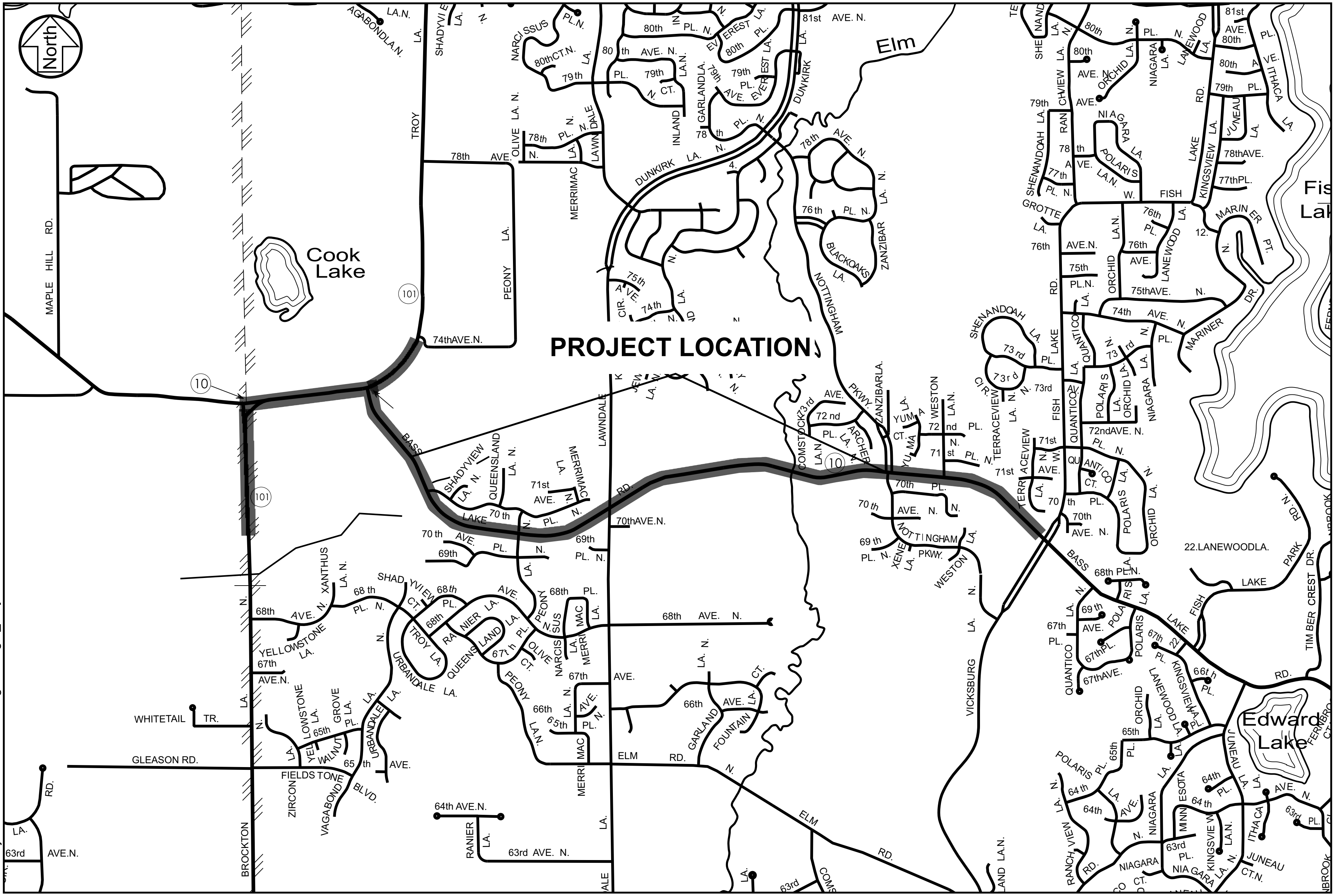
SUBJECT: CSAH 10 Reconstruction Project - Traffic Study
City of Maple Grove, Hennepin County, Minnesota

INTRODUCTION

This memo contains the traffic study results for the proposed CSAH 10 (Bass Lake Road) reconstruction project in the City of Maple Grove, Minnesota. The study limits extend from approximately 400 feet west of Vicksburg Lane to the west junction of CSAH 101 (Brockton Lane), as shown in Figure 1. Currently, this roadway is an undivided two-lane roadway. The proposed upgrade will consist of a four-lane divided urban roadway with dedicated turn lanes at major intersections. In addition, the intersection of CSAH 10/CSAH 101, which currently consists of two off-set intersections, will be realigned to provide a 90-degree four-legged intersection. The realignment of this intersection provides better north-south and east-west mobility and better control of turning movements at a single, controlled intersection.

The purpose of this study is to analyze the current and future operations of this roadway corridor and determine necessary improvements to accommodate the future traffic growth in the area. It includes an operations analysis for the a.m. and p.m. peak periods for the following conditions:

- Existing
- Year 2030 No Build
- Year 2030 Build



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Project Location

Bass Lake Road Reconstruction Project

City of Maple Grove

Figure 1

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The following key intersections are included in the analysis:

- CSAH 10 and Brockton Lane (CSAH 101 west junction)
- CSAH 10 and Troy Lane (CSAH 101 east junction)
- CSAH 10 and Peony Lane
- CSAH 10 and Lawndale Lane
- CSAH 10 and Jewel Lane
- CSAH 10 and Nottingham Parkway

TRAFFIC ANALYSIS

An operations analysis was conducted at the key intersections to determine how traffic currently operates in the study area. The operations analysis is based on methods and performance criteria identified in the *2000 Highway Capacity Manual* (see Table 1: Level of Service Criteria). All signalized intersections were analyzed using the Synchro/SimTraffic software and unsignalized intersections were analyzed using the Synchro/SimTraffic software and the Highway Capacity Manual methodology. For future year 2030 conditions, the traffic operations model was allowed to optimize traffic signal timing parameters.

Table 1
Level of Service Criteria
Signalized and Unsignalized Intersections

LOS Designation	Unsignalized Intersection Average Delay/Vehicle (seconds)	Signalized Intersection Average Delay/Vehicle (seconds)
A	< 10	< 10
B	> 10 – 15	> 10 - 20
C	> 15 – 25	> 20 - 35
D	> 25 – 35	> 35 - 55
E	> 35 – 50	> 55 - 80
F	> 50	> 80

Capacity analysis results identify a Level of Service (LOS), which indicates how well an intersection is operating. The LOS results are based on average delay per vehicle. Intersections are given a ranking from LOS A through LOS F. LOS A indicates the best traffic operation and LOS F indicates an intersection where demand exceeds capacity. LOS A through D is generally considered acceptable by drivers.

For side-street stop controlled intersections, special emphasis is given to providing an estimate for the level of service of the minor approach. The traffic operations at an unsignalized intersection with side-street stop control can be described in two ways. First, consideration is given to the overall intersection level of service. This takes into account the total number of vehicles entering the intersection and the capability of the intersection to support those volumes. Second, it is important to consider the delay on the minor approach. Since the mainline does not have to stop, the majority of delay is attributed to the side-street approaches.

EXISTING CONDITIONS

Existing a.m. and p.m. peak hour turning movement volumes were collected by SRF Consulting Group, Inc. in May 2008. Current traffic control includes side-street stop control at the intersections of CSAH 10 at Brockton Lane (CSAH 101 west junction), Peony Lane, and Jewel Lane and all-way stop control at the intersection of CSAH 10/Troy Lane (CSAH 101 east junction). The intersections of CSAH 10/Lawndale Lane and CSAH 10/Nottingham Parkway are signalized intersections. Existing signal timing, obtained from Hennepin County, was used in this analysis. Existing peak hour volumes for the a.m. and p.m. peak periods, current geometrics and traffic control at the key intersections are shown in Figure 2.

Results of the analysis shown in Table 2 indicate that all intersections are operating at an acceptable overall level of service, with the exception of CSAH 10/Troy Lane (CSAH 101 east junction). This intersection, which is all-way stop control, is currently operating at LOS E during the p.m. peak hour.

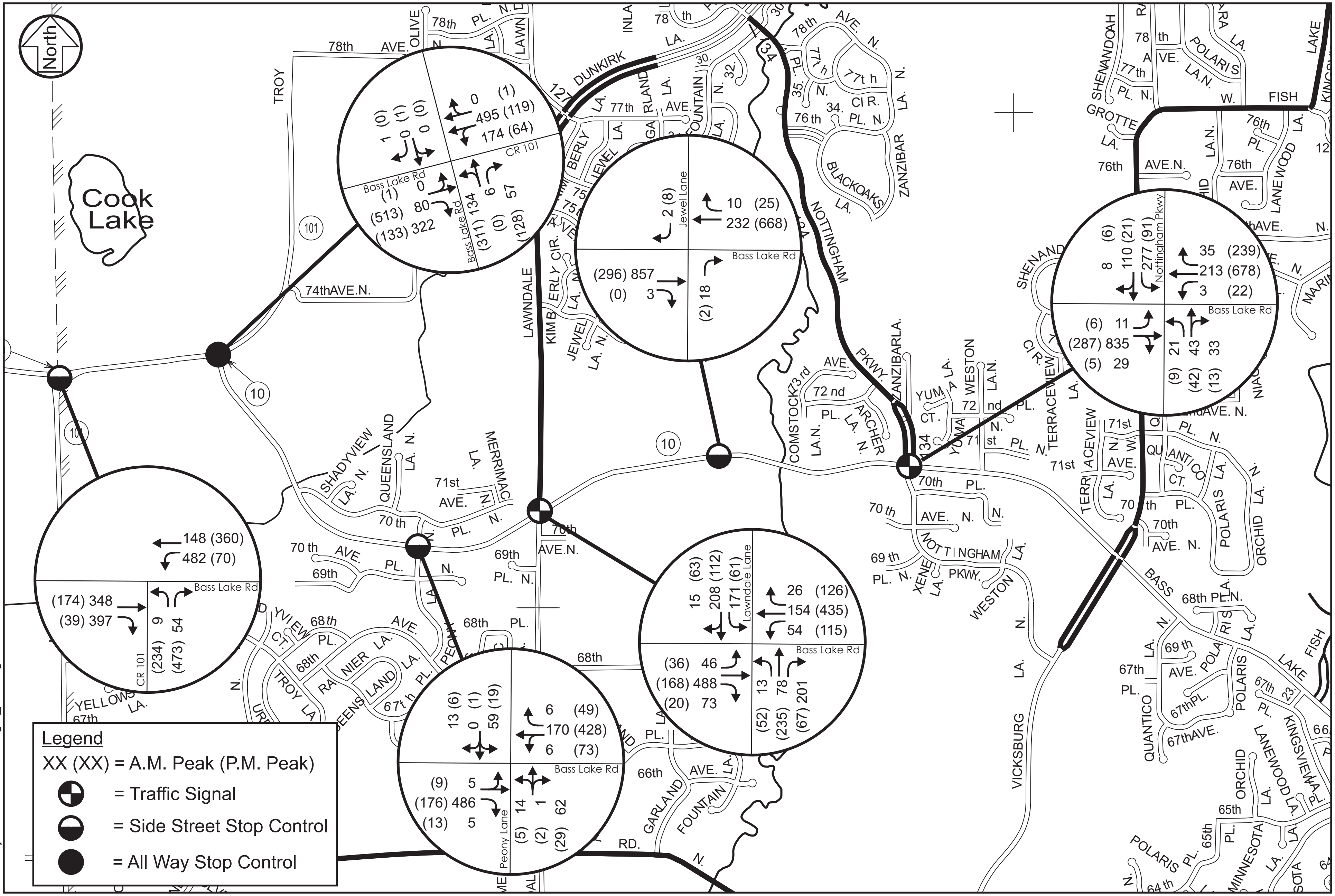
Table 2
Traffic Operations Analysis
Existing Conditions

Intersection	Level of Service	
	A.M Peak	**P.M. Peak**
CSAH 10 and Brockton Lane (CSAH 101 west junction)(1)	A/**E**	B/C
CSAH 10 and Troy Lane (CSAH 101 east junction)(2)	C	**E**
CSAH 10 and Peony Lane(1)	A/C	A/C
CSAH 10 and Lawndale Lane	C	C
CSAH 10 and Jewel Lane(1)	A/C	A/B
CSAH 10 and Nottingham Parkway	C	B

Notes:
(1) Indicates an unsignalized intersection with side-street stop control. LOS: overall intersection/worst approach.
(2) Indicates an unsignalized intersection with all-way stop control.

TRAFFIC FORECASTS

Travel demand forecasts for the year 2030 were developed for CSAH 10 in the City of Maple Grove from CSAH 101 to Vicksburg Lane. Traffic forecasts for the a.m. and p.m. peak periods, in addition to daily forecasts, were developed for 2030 build conditions. The 2030 Maple Grove Transportation Plan was used to develop these forecasts, with some modifications to the network and land use, as indicated by the City. Turning movements were developed for the intersections of CSAH 10 at Brockton Lane (CSAH 101 west junction), Troy Lane (CSAH 101 east junction), Peony Lane, Lawndale Lane, Jewel Lane, and Nottingham Parkway.



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Existing Conditions

Bass Lake Road Reconstruction Project

City of Maple Grove

Figure 2

Forecast daily traffic volumes in the study area were compared with historical traffic volumes. Average annual daily traffic (AADT) volumes were obtained from the Mn/DOT flow maps for the years 1990 to 2007. Table 3 summarizes selected volumes from years 2005 and 2030 forecasts developed for this study. Historical yearly growth rates, determined using the *MnESAL Spreadsheet 2008,* are compared to projected growth rates for the 2030 forecasts.

Table 3
Historical and Forecast Growth Rates

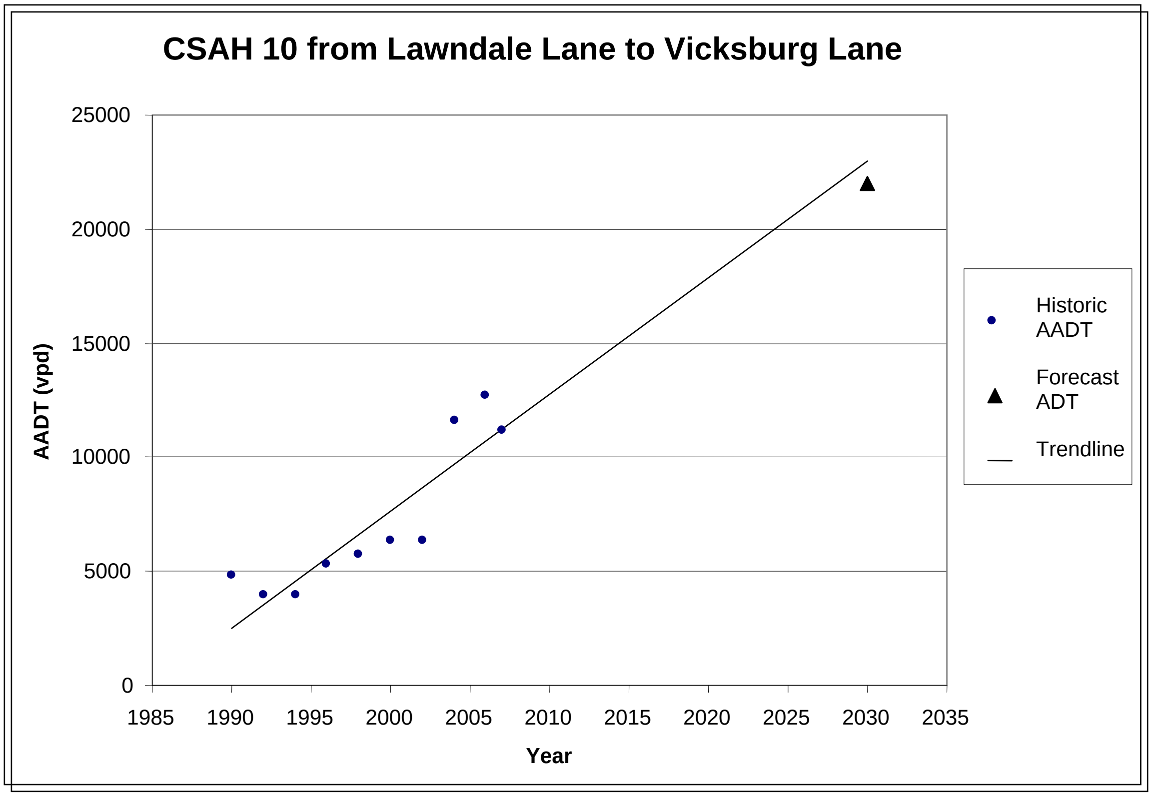
Roadway	Segment	Daily Traffic Volumes		Yearly Growth Rate	
		2005 (Historic)	2030 (Forecast)	Historic	Forecast
CSAH 10	Lawndale to Vicksburg Lane	11,200	22,000	2.91%	2.74%
Lawndale Lane	North of CSAH 10	5,800	15,600	4.12%	4.04%
Lawndale Lane	South of CSAH 10	6,700	11,000	4.63%	2.00%
Nottingham Parkway	North of CSAH 10	3,250	5,700	3.05%	2.27%

As shown in Table 3, the forecast growth rates in the project area are slightly lower than the historic growth rates. The corridor has experienced a high amount of historical growth as a result of rapid development in the area in recent years. As development in this area continues in the future, traffic volumes are expected to grow at rates near historical growth rates. This indicates that the corridor forecasts include a reasonable amount of growth. Figure 3 shows the specific historic daily volumes, forecast volumes, and trendline for CSAH 10 from Lawndale Lane to Vicksburg Lane. This also illustrates that the 2030 forecast is close to, but slightly lower than, the historic growth rate trendline.

To develop year 2030 traffic forecasts, the Year 2030 Maple Grove Transportation Plan and 2007 Mn/DOT ADT Traffic Flow Maps were used to estimate growth rates on each intersection approach along the corridor. The current peak hour volumes were found to be a high percentage of the daily traffic volumes (13-15 percent) due to a high volume of commuter traffic on this roadway.

The *TurnsW32* propensity model was used to estimate the year 2030 turning movement volumes. The forecast volumes were reviewed for reasonableness and revised accordingly to account for the future connection of Peony Lane and Lawndale Lane, in addition to the flattening of peaks and directional splits. Existing traffic counts show that there is currently a strong directional split in the eastbound direction during the a.m. peak hour and in the westbound direction during the p.m. peak hour. In the year 2030, increased development near the study area will result in more directionally balanced peak hour traffic along the corridor. Peak hour traffic forecasts were developed assuming the percentage of daily traffic occurring during the peak periods is reduced somewhat from current conditions (8-10 percent of the daily volume) for the a.m. and p.m. peak periods. Turning movements were estimated based on these assumptions using a turning movement propensity model.

Figure 3
Historical and Forecast Traffic Volumes



The 2030 build scenario (with four lanes on CSAH 10) resulted in daily traffic forecasts on this segment of CSAH 10 to range from 17,400 to 22,000 vehicles per day (vpd). The 2030 no build scenario includes no additional capacity on CSAH 10. However, the demand on CSAH 10 remains constant.

YEAR 2030 NO BUILD CONDITIONS

An operations analysis was conducted for the a.m. and p.m. peak hours for year 2030 no build conditions, assuming the existing intersection geometrics and traffic control along the corridor. The intersection of CSAH 10/Brockton Lane (CSAH 101 west junction) is currently side-street stop controlled and CSAH 10/Troy Lane (CSAH 101 east junction) is all-way stop controlled. Both of these intersections are assumed to be signalized for year 2030 no build conditions. However, the future realignment of these off-set intersections to one intersection was not assumed for no build conditions. A future intersection was assumed for year 2030 no build conditions at CSAH 10/Vagabond Lane. A traffic signal was assumed at this future intersection based on future development adjacent to the intersection. Results of the analysis are shown in Table 4.

Table 4
Traffic Operations Analysis
Year 2030 No Build Conditions

Intersection	Level of Service	
	A.M. Peak	P.M. Peak
CSAH 10 and Brockton Lane (CSAH 101 west junction)	**F**	**F**
CSAH 10 and Troy Lane (CSAH 101 east junction)	**F**	**F**
CSAH 10 and Vagabond Lane	**F**(1)	D
CSAH 10 and Peony Lane(2)	**F/F**	**F/F**
CSAH 10 and Lawndale Lane	**F**	**F**
CSAH 10 and Jewel Lane(2)	A/**F**	A/**E**
CSAH 10 and Nottingham Parkway	**F**	**F**

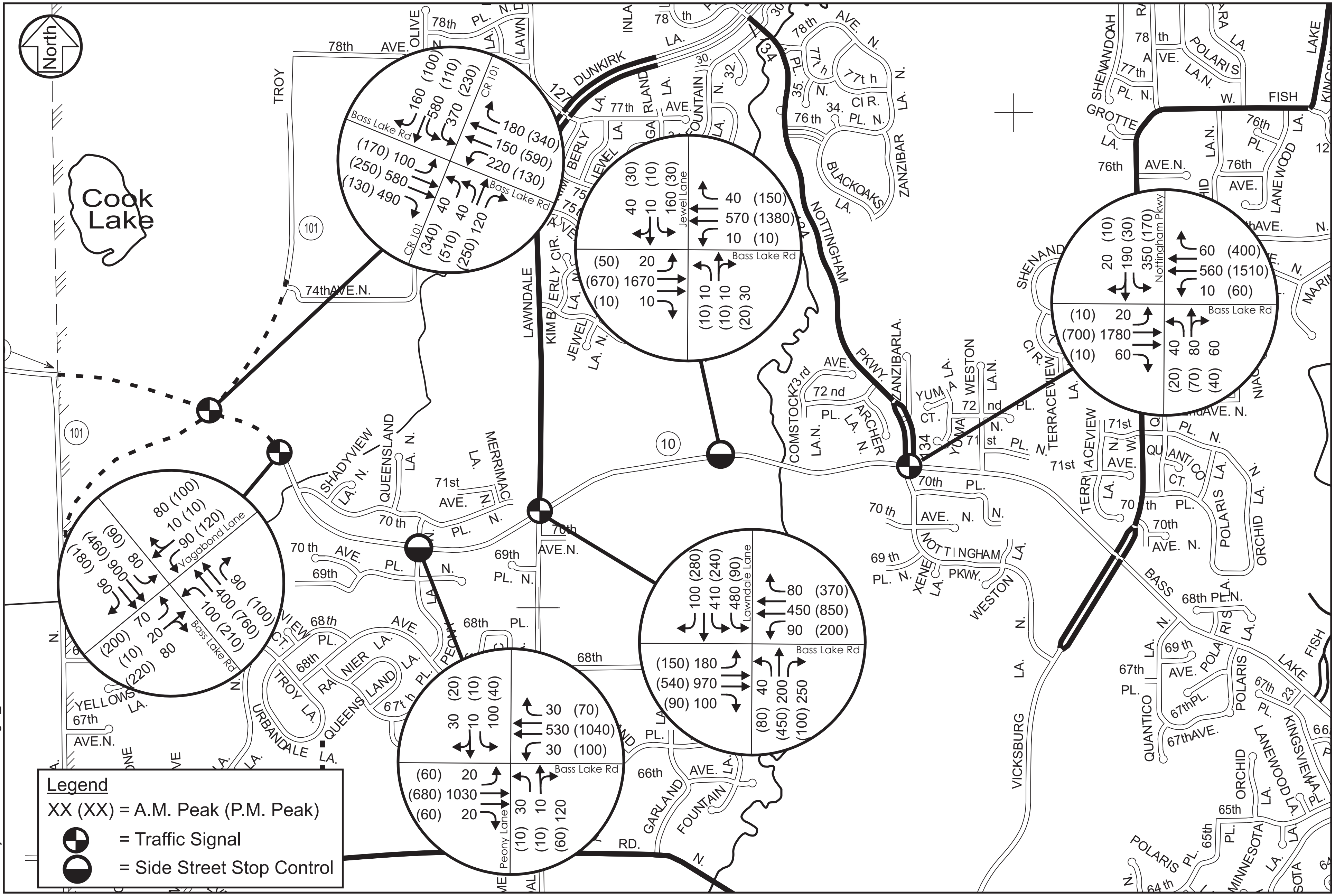
Notes:
(1) Poor operations due to queuing from adjacent intersections.
(2) Indicates an unsignalized intersection with side-street stop control. LOS: overall intersection/worst approach.

The operations analysis indicates that all key intersections are anticipated to operate at an unacceptable level of service during the peak hours with the exception of CSAH 10/Jewel Lane, which will operate at an acceptable overall level of service, with an unacceptable level of service on the side-street approaches.

YEAR 2030 BUILD CONDITIONS

For the current project, CSAH 10 from west of Vicksburg Lane to Brockton Lane (CSAH 101 west junction) will be reconstructed as a four-lane divided roadway with exclusive left and right-turn lanes and traffic signal control at the major key intersections. The intersections of CSAH 10/Peony Lane and CSAH 10/Jewel Lane are assumed to remain as side-street stop control, which is consistent with existing conditions. An operations analysis was conducted for the a.m. and p.m. peak periods for year 2030 build conditions with proposed geometrics and traffic control (see Figure 4). Analysis results are shown in Table 5.

Current intersection geometry at the intersection of CSAH 10 and CSAH 101 consists of two offset intersections, which will be realigned to one 90-degree intersection. Turning movements were developed for this realigned intersection based on current and future projected traffic patterns.



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Year 2030 Conditions

Bass Lake Road Reconstruction Project

City of Maple Grove

Figure 4

Table 5
Traffic Operations Analysis
Year 2030 Build Conditions

Intersection	**Level of Service**	
	A.M. Peak	**P.M. Peak**
CSAH 10 and CSAH 101	D	D
CSAH 10 and Vagabond Lane	B	C
CSAH 10 and Peony Lane(1)	A/D	A/**E**
CSAH 10 and Lawndale Lane	D	D
CSAH 10 and Jewel Lane(1)	A/**F**	A/**E**
CSAH 10 and Nottingham Parkway	D	C

Notes:
(1) Indicates an unsignalized intersection with side-street stop control. LOS: overall intersection/worst approach.

The operations analysis indicates that all key intersections are anticipated to operate at an overall acceptable level of service during the peak hours with the future geometric and traffic control improvements recommended for the corridor. However, at the side-street stop controlled intersections of CSAH 10/Peony Lane and CSAH 10/Jewel Lane, high levels of delay are expected resulting in an unacceptable level of service on the side-street approaches. The following geometrics are assumed for year 2030 conditions along the corridor. In general, standard 300-foot turn lanes were assumed.

<u>CSAH 10 and CSAH 101</u> (Signalized Intersection)

East and west approaches of CSAH 10:

- Exclusive left and right-turn lanes
- Two through lanes

North and south approaches of CSAH 101:

- Dual left-turn lanes
- One through lane*
- Exclusive right-turn lanes

* A shoulder area will be striped between the through lane and right-turn lane to accommodate the potential need for an additional through lane on CSAH 101.

<u>CSAH 10 and Vagabond Lane</u> (Signalized Intersection)

East and west approaches of CSAH 10:

- Exclusive left and right-turn lanes
- Two through lanes

North and south approaches of Vagabond Lane:

- Exclusive left-turn lanes
- Shared through/right-turn lane

<u>CSAH 10 and Peony Lane</u> (Side-Street Stop Control)

East and west approaches of CSAH 10:

- Exclusive left and right-turn lanes
- Two through lanes

North and south approaches of Peony Lane

- Exclusive left-turn lanes
- Shared through/right-turn lanes

<u>CSAH 10 and Lawndale Lane</u> (Signalized Intersection)

East and west approaches of CSAH 10:

- Exclusive left and right-turn lanes
- Two through lanes

North and south approaches of Lawndale Lane

- Dual southbound left-turn lanes
- Exclusive northbound left-turn lane
- One through lane
- Exclusive right-turn lanes

<u>CSAH 10 and Jewel Lane</u> (Side-Street Stop Control)

East and west approaches of CSAH 10:

- Exclusive left and right-turn lanes
- Two through lanes

North and south approaches of Jewel Lane

- Exclusive left-turn lanes
- Shared through/right-turn lanes

<u>CSAH 10 and Nottingham Parkway</u> (Signalized Intersection)

East and west approaches of CSAH 10:

- Exclusive left and right-turn lanes
- Two through lanes

North and south approaches of Nottingham Parkway

- o Exclusive left-turn lanes
- o Shared through/right-turn lanes

SUMMARY & CONCLUSIONS

Based on the traffic analysis for the CSAH 10 reconstruction project, the following conclusions are offered for consideration:

Existing Conditions: Currently, CSAH 10 between Vicksburg Lane and CSAH 101 is an undivided two-lane roadway with traffic signals at Lawndale Lane and Nottingham Parkway. Existing conditions along the corridor indicates that the CSAH 10/Troy Lane (CSAH 101 east junction) operates at an unacceptable LOS E during the p.m. peak hour. The remaining key intersections along the corridor currently operate at an acceptable overall LOS D or better during the peak periods.

Year 2030 No Build Conditions: In general, year 2030 no build conditions assumed the existing intersection geometrics and traffic control along the corridor. However, future traffic signals were assumed along CSAH 10 at the following intersections based on anticipated future development: Brockton Lane (CSAH 101 west junction), Troy Lane (CSAH 101 east junction), and Vagabond Lane (future intersection).

All key intersections are anticipated to operate at an unacceptable level of service during the peak hours with the exception of the side-street stop controlled intersection of CSAH 10/Jewel Lane, which will operate at an acceptable overall level of service, with high delay on the minor approaches.

Year 2030 Build Conditions: Reconstruction of CSAH 10 from west of Vicksburg Lane to Brockton Lane (CSAH 101 west junction) as a four-lane divided roadway with exclusive left and right-turn lanes and traffic signal control at the key intersections was assumed for future year 2030 conditions. The intersections of CSAH 10/Peony Lane and CSAH 10/Jewel Lane are assumed to remain as side-street stop controlled intersections for year 2030 build conditions. The realignment of CSAH 10 and CSAH 101, which currently consists of two offset intersections, will be realigned in the future to one 90-degree intersection. In addition to the realignment, the following geometrics are assumed for the north and south approaches of CSAH 101:

<u>CSAH 101</u> (Signalized Intersection)

- o Dual left-turn lanes
- o One through lane*
- o Exclusive right-turn lanes

* A shoulder area will be striped between the through lane and right-turn lane to accommodate the potential need for an additional through lane on CSAH 101.

The geometrics assumed on the north and south approaches to CSAH 10 for year 2030 build conditions are described below. With the future geometrics and traffic control, all key intersections will operate at an overall acceptable level of service during the peak hours for year 2030 build conditions. However, at the side-street stop controlled intersections of CSAH 10/Peony Lane and CSAH 10/Jewel Lane, high levels of delay are expected resulting in an unacceptable level of service on the side-street approaches.

Vagabond Lane (Signalized Intersection)

- Exclusive left-turn lanes
- Shared through/right-turn lane

Peony Lane (Side-Street Stop Control)

- Exclusive left-turn lanes
- Shared through/right-turn lanes

Lawndale Lane (Signalized Intersection)

- Dual southbound left-turn lanes
- Exclusive northbound left-turn lane
- One through lane
- Exclusive right-turn lanes

Jewel Lane (Side-Street Stop Control)

- Exclusive left-turn lanes
- Shared through/right-turn lanes

Nottingham Parkway (Signalized Intersection)

- Exclusive left-turn lanes
- Shared through/right-turn lanes

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MEMORANDUM

TO: Michael Turner, PE, Principal

FROM: Marie Cote, PE, Principal
Carla Stueve, PE, PTOE, Associate

DATE: October 16, 2008

SUBJECT: CSAH 10 Reconstruction Project
Proposed Alignment: Safety and Operations Analysis

INTRODUCTION

This memo contains the traffic analysis that supports the current proposed alignment of CSAH 10 (Bass Lake Road) from Vicksburg Lane to the west junction of CSAH 101 (Brockton Lane) in the City of Maple Grove, Minnesota. Currently, CSAH 10 is a two-lane undivided roadway with areas of steep grades and sharp horizontal curves. The proposed upgrade will consist of a four-lane divided urban roadway with dedicated turn lanes at major intersections. In addition, improvements to the horizontal and vertical alignment are recommended to improve the safety and operations of the corridor. This memo includes the analysis of safety, traffic operations and intersection alignment.

CRASH ANALYSIS

Safety is important to both the general public and those responsible for maintaining the roadway. To better understand the extent and severity of safety issues at the current offset intersections of CSAH 10 at Brockton Lane (CSAH 101 West Junction) and Troy Lane (CSAH 101 East Junction), an intersection crash analysis was completed using Hennepin County crash data for the three-year period from 2004 through 2006. This data was compared to an average crash rate for similar types of intersections in Hennepin County. The intersection of CSAH 10/CSAH 101 (West Junction) is currently a side-street stop controlled T-intersection and CSAH 10/CSAH 101 (East Junction) is an all-way stop controlled four-legged intersection.

In addition to an average crash rate, the critical crash rate was also calculated to determine the statistical significance of the crash rate comparison. The critical rate is often referred to as the quality control technique for identifying hazardous locations, since it identifies locations that have a crash rate significantly higher than similar locations. Table 1 displays the resultant crash rate calculations.

Table 1
Crash Rate Analysis*
Existing Conditions

Intersection	Number of Crashes	Calculated Crash Rate	County Average Crash Rate	Calculated Critical Crash Rate
CSAH 10/CSAH 101 (West Junction)	3	0.31	0.25	0.65
CSAH 10/CSAH 101 (East Junction)	9	0.86	0.37	0.88

* Note: The crash rate was calculated for the three-year period from 2004-2006.

Both intersections currently have crash rates that exceed the Hennepin County average crash rate for similar types of intersections. However, neither intersection currently exceeds the critical crash rate, although the CSAH 10/CSAH 101 (East Junction) intersection is near the critical threshold.

A crash analysis was conducted for year 2030 conditions to determine the estimated number of yearly crashes at these intersections. This was completed by using the Hennepin County average crash rates for various types of intersections and Year 2030 Average Daily Traffic (ADT) volumes to calculate an estimated number of crashes per year. Under the no build alternative the intersections will remain as two offset intersections with the installation of traffic signals. The analysis for 2030 build conditions includes realignment of these intersections to one 90-degree signalized intersection with geometric improvements.

The crash frequency for existing and 2030 conditions is shown in Table 2. Currently at these two intersections there are a combined total of four crashes per year. In the year 2030, if the intersections are not improved with the exception of a traffic signal, the number of crashes will increase to nine crashes per year. With the off-set intersections reconstructed into one signalized intersection and geometric improvements to include turn lanes and channelization, the number of crashes will decrease to five per year.

Table 2
Crash Frequency
Existing and Year 2030 Conditions

Intersection	Crash Frequency		
	Existing	2030 No Build	2030 Build
CSAH 10/CSAH 101 (West Junction)	1	3	5
CSAH 10/CSAH 101 (East Junction)	3	6	
Total	**4**	**9**	**5**

Additional consideration was given to the installation of a roundabout for future build 2030 conditions at the reconstructed intersection of CSAH 10/CSAH 101. There is limited information available for safety of modern roundabouts in Minnesota. Historically, crash rates at intersections have shown a decrease in crashes for intersections that have been converted from a conventional signalized intersection to a modern roundabout.

Studies have determined the installation of a roundabout can improve overall safety of an intersection when compared to other forms of intersection control. Roundabouts typically have fewer conflict points than conventional intersections and the geometry of a roundabout induces lower speeds for vehicles approaching and traversing an intersection. With lower speeds, the severity of the crashes is decreased. A study completed for the Insurance Institute for Highway Safety (IIHS), found a 39 percent reduction for all crash types at signalized or stop controlled intersections converted to modern roundabouts. The study also estimated a 76 percent reduction for injury crashes.

However, these studies did not take into consideration all safety aspects of a roundabout (e.g – multi-lane approaches, right-turn bypasses, etc.). Multi-lane roundabouts are uncommon in the United States, where drivers are unfamiliar with the environment and the possibility exists that the frequency and severity of side-swipe crashes in the circulating roadway could increase when compared to a single-lane roundabout. Some data has shown higher crash rates associated with multi-lane roundabouts compared to signalized intersections, although the severity rates are shown to decrease, since a roundabout eliminates right-angle and left-turn head-on crashes. The forecast traffic volumes for the intersection of CSAH 10/CSAH 101 would require it to be designed as a multi-lane roundabout. Therefore, the number of crashes is not expected to be significantly lower than with a signal. However, the crash severity rate would be expected to be lower.

TRAFFIC OPERATIONS

An operations analysis was completed to compare the vehicle delay between existing and year 2030 no build and build conditions. The intersections were analyzed using the Synchro/SimTraffic software and the Highway Capacity Manual methodology. The operations for the unsignalized intersections with side-street stop control were described in two ways. First, the overall intersection delay is shown, followed by the delay on the side-street approach. Since the mainline does not have to stop, the majority of delay can be attributed to the side-street approaches.

Table 3
Traffic Operations Analysis
Existing and Year 2030 Conditions

<table>
<tr><th rowspan="3">Intersection</th><th colspan="6">Average Delay Per Vehicle</th></tr>
<tr><th colspan="2">Existing</th><th colspan="2">2030 No Build</th><th colspan="2">2030 Build</th></tr>
<tr><th>A.M. Peak</th><th>P.M. Peak</th><th>A.M. Peak</th><th>P.M. Peak</th><th>A.M. Peak</th><th>P.M. Peak</th></tr>
<tr><td>CSAH 10/CSAH 101 (West Junction)</td><td>8 / 40 seconds(1)</td><td>11 / 20 seconds(1)</td><td>2.5 minutes</td><td>≈ 5 minutes</td><td rowspan="2">50 seconds</td><td rowspan="2">37 seconds</td></tr>
<tr><td>CSAH 10/CSAH 101 (East Junction)</td><td>17 seconds(2)</td><td>37 seconds(2)</td><td>> 5 minutes</td><td>≈ 3 minutes</td></tr>
</table>

Notes:
(1) Unsignalized intersection with side-street stop control. Delay: overall intersection/worst approach.
(2) Unsignalized intersection with all-way stop control. Delay: overall intersection.

Results of the analysis shown in Table 3 indicate that the intersection of CSAH 10/CSAH 101 (West Junction) is currently experiencing acceptable operations during the peak periods, with an overall delay ranging from 8 to 11 seconds. The intersection of CSAH 10/CSAH 101 (East Junction) is operating acceptably during the a.m. peak hour. However, unacceptable operations are experienced during the p.m. peak hour, with an overall delay of 37 seconds (35 seconds or less would indicate acceptable operations at an unsignalized intersection.)

For future no build conditions, both intersections would operate unacceptably during the peak periods, with high levels of delay (approximately three - five minutes per vehicle), as shown. With the reconstruction of these intersections and identified geometric improvements, both intersections would experience acceptable operations for future 2030 build conditions, with overall delay in a range similar to existing conditions.

Evaluation was also completed for a potential roundabout at the intersection of CSAH 10/CSAH 101 for future build 2030 conditions. However, the Highway Capacity Manual (HCM), which was used in the operations analysis shown in Table 3, does not currently provide a methodology to analyze level of service for a roundabout. Therefore, to complete the analysis, the VISSIM software was used to evaluate the operations of a roundabout at this location. For this analysis, multiple simulation runs were completed to obtain the travel time for all vehicles traveling through the intersection between selected entry and exit points on the approaches where vehicles were traveling at free flow conditions. A comparison was completed for 2030 build conditions with the installation of a traffic signal (with identified geometric improvements) and a multi-lane roundabout.

The travel time for the traffic signal was found to be approximately 95 seconds per vehicle, compared to 90 seconds for a roundabout. Queue lengths were also estimated for the two forms of traffic control. The average queues varied for each approach, but were generally found to be longer on all approaches of the signalized intersection alternative, with the exception of the northbound approach, which would experience longer queues with a roundabout. Therefore, the average delay per vehicle is expected to be only slightly lower for a roundabout at the intersection of CSAH 10/CSAH 101, compared to a traffic signal. Hennepin County has described CSAH 10 as an important east-west, high volume commuter route. Therefore, the installation of a traffic signal was selected to control this intersection in order to distribute capacity accordingly. Roundabouts tend to equalize intersection capacity.

INTERSECTION ALIGNMENT

The recommended CSAH 10 roadway concept generally follows the existing alignment, with the exception of the west end (CSAH 101), which is proposed to be reconstructed as outlined previously, and at Lawndale Lane. Currently, CSAH 10 intersects Lawndale Lane at an approximate 60 degree skew. The realignment of CSAH 10 is necessary at Lawndale Lane to create an intersection closer to 90 degrees. State Aid policy requires intersection alignment to remain within 15 degrees of perpendicular. (i.e., 75-105 degrees). Therefore, the current alignment does not conform with State Aid Standards.

It is always desirable from a traffic safety and roadway design perspective, when possible, to align an intersection to as close to 90-degrees as possible for sight-distance reasons. In addition, keeping intersection skew to a minimum allows traffic signal heads to be properly positioned more easily. Intersection alignment close to perpendicular (90 degrees) also minimizes pedestrian crossing distances and is easier to navigate for visually impaired pedestrians.

CONCLUSIONS

Based on the safety and traffic operations review, the future alignment of CSAH 10 is consistent with the previous recommended concept alignment, which shows all roadways intersecting as near to perpendicular as possible, improvements to the horizontal and vertical roadway curvature and realignment of CSAH 10/CSAH 101 from two offset unsignalized intersections to one signalized intersection.

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