MINNESOTA DEPARTMENT OF TRANSPORTATION

INTERSECTION CONTROL EVALUATION

ICE REPORT

for
S.P. 1908-74
T.H. 3 at CSAH 26/70th St
In Inver Grove Heights, Dakota County

Program: SC (Safety Capacity) Funding: SF (State Funds)

Letting Date: December 19, 2008

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

Preparer's name, P.E. Reg. No. Date

REVIEWED:

County Engineer Date

APPROVED:

Metro District Traffic Engineer - Program Support Date

SAMPLE

I. DESCRIPTION OF LOCATION

The proposed traffic control revision is located at the intersection of Trunk Highway (TH) 3 and County State Aid Highway (CSAH) 26 in Inver Grove Heights, Dakota County, Minnesota. The City of Inver Grove Heights is located just south of the capitol city of St. Paul and is situated in the northern portion of Dakota County. The intersection itself is located approximately 1 mile north of TH 55 and approximately 1¾ miles south of I-494. Approximately 1¼ miles east of this intersection along CSAH 26 is USTH 52. (See Figure 1, Project Location Map). The US Census Bureau 2005 Population Estimate for the City of Inver Grove Heights is 33,182.

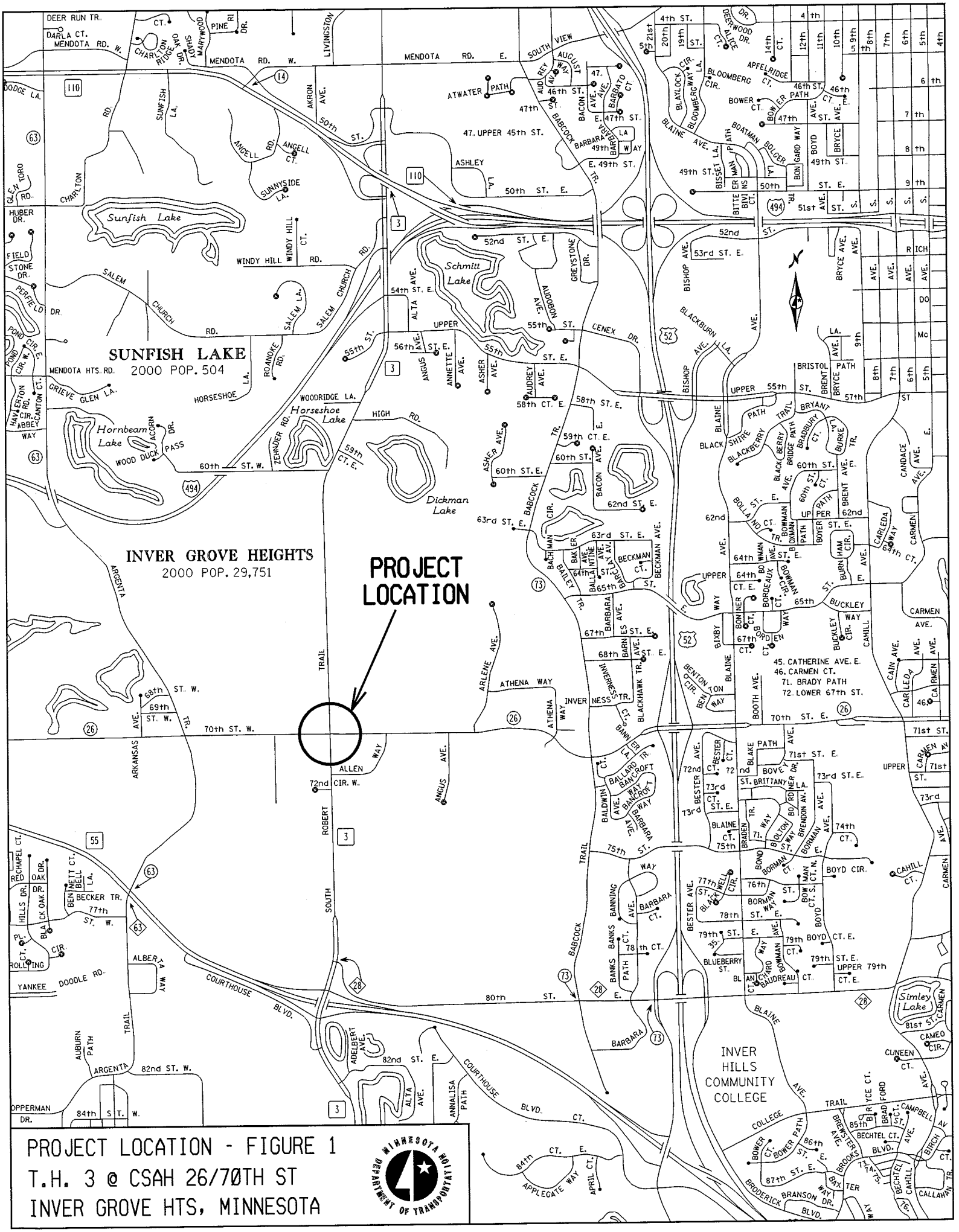
II. EXISTING CONDITIONS

TH 3 is currently a two lane undivided north-south highway at the proposed project location. It is classified as a minor arterial and has a posted speed limit of 50 mph. TH 3 currently has right turn lanes in both directions at the intersection with CSAH 26/70th Street. The AADT (2006) on TH 3 is 6,900 south of the intersection and 6,800 north of the intersection.

CSAH 26/70th Street is a two lane undivided east-west County State Aid Highway in the City of Inver Grove Heights in Dakota County. At the intersection with TH 3, both the eastbound and westbound directions of CSAH 26 have only a single lane of approach with no turn lanes. The posted speed limit on CSAH 26/70th Street is 50 mph and the AADT (2005) is 6,700 east of TH 3 and 5,600 to the west of this location. The 2004 analysis in Table 2 shows a LOS F for northbound TH 3 during the AM peak, and a LOS F for southbound TH 3 and both eastbound and westbound CSAH 26 during the PM peak. This analysis shows the delays at this intersection justify a new traffic control, which is also supported by citizen complaints received.

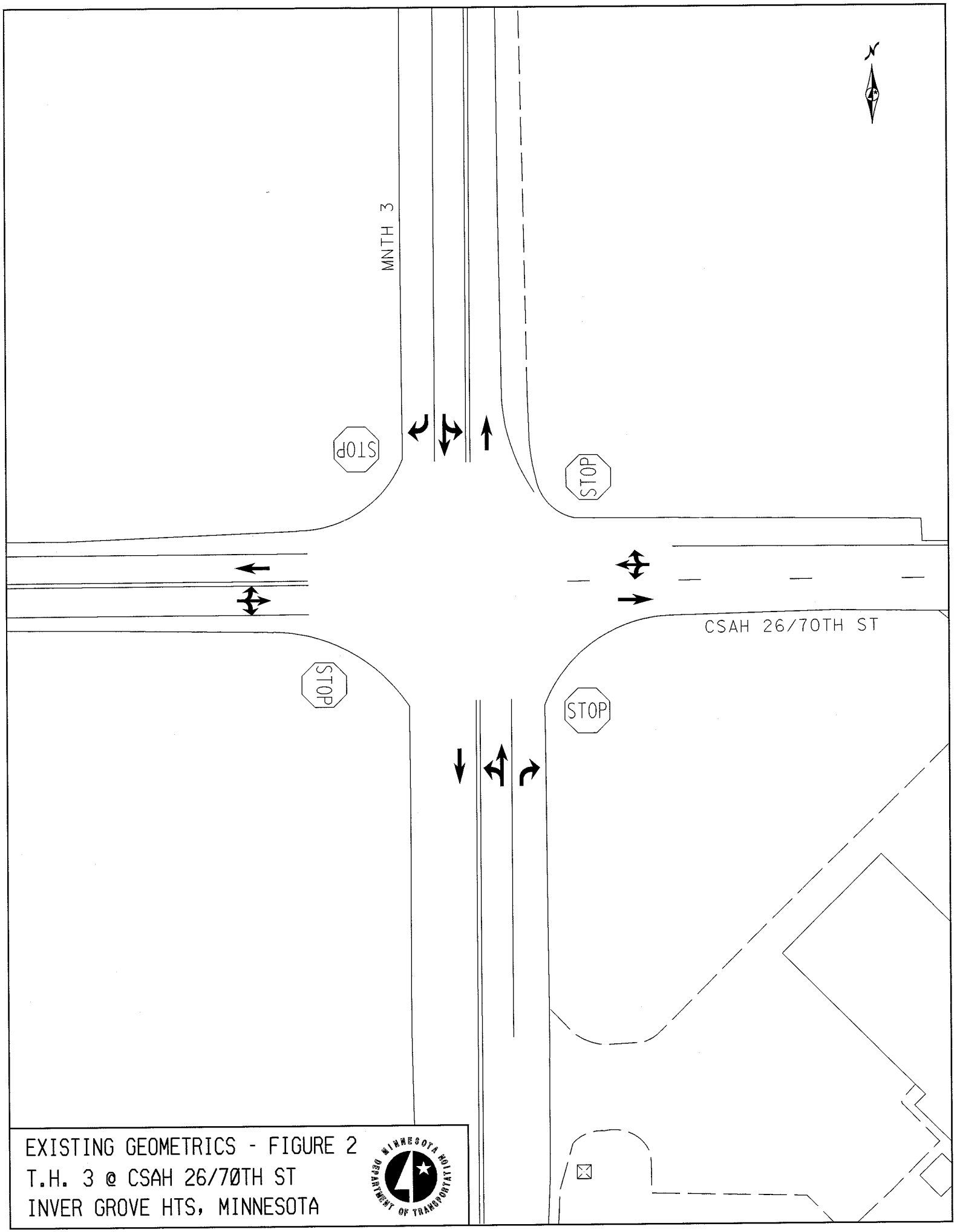
The grade approaching this intersection from the west is approximately -8%. The other approaching grades are relatively flat.

This intersection has been operating in its current all-way stop condition since 1998. (See Figure 2, Existing Geometrics).



PROJECT LOCATION - FIGURE 1
T.H. 3 @ CSAH 26/70TH ST
INVER GROVE HTS, MINNESOTA

MINNESOTA DEPARTMENT OF TRANSPORTATION



EXISTING GEOMETRICS - FIGURE 2
T.H. 3 @ CSAH 26/70TH ST
INVER GROVE HTS, MINNESOTA

III. FUTURE CONDITIONS

A number of new development concepts have been reviewed for this area, including one in the northeast corner of this intersection. The additional trips generated by these proposed developments, will increase the delay and degrade the LOS if an all way stop condition remains inplace.

The current all way stop condition has been at this intersection since 1998 and would be operating at an overall LOS F in 2025 if no other modification were done. Population growth in this area of Dakota County is anticipated to be 3% per year based on historical data. Volume data for 2025 was projected from 2004 field gathered traffic data.

IV. ANALYSIS OF ALTERNATIVES

Crash Analysis

Projected 2025 ADT volumes for the TH 3 and CSAH 26 intersection and standard crash rates by control type for state highway intersections were used to estimate annual numbers of crashes for each alternative. Standard crash rates of 0.6 crashes/Million Entering Vehicles (MEV) for an all-way stop intersection and a rate of 0.7 crashes/MEV for a signalized intersection were used in determining future crash estimates. These rates were taken from The Traffic Safety Fundamentals Handbook, April 2001, published by the Minnesota Department of Transportation. Typically, roundabouts reduce the number of crashes by approximately 50 percent as compared to a signalized intersection thus, a standard crash rate of 0.35 crashes/MEV was used for this alternative.

Table 1 shows the current and projected crash totals for each alternative.

Table 1
Predicted Crash Totals

Alternative	Average Crash Rate	Average Crashes/Year 2003-2005	Projected Crashes/Year 2025
All-Way Stop	0.6	5	5-9 **
Traffic Signal	0.7	NA	6
Roundabout	0.35	NA	3

** This intersection had a total of 15 crashes for the years 2003-2005 for an average of 5 crashes per year. See the collision diagrams in Appendix B. The existing crash rate for the current all-way stop condition at this intersection is 1.0, which is higher than the average (0.6) listed in the Mn/DOT Traffic Safety Fundamentals Handbook. Using the average (0.6) the projected number of crashes per year in 2025 is 5. Using the existing 1.0 crash rate and projecting to 2025, the number of crashes projected per year is 9.

SAMPLE

Warrant Analysis
A signal warrant analysis was done using 48-hour counts taken in September, 2004. The signal warrant requirements were reduced to 70 percent of their stated value based on the fact that the posted speed limit on TH 3 exceeds 40 mph. A Mn/DOT standard practice is to remove 100% of the right turning volumes from the minor legs for this signal warrant analysis based on the turn movement counts at the intersection. The rationale for this practice is that these movements are usually made relatively easily, have minimal conflicts and therefore do not require a traffic signal to minimize delay or improve safety.

The traffic volume at the intersection of TH 3 at CSAH 26/70th Street satisfies the requirements of warrants 1A, 2, and 3. The installation of a traffic signal for this intersection would be justified if this is considered to be the preferred alternative. A roundabout is considered to be justified if the intersection meets either a signal warrant or the all way stop warrant. Because this intersection meets both, a roundabout can also be justified at this location.

The signal warrant analysis, and turning movement counts, are included in Appendix C and D respectively.

Capacity Analysis
A capacity analysis was completed for each of the proposed intersection control alternatives using both current and forecasted AM and PM peak hour volumes. The proposed geometrics for a roundabout option and a signalized option are shown in Appendix A. These are only concept layouts with refinements likely during the final design of each alternative.

An analysis was performed using SYNCHRO traffic modeling software for both the all-way stop and the signal controlled intersection alternatives. An analysis was also conducted using RODEL traffic modeling for the roundabout alternative.

This initial RODEL analysis used typical design parameters and indicates acceptable delay and LOS for opening day for a single lane roundabout. The 2025 analysis, with the same design parameters, shows one approach in the AM and one approach in the PM performing at LOS F. During the final design of a roundabout, these design parameters will be adjusted in order to design a roundabout that will perform at LOS D or better for all approaches 20 years after opening. This may or may not require an approach to have two approach lanes initially.

The capacity analysis measured the effectiveness of each alternative in regards to LOS, average delay, average queue and maximum queue. The data gathered in these analyses is contained in Table 2, Capacity Analysis Table.

Capacity Analysis Table

Table 2

MNTH 3 @ 70TH ST/CSAH 26

Peak Hour Analysis - 2004

AM Peak Hour		Minor Leg: EB CSAH 26			Minor Leg: WB CSAH 26			Major Leg: NB TH 3			Major Leg: SB TH 3		
		L	T	R	L	T	R	L	T	R	L	T	R
Approach Volume (veh/hr)		69	143	16	53	330	29	45	421	248	13	92	88
			LTR			LTR			LT	R		LT	R
All-way Stop Control	LOS		C			E			F	C		B	B
	Avg. Delay		19.7			45.3			97.8	16.4		13.7	11.8
	Avg. Queue		51			110			156	54		38	36
	Max. Queue		124			195			293	92		55	73
Traffic Signal Control	LOS	B	C	B	B	C	A	B	C	A	B	C	A
	Avg. Delay	15.9	23.4	11.1	15.2	29.6	9.4	15.0	25.6	4.6	16.2	22.6	6.3
	Avg. Queue	16	49	0	13	131	0	12	145	0	3	34	0
	Max. Queue	54	127	15	44	297	21	40	395	55	17	90	37
	Approach LOS		C			C			B			B	
Roundabout	Avg. Delay		3.0			4.2			5.4			3.0	
	Avg. Queue		0			25			25			0	
	Max. Queue		0			25			50			0	
	Approach LOS		A			A			A			A	

PM Peak Hour		Minor Leg: EB CSAH 26			Minor Leg: WB CSAH 26			Major Leg: NB TH 3			Major Leg: SB TH 3		
		L	T	R	L	T	R	L	T	R	L	T	R
Approach Volume (veh/hr)		62	362	42	217	188	23	21	167	98	57	375	80
			LTR			LTR			LT	R		LT	R
All-way Stop Control	LOS		F			F			C	B		F	B
	Avg. Delay		142.0			111.4			22.8	14.0		130.8	12.1
	Avg. Queue		559			648			60	39		1176	273
	Max. Queue		892			1151			88	63		3932	452
Traffic Signal Control	LOS	B	D	A	B	C	A	B	C	A	B	C	A
	Avg. Delay	13.7	36.7	8.5	19.5	20.2	9.1	15.6	23.9	5.9	15.5	28.3	6.1
	Avg. Queue	15	159	0	57	67	0	7	74	0	18	148	0
	Max. Queue	44	#335	25	#134	147	17	20	131	35	42	303	32
	Approach LOS		C			B			B			C	
Roundabout	Avg. Delay		5.4			3.6			3.6			4.8	
	Avg. Queue		25			0			0			25	
	Max. Queue		25			25			0			25	
	Approach LOS		A			A			A			A	

Peak Hour Analysis - 2025

AM Peak Hour		Minor Leg: EB CSAH 26			Minor Leg: WB CSAH 26			Major Leg: NB TH 3			Major Leg: SB TH 3		
		L	T	R	L	T	R	L	T	R	L	T	R
Approach Volume (veh/hr)		125	258	29	96	596	52	81	760	448	23	166	159
			LTR			LTR			LT	R		LT	R
All-way Stop Control	LOS		F			F			F	F		C	C
	Avg. Delay		108.0			477.0			625.0	115.0		23.1	17.5
	Avg. Queue		179			3124			3328	328		65	48
	Max. Queue		362			3808			3582	345		161	110
Traffic Signal Control	LOS	E	D	B	C	E	B	B	E	A	B	C	A
	Avg. Delay	68.5	37.0	10.1	25.8	77.6	12.5	18.1	65.2	9.9	19.6	26.5	4.0
	Avg. Queue	76	198	0	57	~630	8	40	~798	81	11	101	0
	Max. Queue	#200	286	24	98	#868	40	69	#1049	187	26	156	44
	Approach LOS		D			E			D			B	
Roundabout	Avg. Delay		3.6			15.0			105.6			4.8	
	Avg. Queue		0			75			1075			0	
	Max. Queue		0			125			1975			25	
	Approach LOS		A			C			F			A	

PM Peak Hour		Minor Leg: EB CSAH 26			Minor Leg: WB CSAH 26			Major Leg: NB TH 3			Major Leg: SB TH 3		
		L	T	R	L	T	R	L	T	R	L	T	R
Approach Volume (veh/hr)		112	654	76	392	340	42	38	302	177	103	677	144
			LTR			LTR			LT	R		LT	R
All-way Stop Control	LOS		F			F			F	C		F	C
	Avg. Delay		653.0			577.2			77.0	18.7		605.3	16.3
	Avg. Queue		3084			3248			153	76		3570	290
	Max. Queue		3536			3808			3377	200		3966	337
Traffic Signal Control	LOS	C	F	B	F	C	A	C	D	A	C	F	B
	Avg. Delay	22.3	137.8	15.8	144.8	30.8	6.5	30.7	42.9	5.5	29.8	116.6	14.1
	Avg. Queue	60	~838	20	~453	250	0	23	254	0	66	~838	36
	Max. Queue	98	#1085	61	#673	343	25	49	354	55	109	#1089	92
	Approach LOS		F			F			C			F	
Roundabout	Avg. Delay		128.4			7.2			6.6			30.6	
	Avg. Queue		850			50			25			200	
	Max. Queue		1625			50			25			375	
	Approach LOS		F			A			A			D	

NOTES:
LOS – Level of Service
Avg Delay – Average Delay for that movement in seconds
Avg Queue – Average queue length for that lane in feet
Max Queue – Maximum queue length for that lane in feet

L – Left Turn Lane T – Through Lane R – Right Turn Lane
~ indicates that the approach is above capacity and the queue length could be much longer
# indicates that the volume for the 95th percentile cycle exceeds capacity

V. RECOMMENDED ALTERNATIVE

Based on the information provided within this document and engineering judgment the following conclusions have been drawn:

- Using the volume projections for year 2025, the current all way stop condition shows all four thru movements would operate at LOS F during PM peak, if no modifications were done to the intersection. An all way stop condition with multiple approach lanes on each leg, introduces driver confusion on whose turn it is to go next, resulting in an inefficient operation of the intersection. The all way stop condition is not being considered further, because of these concerns.

- Using the volume projections for 2025, a signalized intersection with 3 lanes of approach for each leg, would result in three of the approaches operating at LOS F in the PM peak. Additional lanes of approach (thru, left turn lane) would be required before 2025 to keep an acceptable LOS. This would require two lanes departing from the intersection to accept the two thru and/or dual left turn lanes.

- A roundabout would be designed for a LOS D, for each approach leg, for 20 years after constructed.

- The single lane roundabout layout would be designed to accommodate a future multi lane roundabout by using an increased inscribed diameter. Future traffic volumes may warrant an increased capacity need.

- Constructing a roundabout at this location would have a slightly lower initial cost than a signalized intersection, and would not have the associated signal maintenance and power costs a signalized intersection would have.

- The cost for expansion of a roundabout in the future, is determined to be less expensive than to expand a signalized intersection with additional thru and/or left turn lanes.

- The greatest crash reduction is anticipated if a roundabout is constructed at this location.

Because of costs, an interchange, continuous flow, and other non-traditional types of intersections were not analyzed beyond initial discussion.

Based on the above mentioned conclusions, a roundabout is recommended at this intersection. It is anticipated that the roundabout will be designed to have a LOS D for all approach legs at 20 years after construction is completed. It is also anticipated that additional modeling of the roundabout may be necessary during the final layout approval process, as this ICE Report has not modeled the final configuration.

Meetings with the City and County to discuss the different options will happen in the near future. At these meetings, both vertical and horizontal alignment of the intersection and approaches will be discussed, which will determine if additional right-of-way will need to be obtained. It appears that there is an option where no right-of-way will be needed, but shifting the intersection to the east to reduce the approach grade from the west, may result in the need for additional right-of-way.

A final decision for the type of traffic control at this intersection will be made after discussions with the City and County are completed.

VI. APPENDIX

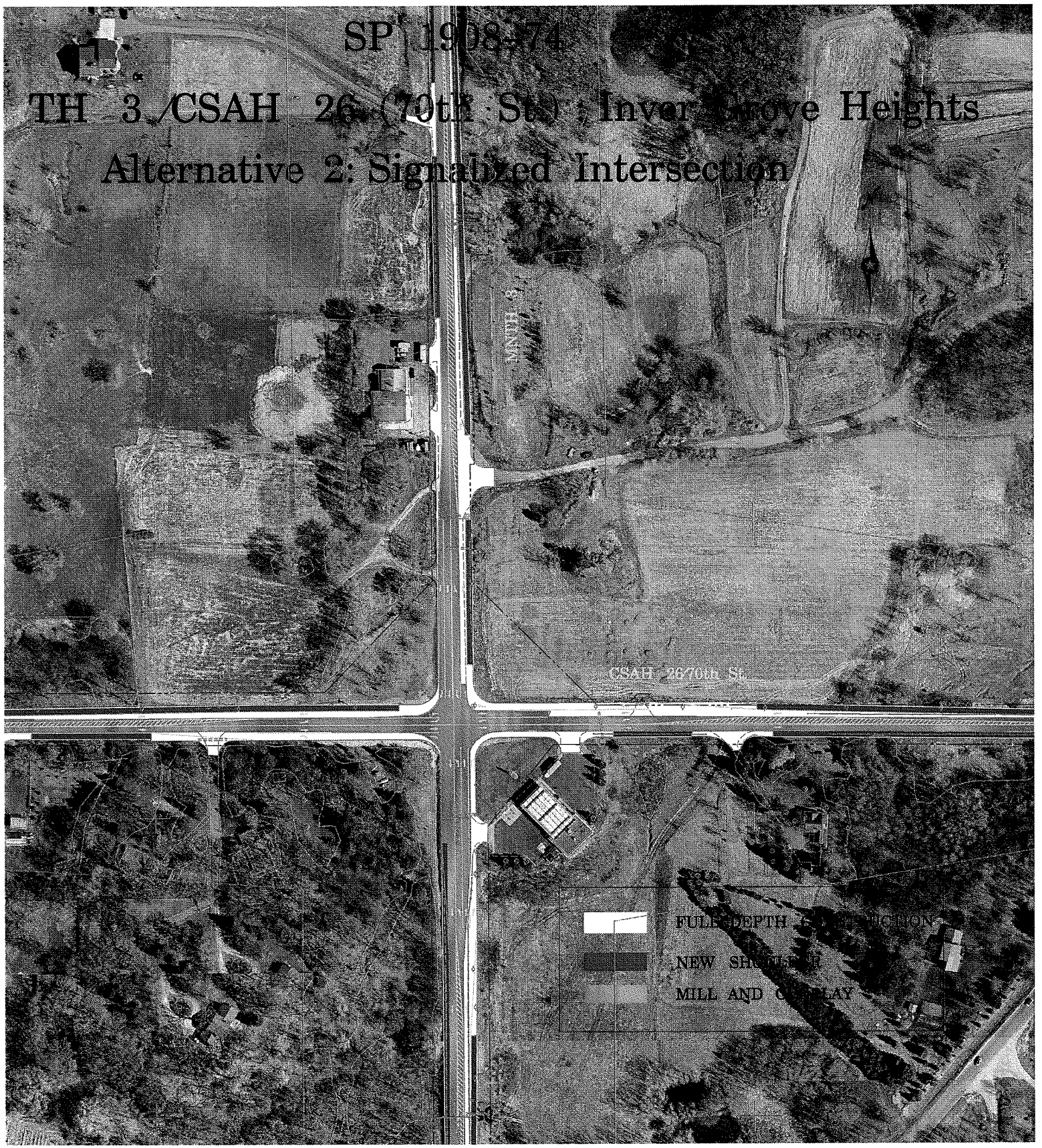
A. Proposed Alternative Geometrics
B. Collision Diagrams
C. Signal Warrant Analysis
D. Turn Movement Counts
E. SYNCHRO Modeling Data
F. RODEL Modeling Data

SAMPLE

Appendix A

Proposed Alternative Geometrics

SAMPLE


SP 1908-74
TH 3/CSAH 26 (70th St.) : Inver Grove Heights
Alternative 2: Signalized Intersection
CSAH 26 70th St.
FULL DEPTH
NEW SHOULDER
MILL AND OVERLAY

SP 1908-74

TH 3/CSAH 26 (70th St.), Inver Grove Heights

Alternative 1: Roundabout

Appendix B

Collision Diagrams

SAMPLE

Mn/DOT 2942 (rev 9-11-92)

COLLISION DIAGRAM

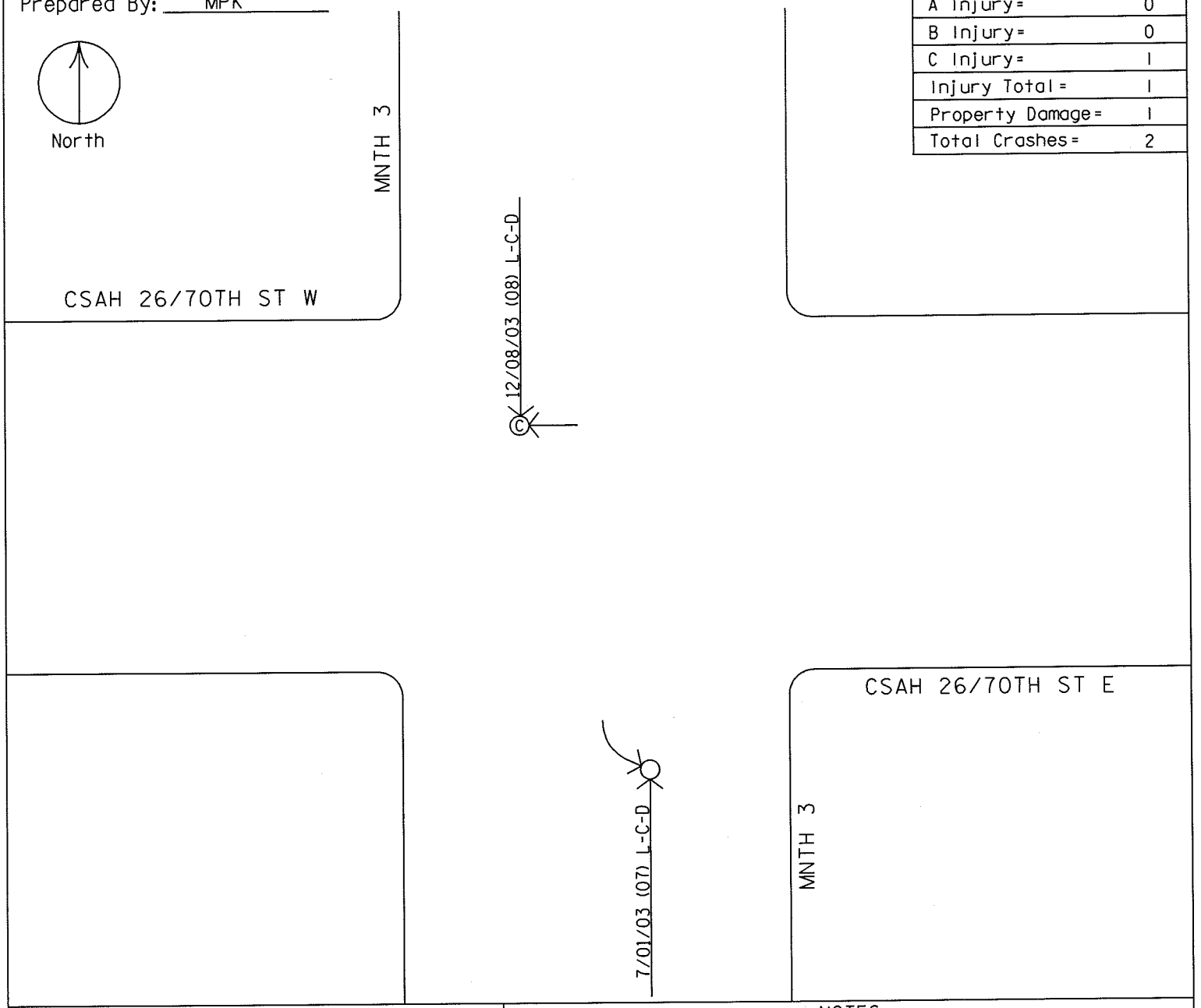
Minnesota Department of Transportation

Location: C.S.1908 MNTH 3 @ CSAH 26/70TH ST 41+00.713

Time Period: 1/1/03 - 12/31/03 Date: 9/7/05

Prepared By: MPK

No. of Crashes	
Fatal =	0
A Injury =	0
B Injury =	0
C Injury =	1
Injury Total =	1
Property Damage =	1
Total Crashes =	2



KEY

- Motor Vehicle Out of Control
- Motor Vehicle Backing Up
- Motor Vehicle Rollover
- Motor Vehicle Sideswipe
- Fixed Object
- Fatal Crash
- A Injury Crash
- B Injury Crash
- C Injury Crash
- Property Damage Crash
- Pedestrian
- Bicycle
- Motorcycle
- Parked Vehicle
- Rear End Property Damage
- Right Angle B Injury

NOTES

[1]
[2]
[3]

Light:	Weather:	Surface:
L = Daylight (1)	C = Clear or Cloudy (1 or 2)	D = Dry (1)
Dn = Dawn (2)	R = Rain (3)	W = Wet (2)
Du = Dusk (3)	S = Snow or Sleet (4 or 5)	S = Snow or Ice (3 or 4)
Dl = Dark, Lighted (4)	F = Fog, Smog, Smoke (6)	M = Muddy (5)
Do = Dark, Lights Off (5)	B = Blowing Sand/Dust (7)	Db = Debris (6)
D = Dark, Unlighted (6)	W = Severe Crosswinds (8)	O = Oily (7)
X = Unknown (99)	X = Other or Unknown (99)	X = Other or Unknown (99)

(X) = Number of Vehicles in Crash (X) Other Vehicle Injury Type [Date]—[Time (hrs)]—[Light-Weather-Surface]

3@70thSt-csah26.dgn 3/19/2007 2:37:06 PM

Mn/DOT 2942 (rev 9-11-92)

COLLISION DIAGRAM

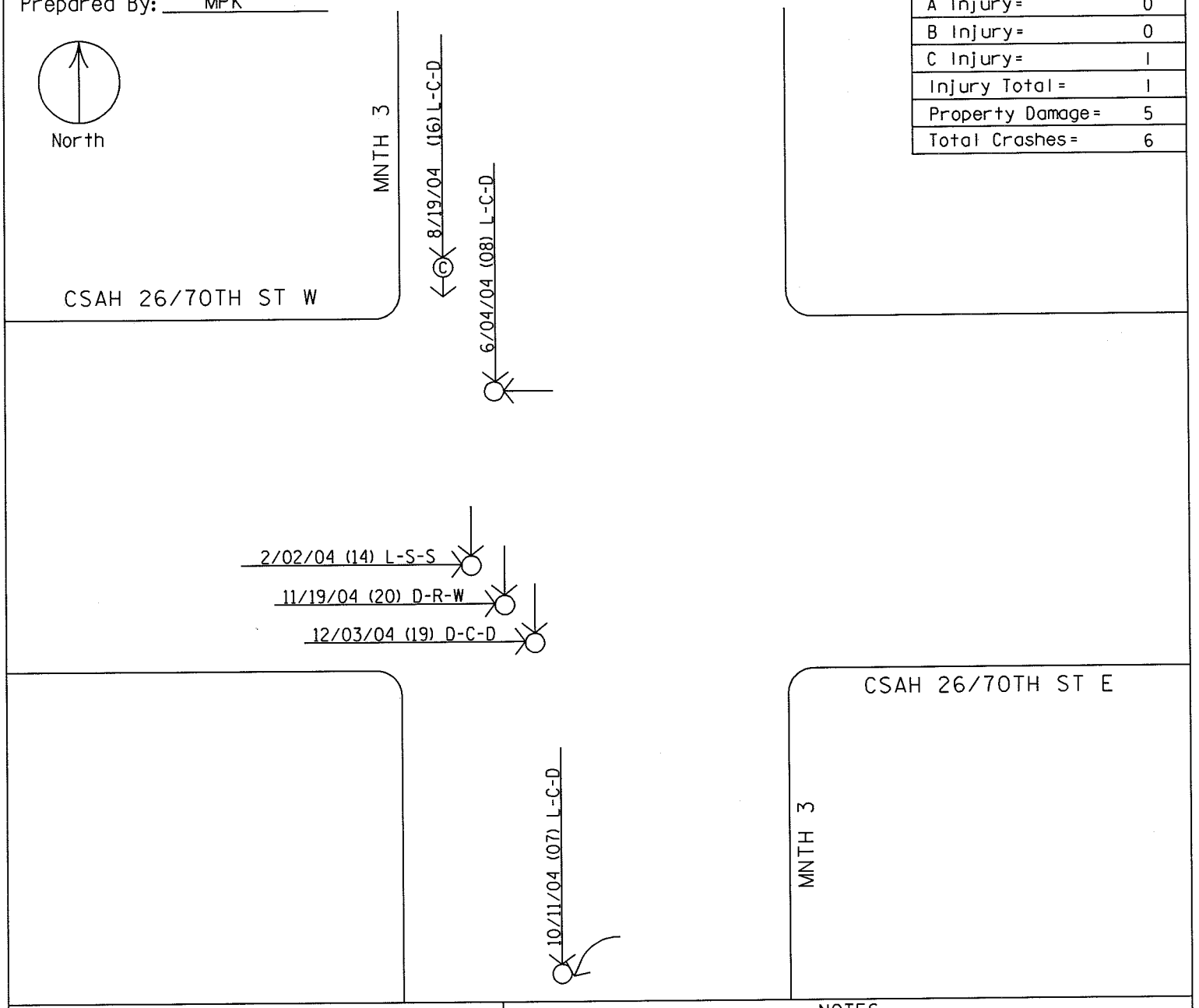
Minnesota Department of Transportation

Location: C.S.1908 MNTH 3 @ CSAH 26/70TH ST 41+00.713

Time Period: 1/1/04 - 12/31/04 Date: 9/7/05

Prepared By: MPK

No. of Crashes	
Fatal =	0
A Injury =	0
B Injury =	0
C Injury =	1
Injury Total =	1
Property Damage =	5
Total Crashes =	6



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Mn/DOT 2942 (rev 9-11-92)

COLLISION DIAGRAM

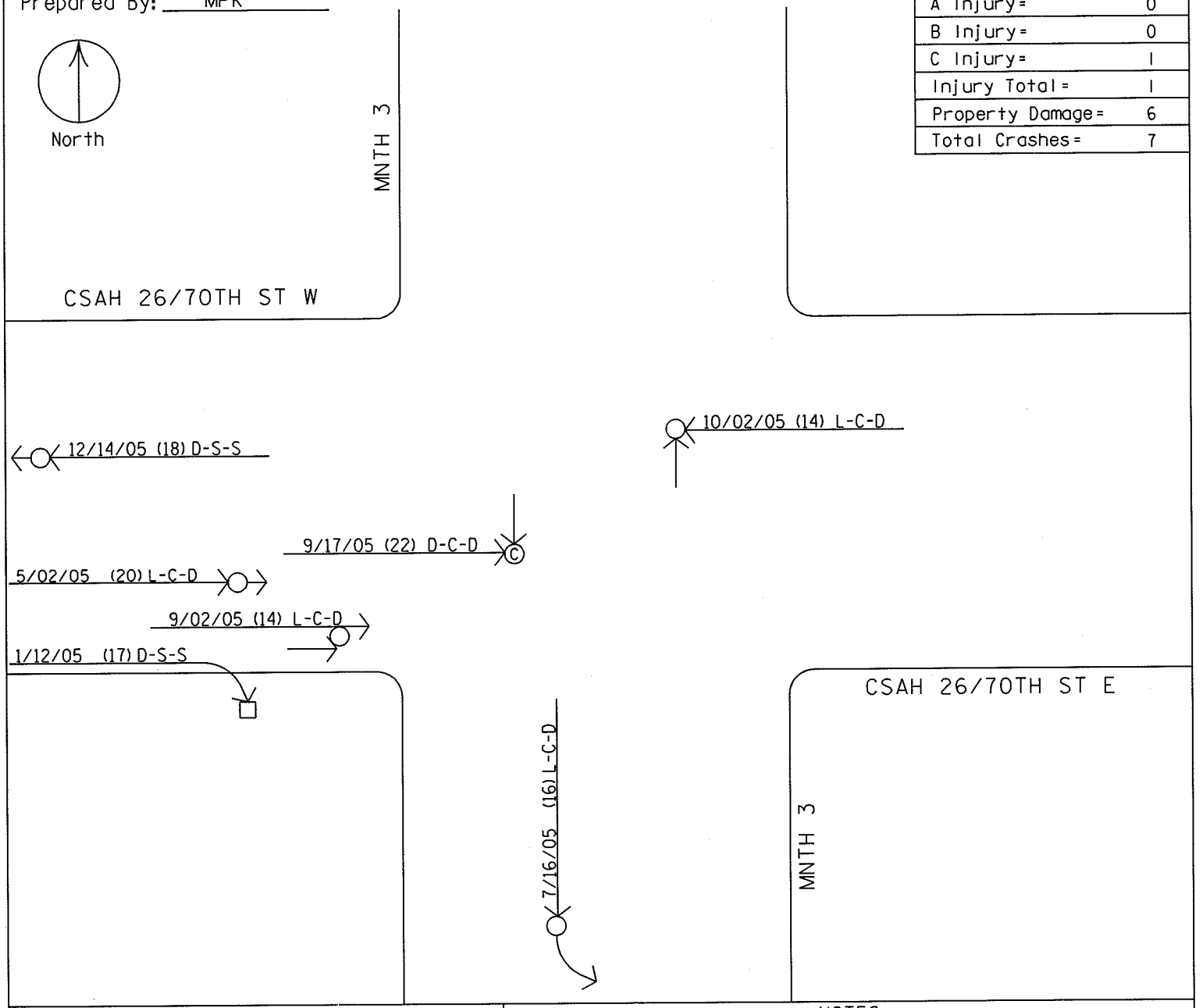
Minnesota Department of Transportation

Location: C.S.1908 MNTH 3 @ CSAH 26/70TH ST 41+00.713

Time Period: 1/1/05 - 12/31/05 Date: 11/8/06

Prepared By: MPK

No. of Crashes	
Fatal =	0
A Injury =	0
B Injury =	0
C Injury =	1
Injury Total =	1
Property Damage =	6
Total Crashes =	7



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(X) = Number of Vehicles in Crash (X) Other Vehicle Injury Type [Date]—[Time (hrs)]—[Light-Weather-Surface]

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Appendix C

Signal Warrant Analysis

SAMPLE

MINNESOTA DEPARTMENT OF TRANSPORTATION

METRO DIVISION - TRAFFIC ENGINEERING

SIGNAL WARRANTS ANALYSIS

LOCATION: TH 3 @ CSAH 26 / 70th St
COUNTY: Dakota
REF. POINT: 41+00.713
DATE: 9/27/2004

OPERATOR: LI

100% OF RIGHT TURNS REMOVED FROM MINOR LEGS

Speed	Approach Description	Lanes
50	Major App1: NB TH3, south of 70th St	2
50	Major App3: SB TH3, north of 70th St	2
50	Minor App2: EB 70th, west of TH3	2
45	Minor App4: WB 70th, east of TH3	2

0.70 FACTOR USED? YES
POPULATION < 10,000? No
EXISTING SIGNAL ? No

THRESHOLDS 1A/1B:				420/630	-9%		-7% 140/70	140/70	
HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 1A/1B	**MET SAME 1A/1B**
0:00 - 1:00	12	12	24	/	12	/	10	/	/
1:00 - 2:00	6	9	15	/	20	/	7	/	/
2:00 - 3:00	12	5	17	/	16	/	6	/	/
3:00 - 4:00	7	7	14	/	15	/	17	/	/
4:00 - 5:00	16	15	31	/	5	/	28	/	/
5:00 - 6:00	76	69	145	/	20	/	109	/X	/
6:00 - 7:00	341	133	474	X/	64	/	304	X/X	**X/**
7:00 - 8:00	740	187	927	X/X	182	X/X	376	X/X	**X/X**
8:00 - 9:00	423	167	590	X/	165	X/X	237	X/X	**X/**
9:00 - 10:00	245	185	430	X/	114	/X	138	/X	/
10:00 - 11:00	191	168	359	/	106	/X	124	/X	/
11:00 - 12:00	198	187	385	/	169	X/X	146	X/X	/
12:00 - 13:00	231	227	458	X/	165	X/X	167	X/X	**X/**
13:00 - 14:00	215	235	450	X/	142	X/X	160	X/X	**X/**
14:00 - 15:00	271	254	525	X/	211	X/X	204	X/X	**X/**
15:00 - 16:00	285	373	658	X/X	351	X/X	254	X/X	**X/X**
16:00 - 17:00	298	514	812	X/X	459	X/X	344	X/X	**X/X**
17:00 - 18:00	274	485	759	X/X	409	X/X	416	X/X	**X/X**
18:00 - 19:00	231	259	490	X/	217	X/X	223	X/X	**X/**
19:00 - 20:00	166	185	351	/	146	X/X	137	/X	/
20:00 - 21:00	124	161	285	/	95	/X	104	/X	/
21:00 - 22:00	83	119	202	/	73	/X	89	/X	/
22:00 - 23:00	39	61	100	/	49	/	60	/	/
23:00 - 24:00	25	26	51	/	48	/	21	/	/

	Met (Hr)	Required (Hr)	
Warrant 1A	**10**	8	**Satisfied**
Warrant 1B	4	8	Not satisfied
Warrant 2	6	4	**Satisfied**
Warrant 3	4	1	**Satisfied**
Warrant 7	**14**	8	**Satisfied, check accident record**

Appendix D

Turn Movement Counts

SAMPLE

MINNESOTA DEPARTMENT OF TRANSPORTATION
METRO Traffic - Program Support

Location: TH-3 @ CSAH-26 70 TH ST.
Ref.Pt.: 041+00.713
Operator: JAMAR # 632 DR
TURN MOVEMENT COUNT

File Name : TH 3 @ CSAH 26 041+OO.713 2004
Site Code : 00000000
Start Date : 9/28/2004
Page No : 1

Groups Printed- Unshifted

	TH 3 Southbound				CSAH 26 Westbound				TH 3 Northbound				CSAH 26 Eastbound				
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Int. Total
06:00	1	21	4	0	11	52	3	0	4	24	18	0	2	5	0	0	145
06:15	2	17	12	0	14	59	4	0	1	42	29	0	2	4	1	0	187
06:30	3	22	11	0	8	70	6	0	9	46	36	0	3	23	2	0	239
06:45	0	22	8	0	9	66	4	0	10	66	39	0	7	20	5	0	256
Total	6	82	35	0	42	247	17	0	24	178	122	0	14	52	8	0	827
07:00	3	20	15	0	16	60	5	0	12	70	59	0	9	25	3	0	297
07:15	2	20	17	0	15	86	7	0	14	97	51	0	14	33	4	0	360
07:30	3	27	25	0	13	76	5	0	13	100	74	0	20	37	6	0	399
07:45	5	26	29	0	14	105	9	0	15	122	69	0	16	35	3	0	448
Total	13	93	86	0	58	327	26	0	54	389	253	0	59	130	16	0	1504
08:00	3	19	17	0	11	63	8	0	3	102	54	0	19	38	3	0	340
08:15	3	18	9	0	11	47	1	0	8	71	42	0	6	29	0	0	245
08:30	4	27	13	0	7	45	3	0	2	54	30	0	8	17	3	0	213
08:45	3	32	9	0	8	32	5	0	3	29	22	0	5	10	1	0	159
Total	13	96	48	0	37	187	17	0	16	256	148	0	38	94	7	0	957
AUTO TRUCK																	
15:00	3	55	6	0	21	25	4	0	2	53	27	0	13	80	8	0	297
15:15	10	61	14	0	37	26	4	0	8	34	13	0	12	56	8	0	283
15:30	18	61	9	0	22	23	5	0	3	33	18	0	16	84	7	0	299
15:45	15	93	17	0	35	37	9	0	6	40	18	0	16	62	7	0	355
Total	46	270	46	0	115	111	22	0	19	160	76	0	57	282	30	0	1234
16:00	8	77	20	0	33	36	3	0	3	39	21	0	16	87	10	0	353
16:15	19	89	18	0	38	36	7	0	0	50	20	0	19	89	7	0	392
16:30	12	88	25	0	41	54	6	0	9	36	29	0	11	93	8	0	412
16:45	15	103	28	0	48	53	8	0	5	42	31	0	19	89	17	0	458
Total	54	357	91	0	160	179	24	0	17	167	101	0	65	358	42	0	1615
17:00	14	88	12	0	59	43	3	0	3	39	23	0	13	91	7	0	395
17:15	16	96	15	0	69	38	6	0	4	50	15	0	19	89	10	0	427
17:30	13	90	13	0	50	50	14	0	7	33	22	0	10	88	17	0	407
17:45	8	61	13	0	48	32	6	0	3	45	31	0	6	60	7	0	320
Total	51	335	53	0	226	163	29	0	17	167	91	0	48	328	41	0	1549
Grand Total	183	1233	359	0	638	1214	135	0	147	1317	791	0	281	1244	144	0	7686
Apprch %	10.3	69.5	20.2	0.0	32.1	61.1	6.8	0.0	6.5	58.4	35.1	0.0	16.8	74.5	8.6	0.0	
Total %	2.4	16.0	4.7	0.0	8.3	15.8	1.8	0.0	1.9	17.1	10.3	0.0	3.7	16.2	1.9	0.0	

AM PEAK

PM PEAK

Appendix E

SYNCHRO Modeling Data

SAMPLE

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	69	143	16	53	330	29	45	421	248	13	92	88
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	75	155	17	58	359	32	49	458	270	14	100	96

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	248	448	507	270	114	96
Volume Left (vph)	75	58	49	0	14	0
Volume Right (vph)	17	32	0	270	0	96
Hadj (s)	0.05	0.02	0.08	-0.67	0.10	-0.67
Departure Headway (s)	7.8	7.2	7.8	7.0	8.7	7.9
Degree Utilization, x	0.54	0.89	1.10	0.53	0.28	0.21
Capacity (veh/h)	438	448	472	507	395	430
Control Delay (s)	19.7	45.3	97.8	16.4	13.7	11.8
Approach Delay (s)	19.7	45.3	69.5		12.9	
Approach LOS	C	E	F		B	

Intersection Summary			
Delay	48.7		
HCM Level of Service	E		
Intersection Capacity Utilization	62.2%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	62	362	42	217	188	23	21	167	98	57	375	80
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	67	393	46	236	204	25	23	182	107	62	408	87

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	507	465	204	107	470	87
Volume Left (vph)	67	236	23	0	62	0
Volume Right (vph)	46	25	0	107	0	87
Hadj (s)	0.01	0.10	0.09	-0.67	0.10	-0.67
Departure Headway (s)	8.6	8.7	9.7	9.0	9.0	8.3
Degree Utilization, x	1.21	1.12	0.55	0.27	1.18	0.20
Capacity (veh/h)	424	427	360	397	396	430
Control Delay (s)	142.0	111.4	22.8	14.0	130.8	12.1
Approach Delay (s)	142.0	111.4	19.8		112.3	
Approach LOS	F	F	C		F	

Intersection Summary			
Delay	104.6		
HCM Level of Service	F		
Intersection Capacity Utilization	94.5%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	125	258	29	96	596	52	81	760	448	23	166	159
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	136	280	32	104	648	57	88	826	487	25	180	173

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	448	809	914	487	205	173
Volume Left (vph)	136	104	88	0	25	0
Volume Right (vph)	32	57	0	487	0	173
Hadj (s)	0.05	0.02	0.08	-0.67	0.09	-0.67
Departure Headway (s)	8.9	8.9	9.2	8.4	9.8	9.0
Degree Utilization, x	1.11	2.00	2.33	1.14	0.56	0.43
Capacity (veh/h)	395	412	401	431	359	396
Control Delay (s)	107.5	476.8	624.5	114.7	23.1	17.5
Approach Delay (s)	107.5	476.8	447.3		20.6	
Approach LOS	F	F	F		C	

Intersection Summary			
Delay	351.9		
HCM Level of Service	F		
Intersection Capacity Utilization	108.2%	ICU Level of Service	G
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	112	654	76	392	340	42	38	302	177	103	677	144
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	122	711	83	426	370	46	41	328	192	112	736	157

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	915	841	370	192	848	157
Volume Left (vph)	122	426	41	0	112	0
Volume Right (vph)	83	46	0	192	0	157
Hadj (s)	0.01	0.10	0.09	-0.67	0.10	-0.67
Departure Headway (s)	9.4	9.5	9.7	9.0	9.7	8.9
Degree Utilization, x	2.39	2.22	1.00	0.48	2.28	0.39
Capacity (veh/h)	391	387	370	388	379	399
Control Delay (s)	653.0	577.2	77.0	18.7	605.3	16.3
Approach Delay (s)	653.0	577.2	57.1		513.5	
Approach LOS	F	F	F		F	

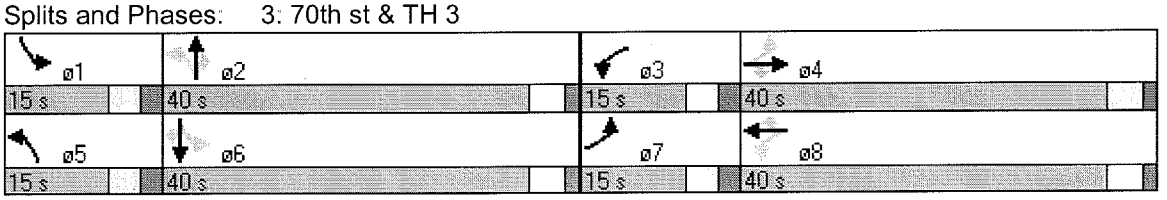
Intersection Summary			
Delay	490.9		
HCM Level of Service	F		
Intersection Capacity Utilization	160.0%	ICU Level of Service	H
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	1863	1583	1770	1863	1583
Flt Permitted	0.327			0.604			0.686			0.204		
Satd. Flow (perm)	609	1863	1583	1125	1863	1583	1278	1863	1583	380	1863	1583
Satd. Flow (RTOR)			17			32			270			96
Volume (vph)	69	143	16	53	330	29	45	421	248	13	92	88
Lane Group Flow (vph)	75	155	17	58	359	32	49	458	270	14	100	96
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Total Split (s)	15.0	40.0	40.0	15.0	40.0	40.0	15.0	40.0	40.0	15.0	40.0	40.0
Act Effct Green (s)	25.9	21.7	21.7	24.9	21.3	21.3	29.0	27.9	27.9	27.6	25.1	25.1
Actuated g/C Ratio	0.35	0.31	0.31	0.34	0.31	0.31	0.39	0.40	0.40	0.36	0.36	0.36
v/c Ratio	0.20	0.26	0.03	0.12	0.62	0.06	0.09	0.61	0.34	0.05	0.15	0.15
Control Delay	15.9	23.4	11.1	15.2	29.6	9.4	15.0	25.6	4.6	16.2	22.6	6.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.9	23.4	11.1	15.2	29.6	9.4	15.0	25.6	4.6	16.2	22.6	6.3
LOS	B	C	B	B	C	A	B	C	A	B	C	A
Approach Delay		20.3			26.3			17.6			14.7	
Approach LOS		C			C			B			B	
Queue Length 50th (ft)	16	49	0	13	131	0	12	145	0	3	34	0
Queue Length 95th (ft)	54	127	15	44	297	21	40	395	55	17	90	37
Internal Link Dist (ft)		3464			3736			3496			3880	
Turn Bay Length (ft)	300		300	300		300	300		300	300		300
Base Capacity (vph)	400	862	741	486	857	745	572	923	921	355	896	811
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.19	0.18	0.02	0.12	0.42	0.04	0.09	0.50	0.29	0.04	0.11	0.12

Intersection Summary

Cycle Length: 110
Actuated Cycle Length: 69
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.62
Intersection Signal Delay: 20.0 — Intersection LOS: B
Intersection Capacity Utilization 55.4% — ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 3: 70th st & TH 3

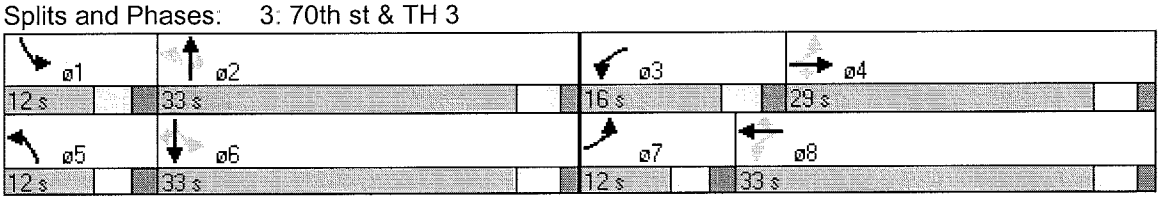


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	1863	1583	1770	1863	1583
Flt Permitted	0.630			0.198			0.272			0.579		
Satd. Flow (perm)	1174	1863	1583	369	1863	1583	507	1863	1583	1079	1863	1583
Satd. Flow (RTOR)			46			25			107			87
Volume (vph)	62	362	42	217	188	23	21	167	98	57	375	80
Lane Group Flow (vph)	67	393	46	236	204	25	23	182	107	62	408	87
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Total Split (s)	12.0	29.0	29.0	16.0	33.0	33.0	12.0	33.0	33.0	12.0	33.0	33.0
Act Effct Green (s)	27.6	19.6	19.6	34.8	28.8	28.8	25.3	21.3	21.3	26.0	23.6	23.6
Actuated g/C Ratio	0.37	0.28	0.28	0.49	0.41	0.41	0.32	0.30	0.30	0.34	0.33	0.33
v/c Ratio	0.14	0.76	0.10	0.59	0.27	0.04	0.08	0.32	0.19	0.14	0.66	0.15
Control Delay	13.7	36.7	8.5	19.5	20.2	9.1	15.6	23.9	5.9	15.5	28.3	6.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.7	36.7	8.5	19.5	20.2	9.1	15.6	23.9	5.9	15.5	28.3	6.1
LOS	B	D	A	B	C	A	B	C	A	B	C	A
Approach Delay		31.1			19.3			17.1			23.4	
Approach LOS		C			B			B			C	
Queue Length 50th (ft)	15	159	0	57	67	0	7	74	0	18	148	0
Queue Length 95th (ft)	44	#335	25	#134	147	17	20	131	35	42	303	32
Internal Link Dist (ft)		3464			3736			3496			3880	
Turn Bay Length (ft)	300		300	300		300	300		300	300		300
Base Capacity (vph)	494	631	566	423	788	684	298	709	669	446	729	672
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.14	0.62	0.08	0.56	0.26	0.04	0.08	0.26	0.16	0.14	0.56	0.13

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 70.8
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.76
Intersection Signal Delay: 23.4 Intersection LOS: C
Intersection Capacity Utilization 70.0% ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: 70th st & TH 3



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	1863	1583	1770	1863	1583
Flt Permitted	0.085			0.425			0.593			0.066		
Satd. Flow (perm)	158	1863	1583	792	1863	1583	1105	1863	1583	123	1863	1583
Satd. Flow (RTOR)			32			44			348			173
Volume (vph)	125	258	29	96	596	52	81	760	448	23	166	159
Lane Group Flow (vph)	136	280	32	104	648	57	88	826	487	25	180	173
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Total Split (s)	12.0	51.3	51.3	12.0	51.3	51.3	12.0	64.7	64.7	12.0	64.7	64.7
Act Effct Green (s)	55.4	47.4	47.4	55.4	47.4	47.4	65.5	60.8	60.8	63.9	55.7	55.7
Actuated g/C Ratio	0.41	0.35	0.35	0.41	0.35	0.35	0.48	0.45	0.45	0.46	0.41	0.41
v/c Ratio	0.84	0.43	0.06	0.27	0.99	0.10	0.15	0.99	0.54	0.17	0.23	0.23
Control Delay	68.5	37.0	10.1	25.8	77.6	12.5	18.1	65.2	9.9	19.6	26.5	4.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	68.5	37.0	10.1	25.8	77.6	12.5	18.1	65.2	9.9	19.6	26.5	4.0
LOS	E	D	B	C	E	B	B	E	A	B	C	A
Approach Delay		44.6			66.4			43.0			15.7	
Approach LOS		D			E			D			B	
Queue Length 50th (ft)	76	198	0	57	~630	8	40	~798	81	11	101	0
Queue Length 95th (ft)	#200	286	24	98	#868	40	69	#1049	187	26	156	44
Internal Link Dist (ft)		3464			3736			3496			3880	
Turn Bay Length (ft)	300		300	300		300	300		300	300		300
Base Capacity (vph)	161	653	576	383	653	584	574	838	903	150	808	784
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.84	0.43	0.06	0.27	0.99	0.10	0.15	0.99	0.54	0.17	0.22	0.22

Intersection Summary

Cycle Length: 140
Actuated Cycle Length: 135.2
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.99
Intersection Signal Delay: 46.1 Intersection LOS: D
Intersection Capacity Utilization 97.5% ICU Level of Service F
Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	1863	1583	1770	1863	1583
Flt Permitted	0.541			0.077			0.077			0.370		
Satd. Flow (perm)	1008	1863	1583	143	1863	1583	143	1863	1583	689	1863	1583
Satd. Flow (RTOR)			54			46			192			102
Volume (vph)	112	654	76	392	340	42	38	302	177	103	677	144
Lane Group Flow (vph)	122	711	83	426	370	46	41	328	192	112	736	157
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Total Split (s)	12.0	52.0	52.0	30.0	70.0	70.0	12.0	56.0	56.0	12.0	56.0	56.0
Act Effct Green (s)	56.1	48.1	48.1	78.1	66.1	66.1	57.6	49.5	49.5	58.4	52.1	52.1
Actuated g/C Ratio	0.38	0.33	0.33	0.53	0.45	0.45	0.38	0.34	0.34	0.40	0.35	0.35
v/c Ratio	0.29	1.17	0.15	1.18	0.44	0.06	0.29	0.52	0.29	0.34	1.12	0.25
Control Delay	22.3	137.8	15.8	144.8	30.8	6.5	30.7	42.9	5.5	29.8	116.6	14.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.3	137.8	15.8	144.8	30.8	6.5	30.7	42.9	5.5	29.8	116.6	14.1
LOS	C	F	B	F	C	A	C	D	A	C	F	B
Approach Delay		111.4			87.2			29.2			90.9	
Approach LOS		F			F			C			F	
Queue Length 50th (ft)	60	~838	20	~453	250	0	23	254	0	66	~838	36
Queue Length 95th (ft)	98	#1085	61	#673	343	25	49	354	55	109	#1089	92
Internal Link Dist (ft)		3464			3736			3496			3880	
Turn Bay Length (ft)	300		300	300		300	300		300	300		300
Base Capacity (vph)	424	606	552	362	834	734	142	646	674	331	657	624
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.29	1.17	0.15	1.18	0.44	0.06	0.29	0.51	0.28	0.34	1.12	0.25

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 147.6
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.18
Intersection Signal Delay: 85.2 Intersection LOS: F
Intersection Capacity Utilization 110.9% ICU Level of Service H
Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Appendix F

RODEL Modeling Data

SAMPLE

RODEL Analysis - TH 3 at CSAH 26 **(06-19-07)**

This is an addendum to the previous report of November 13, 2006. A new concept design for the single lane roundabout has been developed using a 180 foot diameter.

A Rodel analysis was performed for the intersection at TH 3 and CSAH 26 in Inver Grove Heights to see if a roundabout would be an acceptable option. Volume data included turning counts and tube counts from 2004. A 3% annual growth rate was applied to the volume data to estimate 2025 traffic conditions.

With the 2004 volumes, it was found that the modified single lane roundabout will work and have a LOS A for both the AM and PM time period.

With the 2025 volumes, the modified single lane roundabout just passes the LOS F threshold during the AM peak with the northbound leg operating at LOS F with a queue length of 43 vehicles (860 feet). This roundabout operates just below the LOS F threshold during the PM peak with the eastbound leg operating at LOS F with a queue length of 34 vehicles (680 feet).

The first 2 tables show the traffic volumes and roundabout geometrics utilized in the analysis. The remaining tables are the Rodel analysis tables.

Table 1 : Traffic Turning Movements (TH 3 at CSAH 26)

	SB TH 3			EB CSAH 26			NB TH 3			WB CSAH 26		
	SBR	SBT	SBL	EBR	EBT	EBL	NBR	NBT	NBL	WBR	WBT	WBL
2004 AM Peak	88	92	13	16	143	69	248	421	45	29	330	53
2004 PM Peak	80	375	57	42	362	62	98	167	21	23	188	217
2025 AM Peak	159	166	23	29	258	125	448	760	81	52	596	96
2025 PM Peak	144	677	103	76	654	112	177	302	38	42	340	392

2025 turning movements assume a 3% growth rate applied to the 2004 volumes over a 20 year time period.

Table 2 : Modified Roundabout Design Parameters (TH 3 at CSAH 26)

	Single Lane Roundabout	
Entry Width (E)	18 ft	
Half Width (V)	12 ft	
Flare Length (L')	150 ft	
Entry Radius (R)	80 ft	
Entry Angle (phi)	30 deg	
Inscribed Circle Diameter (D)	180 ft	

Table 3 : Modified Single Lane Roundabout - 2004 AM Peak

```
*****************************************************************************
*                                                                           *
*  8:11:06                    TH 3 AT CSAH 26                         2004 *
*                                                                           *
*****************************************************************************
*                                                 *                         *
* E     (m)    5.49   5.49   5.49   5.49          * TIME PERIOD     min    90 *
* L'    (m)   45.72  45.72  45.72  45.72          * TIME SLICE      min    15 *
* V     (m)    3.66   3.66   3.66   3.66          * RESULTS PERIOD  min 15 75 *
* RAD   (m)   24.38  24.38  24.38  24.38          * TIME COST      $/hr 15.00 *
* PHI   (d)   30.00  30.00  30.00  30.00          * FLOW PERIOD     min 15 75 *
* DIA   (m)   54.86  54.86  54.86  54.86          * FLOW TYPE   pcu/veh   VEH *
* GRAD SEP       0      0      0      0           * FLOW PEAK  am/op/pm    AM *
*                                                 *                         *
*****************************************************************************
* LEG NAME *PCU *VEH TURNS (1st exit, 2nd..U)*CAPF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB       *1.05*   88   92   13  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB       *1.05*   16  143   69  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB       *1.05*  248  421   45  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB       *1.05*   29  330   53  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*****************************************************************************
*                      SB     EB     NB     WB                *                 *
* FLOW        veh     193    228    714    412                * AVEDEL  s   4.4 *
* CAPACITY    veh    1293   1447   1409   1232                * LOS   SIG     A *
* AVE DELAY  mins    0.05   0.05   0.09   0.07                * LOS UNSIG     A *
* MAX DELAY  mins    0.07   0.06   0.12   0.10                *                 *
* AVE QUEUE   veh       0      0      1      1                * VEHIC HRS   1.9 *
* MAX QUEUE   veh       0      0      1      1                * COST    $    28 *
* LOS UNSIG             A      A      A      A                *                 *
*****************************************************************************
```

Table 4 : Modified Single Lane Roundabout - 2004 PM Peak

```
*****************************************************************************
*                                                                           *
*  8:11:06                    TH 3 AT CSAH 26                         2004 *
*                                                                           *
*****************************************************************************
*                                                 *                         *
* E     (m)    5.49   5.49   5.49   5.49          * TIME PERIOD     min    90 *
* L'    (m)   45.72  45.72  45.72  45.72          * TIME SLICE      min    15 *
* V     (m)    3.66   3.66   3.66   3.66          * RESULTS PERIOD  min 15 75 *
* RAD   (m)   24.38  24.38  24.38  24.38          * TIME COST      $/hr 15.00 *
* PHI   (d)   30.00  30.00  30.00  30.00          * FLOW PERIOD     min 15 75 *
* DIA   (m)   54.86  54.86  54.86  54.86          * FLOW TYPE   pcu/veh   VEH *
* GRAD SEP       0      0      0      0           * FLOW PEAK  am/op/pm    PM *
*                                                 *                         *
*****************************************************************************
* LEG NAME *PCU *VEH TURNS (1st exit, 2nd..U)*CAPF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB       *1.05*   80  375   57  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB       *1.05*   42  362   62  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB       *1.05*   98  167   21  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB       *1.05*   23  188  217  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*****************************************************************************
*                      SB     EB     NB     WB              *                 *
* FLOW        veh     512    466    286    428              * AVEDEL  s   4.3 *
* CAPACITY    veh    1294   1167   1263   1395              * LOS   SIG     A *
* AVE DELAY  mins    0.08   0.09   0.06   0.06              * LOS UNSIG     A *
* MAX DELAY  mins    0.10   0.12   0.08   0.08              *                 *
* AVE QUEUE   veh       1      1      0      0              * VEHIC HRS   2.0 *
* MAX QUEUE   veh       1      1      0      1              * COST    $    30 *
* LOS UNSIG             A      A      A      A              *                 *
*****************************************************************************
```

Table 5 : Modified Single Lane Roundabout - 2025 AM Peak

```
*****************************************************************************
*                                                                           *
*  9:11:06                    TH 3 AT CSAH 26                        2025   *
*                                                                           *
*****************************************************************************
*                                                 *                         *
* E     (m)    5.49   5.49   5.49   5.49          * TIME PERIOD     min    90 *
* L'    (m)   45.72  45.72  45.72  45.72          * TIME SLICE      min    15 *
* V     (m)    3.66   3.66   3.66   3.66          * RESULTS PERIOD  min 15 75 *
* RAD   (m)   24.38  24.38  24.38  24.38          * TIME COST      $/hr 15.00 *
* PHI   (d)   30.00  30.00  30.00  30.00          * FLOW PERIOD     min 15 75 *
* DIA   (m)   54.86  54.86  54.86  54.86          * FLOW TYPE   pcu/veh   VEH *
* GRAD SEP       0      0      0      0           * FLOW PEAK  am/op/pm    AM *
*                                                 *                         *
*****************************************************************************
* LEG NAME *PCU *VEH TURNS (1st exit, 2nd..U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB       *1.05*  159  166   23  0          *1.00*50*1.00 1.000 1.00*15 45 75 *
* EB       *1.05*   29  258  125  0          *1.00*50*1.00 1.000 1.00*15 45 75 *
* NB       *1.05*  448  760   81  0          *1.00*50*1.00 1.000 1.00*15 45 75 *
* WB       *1.05*   52  596   96  0          *1.00*50*1.00 1.000 1.00*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*****************************************************************************
*                      SB     EB     NB     WB              *                 *
* FLOW        veh     348    412   1289    744              * AVEDEL  s  53.8 *
* CAPACITY    veh    1098   1375   1306   1000              * LOS   SIG     D *
* AVE DELAY  mins    0.08   0.06   1.76   0.25              * LOS UNSIG     F *
* MAX DELAY  mins    0.11   0.08   3.63   0.41              *                 *
* AVE QUEUE   veh       0      0     43      3              * VEHIC HRS  41.8 *
* MAX QUEUE   veh       1      0     79      5              * COST    $   626 *
* LOS UNSIG             A      A      F      C              *                 *
*****************************************************************************
```

Table 6 : Modified Single Lane Roundabout - 2025 PM Peak

```
*******************************************************************************
*                                                                             *
*  9:11:06                      TH 3 AT CSAH 26                        2025   *
*                                                                             *
*******************************************************************************
*                                                  *                          *
* E     (m)    5.49   5.49   5.49   5.49           * TIME PERIOD     min    90  *
* L'    (m)   45.72  45.72  45.72  45.72           * TIME SLICE      min    15  *
* V     (m)    3.66   3.66   3.66   3.66           * RESULTS PERIOD  min 15 75  *
* RAD   (m)   24.38  24.38  24.38  24.38           * TIME COST      $/hr 15.00  *
* PHI   (d)   30.00  30.00  30.00  30.00           * FLOW PERIOD     min 15 75  *
* DIA   (m)   54.86  54.86  54.86  54.86           * FLOW TYPE   pcu/veh   VEH  *
* GRAD SEP       0      0      0      0            * FLOW PEAK  am/op/pm    PM  *
*                                                  *                          *
*******************************************************************************
* LEG NAME *PCU *VEH TURNS (1st exit, 2nd..U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB       *1.05*  144  677  103  0          *1.00*50*1.00 1.000 1.00*15 45 75 *
* EB       *1.05*   76  654  112  0          *1.00*50*1.00 1.000 1.00*15 45 75 *
* NB       *1.05*  177  302   38  0          *1.00*50*1.00 1.000 1.00*15 45 75 *
* WB       *1.05*   42  340  392  0          *1.00*50*1.00 1.000 1.00*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                      SB     EB     NB     WB                *                 *
* FLOW        veh     924    842    517    774                * AVEDEL  s  47.5 *
* CAPACITY    veh    1098    868   1056   1282                * LOS   SIG     D *
* AVE DELAY  mins    0.51   2.14   0.11   0.12                * LOS UNSIG     E *
* MAX DELAY  mins    1.03   4.38   0.15   0.18                *                 *
* AVE QUEUE   veh       8     34      1      2                * VEHIC HRS  40.3 *
* MAX QUEUE   veh      15     65      1      2                * COST    $   605 *
* LOS UNSIG             D      F      A      A                *                 *
*******************************************************************************
```