CITY of NOVI CITY COUNCIL

Agenda Item C
November 23, 2009

SUBJECT: Approval of Traffic Control Orders 09-07 for the installation of a stop sign on southbound Town Center to stop at Eleven Mile Road, 09-08 for northbound Town Center to stop at Eleven Mile Road, and 09-09 requiring that northbound Town Center right lane traffic must turn right to eastbound Eleven Mile Road.

SUBMITTING DEPARTMENT: Department of Public Services, Engineering Division

CITY MANAGER APPROVAL:

BACKGROUND INFORMATION:

In response to several complaints and a high frequency of preventable crashes at the intersection of Town Center Drive and 11 Mile Road, the Engineering Division and our traffic Consultant, Birchler Arroyo, have completed a traffic study of the intersection. Both 11 Mile approaches are currently controlled by stop signs, while Town Center is not. There have been approximately 15 crashes at this intersection in the past 4 ½ years, of which 13 crashes (87%) were attributable to drivers on 11 Mile Road that either failed to yield, disregarded the stop sign, or were unable to stop for some other reason. Additionally, we have received several phone calls from motorists expressing concern about the safety of the intersection – mostly related to sight distance.

The enclosed report from Birchler Arroyo recommends that the existing two-way stop control at the intersection be replaced by a four-way stop control. The report identifies that the four-way stop control is warranted by the number of crashes at the intersection, the observed traffic volumes, and the lack of sight distance (see photos in report). The traffic analysis indicates that the intersection level of service (LOS) in most cases would improve from as low as LOS D to as high as LOS A as a result of the four-way stop control.

The implementation can be completed under our existing pavement marking contract and using Department of Public Services staff to install the signage.

RECOMMENDED ACTION: Approval of Traffic Control Orders 09-07 for the installation of a stop sign on southbound Town Center to stop at Eleven Mile Road, 09-08 for northbound Town Center to stop at Eleven Mile Road, and 09-09 requiring that northbound Town Center right lane traffic must turn right to eastbound Eleven Mile Road.

	1	2	Y	N
Mayor Landry				
Mayor Pro Tem Gatt				
Council Member Crawford				
Council Member Fischer				

	1	2	Y	N
Council Member Margolis				
Council Member Mutch				
Council Member Staudt				

CITY OF NOVI
TRAFFIC CONTROL ORDER

SPEED
PARKING
__X__ OTHER

DATE OF ORDER: **NOVEMBER 12, 2009**

CONTROL NUMBER: **09-07**

PURSUANT TO CHAPTER NO. 33 OF THE CODE OF ORDINANCES OF THE CITY OF NOVI, MICHIGAN, SAME BEING THE UNIFORM TRAFFIC CODE FOR CITIES, TOWNSHIPS AND VILLAGES OF MICHIGAN AND IN THE INTEREST OF PUBLIC SAFETY AND CONVENIENCE THE FOLLOWING TRAFFIC CONTROL ORDER IS HEREBY ISSUED BY BRIAN COBURN, SENIOR CIVIL ENGINEER, DULY AUTHORIZED AS TRAFFIC ENGINEER, BY SEC. 33.141 OF THE AFORESAID CHAPTER.

ISSUANCE OF THIS TRAFFIC CONTROL ORDER WAS PRECEDED BY STUDY AND INVESTIGATION OF TRAFFIC CONDITIONS ON THE FOLLOWING PUBLIC ROAD OR ROADS IN THE CITY OF NOVI, MICHIGAN.

TOWN CENTER

AND AFTER SAID INVESTIGATION, IT IS HEREBY ORDERED AND DIRECTED THAT THE DEPARTMENT OF PUBLIC SERVICES ERECT AND MAINTAIN THE **STOP** SIGN (S) IN ACCORDANCE WITH THE MICHIGAN MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES AS REQUIRED BY SEC. 33.217 OF THE AFORESAID CHAPTER, SAID SIGNS TO GIVE NOTICE OF THE FOLLOWING DETERMINATION:

SOUTH BOUND TOWN CENTER TO STOP AT ELEVEN MILE ROAD

TRAFFIC ENGINEER-BRIAN COBURN

DATED: 11/12/2009

APPROVED BY CITY COUNCIL

TRAFFIC CONTROL ORDER NUMBER **09-07** HAVING BEEN PRESENTED TO THE COUNCIL OF THE CIT OF NOVI, MICHIGAN FOR STUDY AND APPROVAL, IS HEREBY APPROVED AND IT IS HEREBY ORDEED AND DIRECTED THAT THIS ORDER BE FILED IN THE OFFICE OF THE CITY CLERK AND A COP THEREOF IN THE OFFICE OF THE CHIEF OF POLICE OF SAID CITY.

IT IS FURTHER ORDERED AND DIRECTED THAT THIS ORDER SHALL BECOME EFECTIVE UPON BEING FILED WITH THE CLERK AND UPON ERECTION OF ADEQUATE SIGNS GIVING NOTICE OF THE EXISTENCE OF AFORESAID,

SOUTH BOUND TOWN CENTER TO STOP AT ELEVEN MILE ROAD

ADOPTED AT THE REGULAR MEETING
OF COUNCIL ON _____.

BY: _____
Mayor - David Landry

By: _____
City Clerk - Maryanne Cornelius

CITY OF NOVI
TRAFFIC CONTROL ORDER

SPEED
PARKING
__X__ OTHER

DATE OF ORDER: **NOVEMBER 12, 2009**

CONTROL NUMBER: **09-08**

PURSUANT TO CHAPTER NO. 33 OF THE CODE OF ORDINANCES OF THE CITY OF NOVI, MICHIGAN, SAME BEING THE UNIFORM TRAFFIC CODE FOR CITIES, TOWNSHIPS AND VILLAGES OF MICHIGAN AND IN THE INTEREST OF PUBLIC SAFETY AND CONVENIENCE THE FOLLOWING TRAFFIC CONTROL ORDER IS HEREBY ISSUED BY BRIAN COBURN, SENIOR CIVIL ENGINEER, DULY AUTHORIZED AS TRAFFIC ENGINEER, BY SEC. 33.141 OF THE AFORESAID CHAPTER.

ISSUANCE OF THIS TRAFFIC CONTROL ORDER WAS PRECEDED BY STUDY AND INVESTIGATION OF TRAFFIC CONDITIONS ON THE FOLLOWING PUBLIC ROAD OR ROADS IN THE CITY OF NOVI, MICHIGAN.

TOWN CENTER

AND AFTER SAID INVESTIGATION, IT IS HEREBY ORDERED AND DIRECTED THAT THE DEPARTMENT OF PUBLIC SERVICES ERECT AND MAINTAIN THE **STOP** SIGN (S) IN ACCORDANCE WITH THE MICHIGAN MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES AS REQUIRED BY SEC. 33.217 OF THE AFORESAID CHAPTER, SAID SIGNS TO GIVE NOTICE OF THE FOLLOWING DETERMINATION:

NORTH BOUND TOWN CENTER TO STOP AT ELEVEN MILE ROAD

TRAFFIC ENGINEER-BRIAN COBURN

DATED: 11/12/2009

APPROVED BY CITY COUNCIL

TRAFFIC CONTROL ORDER NUMBER **09-08** HAVING BEEN PRESENTED TO THE COUNCIL OF THE CIT OF NOVI, MICHIGAN FOR STUDY AND APPROVAL, IS HEREBY APPROVED AND IT IS HEREBY ORDEED AND DIRECTED THAT THIS ORDER BE FILED IN THE OFFICE OF THE CITY CLERK AND A COP THEREOF IN THE OFFICE OF THE CHIEF OF POLICE OF SAID CITY.

IT IS FURTHER ORDERED AND DIRECTED THAT THIS ORDER SHALL BECOME EFECTIVE UPON BEING FILED WITH THE CLERK AND UPON ERECTION OF ADEQUATE SIGNS GIVING NOTICE OF THE EXISTENCE OF AFORESAID,

NORTH BOUND TOWN CENTER TO STOP AT ELEVEN MILE ROAD

ADOPTED AT THE REGULAR MEETING
OF COUNCIL ON _____.

BY: _____
Mayor - David Landry

By: _____
City Clerk - Maryanne Cornelius

CITY OF NOVI
TRAFFIC CONTROL ORDER

SPEED
PARKING
__X__ OTHER

DATE OF ORDER: **November 12, 2009**

CONTROL NUMBER: **09-09**

PURSUANT TO CHAPTER NO. 33 OF THE CODE OF ORDINANCES OF THE CITY OF NOVI, MICHIGAN, SAME BEING THE UNIFORM TRAFFIC CODE FOR CITIES, TOWNSHIPS AND VILLAGES OF MICHIGAN AND IN THE INTEREST OF PUBLIC SAFETY AND CONVENIENCE THE FOLLOWING TRAFFIC CONTROL ORDER IS HEREBY ISSUED BY BRIAN COBURN, SENIOR CIVIL ENGINEER, DULY AUTHORIZED AS TRAFFIC ENGINEER, BY SEC. 33.141 OF THE AFORESAID CHAPTER.

ISSUANCE OF THIS TRAFFIC CONTROL ORDER WAS PRECEDED BY STUDY AND INVESTIGATION OF TRAFFIC CONDITIONS ON THE FOLLOWING PUBLIC ROAD OR ROADS IN THE CITY OF NOVI, MICHIGAN.

TOWN CENTER

AND AFTER SAID INVESTIGATION, IT IS HEREBY ORDERED AND DIRECTED THAT THE DEPARTMENT OF PUBLIC SERVICES ERECT AND MAINTAIN THE **MUST TURN RIGHT** SIGN (S) IN ACCORDANCE WITH THE MICHIGAN MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES AS REQUIRED BY SEC. 33.217 OF THE AFORESAID CHAPTER, SAID SIGNS TO GIVE NOTICE OF THE FOLLOWING DETERMINATION:

NORTH BOUND TOWN CENTER RIGHT LANE MUST TURN RIGHT

TRAFFIC ENGINEER-BRIAN COBURN

DATED: 11/12/2009

APPROVED BY CITY COUNCIL

TRAFFIC CONTROL ORDER NUMBER **09-09** HAVING BEEN PRESENTED TO THE COUNCIL OF THE CITY OF NOVI, MICHIGAN FOR STUDY AND APPROVAL, IS HEREBY APPROVED AND IT IS HEREBY ORDEED AND DIRECTED THAT THIS ORDER BE FILED IN THE OFFICE OF THE CITY CLERK AND A COP THEREOF IN THE OFFICE OF THE CHIEF OF POLICE OF SAID CITY.

IT IS FURTHER ORDERED AND DIRECTED THAT THIS ORDER SHALL BECOME EFECTIVE UPON BEING FILED WITH THE CLERK AND UPON ERECTION OF ADEQUATE SIGNS GIVING NOTICE OF THE EXISTENCE OF AFORESAID,

NORTH BOUND TOWN CENTER RIGHT LANE MUST TURN RIGHT

ADOPTED AT THE REGULAR MEETING
OF COUNCIL ON _____.

BY: _____
Mayor - David Landry

By: _____
City Clerk - Maryanne Cornelius

November 13, 2009

BIRCHLER ARROYO ASSOCIATES, INC.

Brian T. Coburn, P.E.
Engineering Div., Dept. of Public Services
City of Novi
26300 Delwal Drive
Novi, MI 48375
bcoburn@cityofnovi.org

Subject: Traffic Study Report for Intersection of Eleven Mile Road and Town Center Drive

Dear Mr. Coburn:

We have completed our study of the above intersection, conducted per the City-approved proposal of August 13, 2009. This report summarizes our recommendations and the supporting analyses.

Recommendations

1. The existing two-way stop control at Eleven Mile and Town Center should be replaced by four-way stop control.

2. The right lane on the northbound approach should be marked and signed for right turns only, eliminating the need for merging as northbound traffic passes through the intersection.

3. The sidewalks along the east side of Town Center should be realigned near Eleven Mile to facilitate a north-south crosswalk nominally parallel to Town Center, pedestrian ramps should be provided on all corners, and crosswalks should be striped on all four intersection legs.

4. Stop bars should be placed on the north-south approaches, and the existing stop bar on the westbound approach relocated closer to (within 4-6 ft of) the recommended crosswalk.

5. The north-facing Keep Right sign on the landscaped median should be relocated closer to the intersection and mounted on a breakaway post. A supplemental south-facing STOP sign (and 4-WAY) sign should be mounted on the back of the Keep Right sign.

Existing Conditions

The subject intersection is located at the southeast corner of the Novi Town Center (Figure 1). The nearest traffic signals are at the intersections of Town Center Drive and Grand River Avenue (a short block to the south) and Eleven Mile Road and Meadowbrook Road (about ¾ mile to the east). The intersection of Town Center Drive and Crescent Boulevard is controlled by 3-way STOP signs. Speed limits are currently 25 mph on Town Center Drive and 30 mph on Eleven Mile Road.

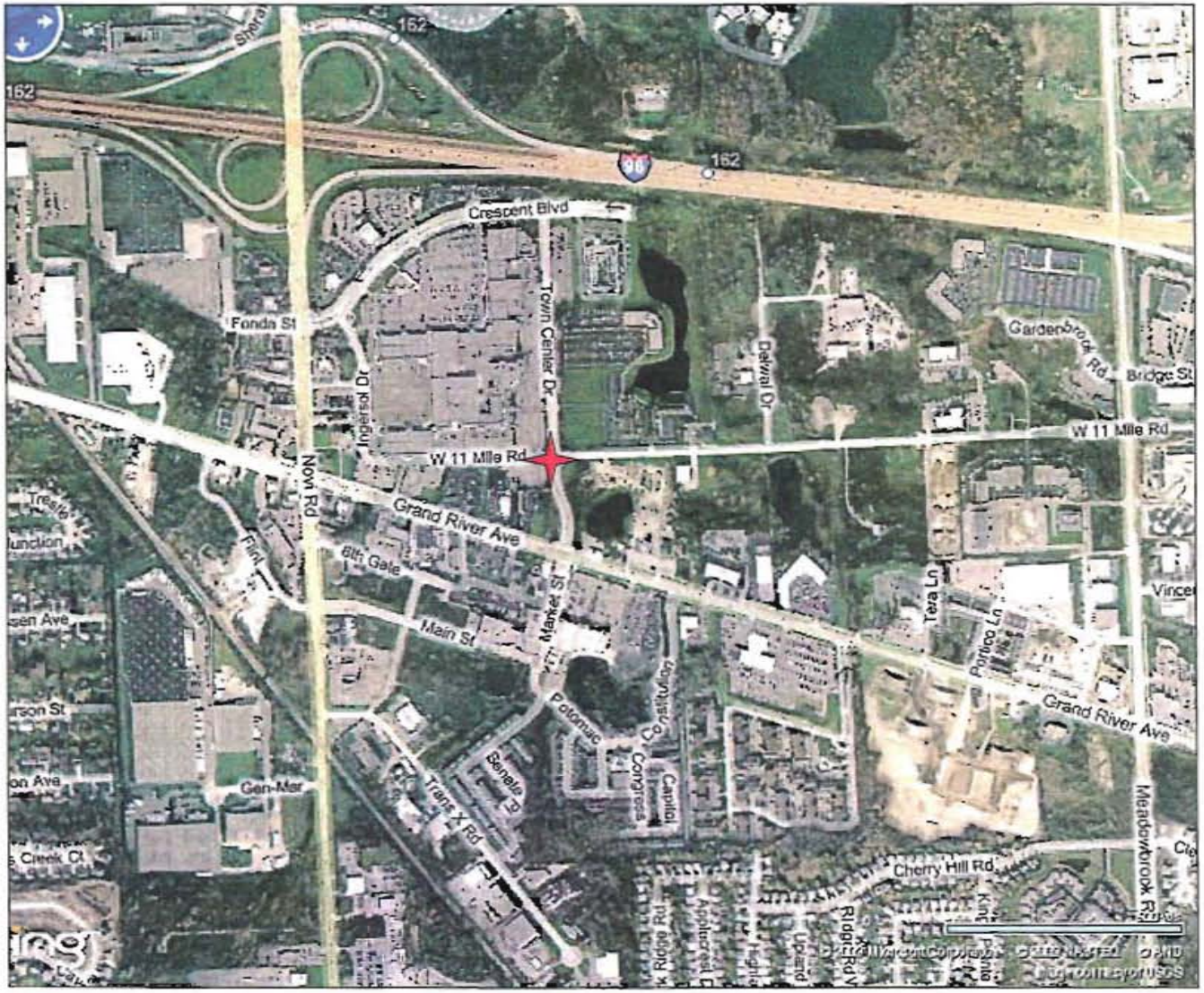

Figure 1. Vicinity Aerial

BIRCHLER ARROYD ASSOCIATES, INC.

As can be seen in Figure 2, the Eleven Mile / Town Center intersection has a different lane configuration on each approach. The eastbound approach has a single (left-through-right) lane, and the westbound approach has a left-turn-only lane and a shared through-right lane. The northbound approach has a left-turn-only lane, one through lane, and one lane dropping at Eleven Mile but not currently marked as a right-turn-only lane. The southbound approach has a left-turn-only lane adversely offset from the opposing northbound left-turn-only lane, plus one through lane. A second southbound through lane starts at Eleven Mile and extends to Grand River.

Both Eleven Mile Road approaches to Town Center Drive are controlled by STOP signs, supplemented for the past few months by CROSS TRAFFIC DOES NOT STOP signs. These supplemental signs were added after a citizen expressed concern that some drivers do not seem to realize that traffic on Town Center does not also have to stop, and the 2005-2007 crash history appeared to support that theory.

Continuing concerns about the intersection's safety prompted this more comprehensive review. Birchler Arroyo first conducted a field inspection, taking the photographs included here (as Figures 3-6) and also estimating intersection (or corner) sight distance to the north and south.

The City of Novi (per Design and Construction Standards Figure VIII-E) requires at least 280 ft of corner sight distance relative to a crossroad with a 25-mph speed limit, measured *(in the general case)* from 20 ft in advance of the near edge of that crossroad. Current national standards (per AASHTO's 2004 *Policy on Geometric Design of Highways and Streets)* call for 335 ft for left turns and 290 ft for through movements and right turns, both measured *(in the general case)* from 14.5 ft in advance of the crossroad's near edge (for the 30-mph design speed typically associated with a 25-mph speed limit).

Sight distance observations were first made relative to the above general guidelines. The only deficient observation was between the eastbound and southbound approaches from 20 ft in advance of Town Center, where the available sight distance was found to be only 180 ft – or 100 ft short of the City standard. All other observations found essentially unlimited sight distance.

The overall sight distance situation at this intersection is worse than the above findings might suggest. We believe that it is inappropriate – given the existing stop bar locations – to determine sight distance from 14.5 ft, or even as much as 20 ft, in advance of Town Center. To reach those standard sighting points, approaching vehicles must go well beyond the stop bars; this encourages drivers to pass over the implied crosswalk locations at some speed.

Furthermore, it is apparent in Figures 3-4 that the sight lines on the more critical eastbound approach are severely limited by solid wood fencing around the electrical transformers. From a typical driver viewing position 7 ft in advance of the stop bar, it was estimated that *the corner sight distance to the center of the near through lane is only about 125 ft to both the north and south.*

Corner sight distance was not estimated on the westbound approach, but it is apparent in Figures 5-6 that the sight distance in both directions is unnecessarily limited by the placement of the stop

Figure 2. Birdseye Aerial

Figure 3. Looking Northeast from Eastbound Eleven Mile

Figure 4. Looking Southeast from Eastbound Eleven Mile

Figure 5. Looking Northwest from Westbound Eleven Mile

Figure 6. Looking Southwest from Westbound Eleven Mile

bar well in advance of the implied (but unmarked) crosswalk (there is no need to place a stop bar at the ends of the curb returns, as was done in this location).

Given the sight distance limitations described above, drivers on Eleven Mile (especially those approaching from the west) are forced to pull up to or into the intersection to acquire barely enough sight distance to proceed safely. Drivers proceeding to the more forward position – without first pausing at the stop bar – endanger pedestrians and bicyclists using the sidewalk, and may startle approaching drivers on Town Center.

Crash History

To determine whether or not the problematic sight distance identified above is affecting safety, crash data were obtained from the Traffic Improvement Association (TIA) for the latest available 4½ calendar years, from January 1, 2005 through June 30, 2009. These data are detailed in Appendix A and summarized in Table 1 (below). Key findings are as follows:

- Thirteen of the 15 reported crashes (87%) were angle collisions, all involving drivers on Eleven Mile failing to yield, disregarding the STOP sign, or being "unable to stop."

- Five of the eastbound "failures to yield" to cross traffic occurred with a 12-month period, specifically, between 11-21-07 and 8-23-08. This frequency of preventable crashes meets one of the criteria for the installation of multi-way stop control (per Section 2B.07 of the 2005 *Michigan Manual on Uniform Traffic Control Devices)*. One of these five crashes involved possible personal injury (severity level C).

(continued)

Table 1. Most Recent 4½-Year Crash History for Intersection of Eleven Mile and Town Center[1]

Year	Date	Hour	Crash Type						Crash Severity			Possible Causal Factors
			Angle	Head-On	Sideswipe		Rear-End	Single-Vehicle	Fatal	Personal Injury	Property Damage Only (PDO)	
					Opposite Direction	Same Direction						
09	01-26	8 am	●								●	EB vehicle failed to yield to NB.
08	08-23	12 pm	●								●	EB vehicle failed to yield to NB.
	04-13	10 am	●							●		EB vehicle failed to yield to NB.
	03-04	12 pm	●								●	EB vehicle failed to yield to NB.
07	12-20	4 pm	●								●	EB vehicle failed to yield to SB.
	11-21	6 pm	●								●	EB vehicle failed to yield to NB.
	06-30	7 pm						●			●	WB left turn hit sign in median.
	03-05	12 pm	●								●	WB vehicle failed to yield to SB.
06	12-22	8 am	●								●	WB disregarded STOP and hit SB.
	06-25	12 pm	●							●		WB "unable to stop" and hit NB.
	04-24	1 pm	●								●	EB vehicle failed to yield to NB.
05	12-16	1 pm					●				●	WB vehicle unable to stop on snow.
	10-18	4 pm	●							●		EB vehicle failed to yield to NB.
	08-15	9 pm	●								●	EB vehicle failed to yield to NB.
	05-20	11 am	●							●		EB vehicle failed to yield to SB.
Totals			13	0	0	0	1	1	0	4	11	

[1] January 1, 2005 through June 30, 2009, inclusive. See detailed printouts provided by Traffic Improvement Association.
NOTE: Shaded rows identify five or more crashes preventable with multi-way stop control within a 12-month period

Traffic Counts

To facilitate an evaluation of alternative forms of traffic control at Eleven Mile and Town Center, City staff installed automated (hose) counters on each of the four intersection approaches (see Figure 2). Counts were then were conducted over several typical weekdays as well as a typical weekend. The results are detailed in Appendix B and partially summarized below.

Table 2. Approach Volumes in Eight Busiest Hours of the Day

Hour Ending	Approach				Total
	EB	WB	NB	SB	
Average Weekday					
12:00 p	133	202	162	163	658
1:00 p	207	275	233	237	951
2:00 p	160	240	181	217	796
3:00 p	105	166	146	173	588
4:00 p	84	148	152	151	534
5:00 p	94	175	147	177	592
6:00 p	126	201	195	191	712
7:00 p	138	171	184	189	681
Saturday					
1:00 p	92	100	220	149	561
2:00 p	108	92	209	158	567
3:00 p	95	72	214	151	532
4:00 p	102	80	225	175	582
5:00 p	103	78	260	157	598
6:00 p	151	87	313	171	722
7:00 p	174	98	263	204	739
8:00 p	153	61	194	209	617

To facilitate an evaluation of peak-hour delays and levels of service, Birchler Arroyo conducted manual turning-movement counts 12:00-2:00 p.m. and 5:00-7:00 p.m. on a typical weekday, and 5:00-7:00 p.m. on a typical Saturday (i.e., during the shaded busiest hours in Table 2). The results are detailed in Appendix C and summarized (for the corresponding peak hours) in Figure 7.

Peak-Hour Levels of Service

Synchro 7 capacity analysis software was used to predict average vehicular delays, associated levels of service, and queue lengths. As briefly explained at the beginning of Appendix D, the level of service (LOS) for a traffic movement, approach, or intersection is a letter grade between A and F, assigned by

the analysis software based on the average delay per vehicle predicted in a computer simulation. An overall level of service of D or better is typically sought in an urban or suburban area.

Table 3 (on next page) summarizes the LOS results obtained from our analysis of the subject intersection. Results are provided for both the existing two-way stop control and potential four-way stop control. Highlights of these results are as follows:

- Only the westbound left turn during the weekday peak hours now experience a level of service as low as D, normally considered the minimum acceptable for an urban area. Overall, the Eleven Mile Road approaches currently operate at LOS B or C, and the left turns from Town Center operate at LOS A.

- With installation of four-way stop control, all movements and the overall intersection would operate at LOS A or B. Average delays would range from 8-13 sec per vehicle.

Evaluation of Criteria for Multi-Way Stop Control

The relevant excerpt from the 2005 *Michigan Manual on Uniform Traffic Control Devices* appears in Appendix D. According to the MMUTCD, "multi-way stop control is used where the volume of traffic on the intersecting roads is approximately equal." The counts summarized in Table 2 show that this condition is met at Eleven Mile and Town Center.

Furthermore, specific MMUTCD criteria satisfied by the data collected in this study are as follows:

- Crashes (guideline B) – There were "5 or more reported crashes in a 12-month period... susceptible to correction by a multi-way stop installation."

- Minimum Volumes (guideline C) – Total current volumes on Town Center exceed 300 vehicles per hour in the 8 busiest hours of the weekday, total current volumes on Eleven Mile exceed 200 vehicles per hour in those same 8 hours, and westbound left turns from Eleven Mile experience over 30 seconds of delay per vehicle during the highest hour.

- Sight Distance (optional criterion C) – Based on the above observations and discussion, Eleven Mile and Town Center is a location "where a road user, after stopping, cannot see conflicting traffic and is not able to reasonably safely negotiate the intersection unless conflicting cross traffic is also required to stop."

Lane Usage

The above level of service analyses, showing that the intersection will operate very satisfactorily with four-way stop control, assumed (due to a limitation of the traffic model) that the northbound approach consists of a left-turn lane and a single through-right lane. It is reasonable to conclude that *any* use of the extra northbound through lane that actually exists will only result in even more favorable levels of service. We recommend that this fact be utilized to mark and sign the northbound right lane for right turns only, simplifying driver and pedestrian expectations and further enhancing traffic safety.

Table 3. Levels of Service at Eleven Mile and Town Center[1]

Approach[2]	Move-ment[3]	Weekday 12:30-1:30 p.m.			Weekday 5:00-6:00 pm			Saturday 6:00-7:00 p.m.		
		Volume (veh)	Avg. Delay (sec/veh)	LOS	Volume (veh)	Avg. Delay (sec/veh)	LOS	Volume (veh)	Avg. Delay (sec/veh)	LOS
Existing Two-Way Stop Control										
EB	All	202	24.3	C	103	14.0	B	130	13.6	B
WB	L	43	27.6	D	119	**31.3**	D	12	17.6	C
	T + R	157	14.6	B	166	15.7	C	81	12.1	B
	All	200	17.4	C	285	22.2	C	93	12.8	B
NB	L	38	7.8	A	43	7.7	A	65	7.7	A
SB	L	70	7.7	A	54	7.8	A	35	7.5	A
Potential Four-Way Stop Control[4]										
All		826	11.3	B	810	10.9	B	586	9.1	A
EB	All	202	13.0	B	103	10.9	B	130	10.1	B
WB	L	43	9.5	A	119	11.1	B	12	8.3	A
	T + R	157	10.5	B	166	10.7	B	81	8.2	A
	All	200	10.3	B	285	10.9	B	93	8.3	A
NB	L	38	9.4	A	43	9.4	A	65	8.7	A
	T + R	145	10.8	B	183	11.4	B	113	8.5	A
	All	183	10.5	B	226	11.0	B	178	8.6	A
SB	L	70	10.0	A	54	9.7	A	35	8.3	A
	T + R	171	11.8	B	142	11.2	B	150	9.5	A
	All	241	11.3	B	196	10.8	B	185	9.3	A

[1] Level of service (LOS) based on average delay per vehicle, the latter computed with *Synchro 7* software based on *Highway Capacity Manual* (Special Report 209, Transportation Research Board, 2000). See Appendix D for details.

[2] EB = eastbound, WB = westbound, NB = northbound, and SB = southbound.

[3] L = left turn, T = through, and R = right turn.

[4] Since Synchro / HCM is unable to model more than two lanes on an approach to an all-way stop, the NB approach was assumed to have a left-only lane and a shared through-right lane. The actual LOS produced in reality (with a left-only lane, through-only lane, and right-only lane should therefore be somewhat better than tabulated here.

Sincerely,
BIRCHLER ARROYO ASSOCIATES, INC.

Rodney L. Arroyo, AICP
Vice President

William A. Stimpson, P.E.
Director of Traffic Engineering

APPENDIX A:

CRASH DATA

Intersection Crash Report

For Sgt. Terry L. Whitefield (Town Center Drive & 11 Mile Road)

Date Range - 1/1/2005 to 12/31/2007

Prepared by Traffic Improvement Association

Crash Data Report | Date Range - 1/1/2005 to 12/31/2007 | Pages: 1/5 | Printed: 10/08/2008

#1 Location: S TOWN CENTER DR (0.12) 10 feet SW of 11 MILE RD — Crash ID: 6058375

Crash Date: 05/20/2005 | Day: Fri | Hour: 11 | Weather: clear | Roadway: dry | Light: day

Injuries K: 0 | Inj A: 0 | Inj B: 0 | Inj C: 2 | Inj O: 1 | How: angle

CVT: 62 | Area: w/i intersection | HBD: 0

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	right turn	veh in transpl	none	none	none	fail to yield	car	lltfrnt
2	S	go straight	veh in transpl	none	none	none	none	car	rtside

#2 Location: TOWN CENTER DR (0.12) 0 feet X of 11 MILE RD — Crash ID: 6097191

Crash Date: 08/15/2005 | Day: Mon | Hour: 21 | Weather: clear | Roadway: dry | Light: dark/ltd

Injuries K: 0 | Inj A: 0 | Inj B: 0 | Inj C: 0 | Inj O: 3 | How: angle

CVT: 62 | Area: unkn | HBD: 0

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	go straight	veh in transpl	none	none	none	disrgd traf ctl	smltruck	ctrfrnt
2	N	go straight	veh in transpl	none	none	none	none	smltruck	lltfrnt

#3 Location: TOWN CENTER DR (0.12) 10 feet S of 11 MILE RD — Crash ID: 6154164

Crash Date: 10/18/2005 | Day: Tue | Hour: 16 | Weather: clear | Roadway: dry | Light: day

Injuries K: 0 | Inj A: 0 | Inj B: 0 | Inj C: 1 | Inj O: 1 | How: angle

CVT: 62 | Area: w/i intersection | HBD: 0

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	start on road	veh in transpl	none	none	none	fail to yield	car	rtfrnt
2	N	go straight	veh in transpl	none	none	none	none	car	lltfrnt

#4 **Location:** TOWN CENTER DR (0.12) 0 feet X of 11 MILE RD — **Crash ID:** 6231085

Crash Date: 12/16/2005 **Day:** Fri **Hour:** 13 **Weather:** snow **Roadway:** snowy **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 3 **How:** rr-end
CVT: 62 **Area:** w/i intersection **HBD:** 0

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	W	stop on road	cargo loss/shft	none	none	none	none	car	ctrrear
2	W	stop on road	loss of control	parked vehicle	none	none	unable to stop	car	ctrfrnt

#5 **Location:** TOWNCENTER DR (0.12) 5 feet N of 11 MILE RD — **Crash ID:** 6325351

Crash Date: 04/24/2006 **Day:** Mon **Hour:** 13 **Weather:** cloudy **Roadway:** dry **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 2 **How:** angle
CVT: 62 **Area:** w/i intersection **HBD:** 0

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	go straight	veh in transpt	none	none	none	fail to yield	van	ctrfrnt
2	N	go straight	veh in transpt	none	none	none	none	car	lftside

#6 **Location:** 11 MILE (0.00) 10 feet E of TOWNCENTER — **Crash ID:** 6376210

Crash Date: 06/25/2006 **Day:** Sun **Hour:** 12 **Weather:** cloudy **Roadway:** dry **Light:** day
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 3 **Inj O:** 0 **How:** angle
CVT: 62 **Area:** w/i intersection **HBD:** 0

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	W	go straight	veh in transpt	none	none	none	unable to stop	car	ctrfrnt
2	N	go straight	veh in transpt	none	none	none	none	car	rtside

#7 **Location:** ELEVEN MILE (0.00) 10 feet N of TOWN CENTER — **Crash ID:** 6550423

Crash Date: 12/22/2006 **Day:** Fri **Hour:** 8 **Weather:** fog/smke **Roadway:** wet **Light:** dawn
Injuries K: 0 **Inj A:** 0 **Inj B:** 0 **Inj C:** 0 **Inj O:** 2 **How:** angle
CVT: 62 **Area:** w/i intersection **HBD:** 0

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	W	go straight	veh in transpt	none	none	none	disrgd traf ctl	car	rtfrnt
2	S	left turn	veh in transpt	none	none	none	none	car	lftside

#8 Location: 11 MILE RD (0.00) 0 feet X of TOWN CENTER — Crash ID: 6618297

Crash Date: 03/05/2007 | Day: Mon | Hour: 12 | Weather: clear | Roadway: dry | Light: day
Injuries K: 0 | Inj A: 0 | Inj B: 0 | Inj C: 0 | Inj O: 3 | How: angle
CVT: 62 | Area: w/i intersection | HBD: 0

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	W	go straight	veh in transpt	none	none	none	fail to yield	car	ctrfrnt
2	S	go straight	veh in transpt	none	none	none	none	car	lftside

#9 Location: TOWN CENTER DR (0.12) 40 feet S of 11 MILE RD — Crash ID: 6712978

Crash Date: 06/30/2007 | Day: Sat | Hour: 19 | Weather: cloudy | Roadway: dry | Light: day
Injuries K: 0 | Inj A: 0 | Inj B: 0 | Inj C: 0 | Inj O: 1 | How: single
CVT: 62 | Area: w/i intersection | HBD: 0

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	W	left turn	curb	traff sign post	none	none	improp turn	car	lftfrnt

#10 Location: 11 MILE RD (0.00) 20 feet E of TOWN CENTER DR — Crash ID: 6837174

Crash Date: 11/21/2007 | Day: Wed | Hour: 18 | Weather: rain | Roadway: wet | Light: dark/ltd
Injuries K: 0 | Inj A: 0 | Inj B: 0 | Inj C: 0 | Inj O: 2 | How: angle
CVT: 62 | Area: w/i intersection | HBD: 0

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	go straight	veh in transpt	none	none	none	disrgd traf ctl	car	rtside
2	N	go straight	veh in transpt	none	none	none	none	car	ctrfrnt

#11 Location: TOWN CENTER (0.12) 15 feet E of ELEVEN MILE — Crash ID: 6871023

Crash Date: 12/20/2007 | Day: Thu | Hour: 16 | Weather: clear | Roadway: dry | Light: day
Injuries K: 0 | Inj A: 0 | Inj B: 0 | Inj C: 0 | Inj O: 2 | How: angle
CVT: 62 | Area: strght.unrel | HBD: 0

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	start on road	veh in transpt	none	none	none	fail to yield	car	ctrfrnt
2	S	go straight	veh in transpt	none	none	none	none	car	rtfrnt

Crash Type

0	unknown
1	single
0	head on
0	ho-lt
9	angle
1	rr-end
0	rr-lt
0	rr-rt
0	ss-same
0	ss-opp
0	other
11	Total

Vehicle Types

0	unknown
18	car
1	van
0	pickup
2	sml/truck
0	mcycle
0	moped
0	go-cart
0	snowmobile
0	orv/atv
0	other
0	truck/bus
21	Total

Hazardous Action

10	none
0	too fast
0	too slow
5	fail to yield
3	disrgd traf ctl
0	wrong way
0	left of center
0	improp passing
0	improp lane use
1	improp turn
0	improp/no signl
0	improp backing
2	unable to stop
0	other
0	unknown
0	reck drving
0	negl drving
21	Total

Crashes by Month

Jan	0	0%
Feb	0	0%
Mar	1	9.1%
Apr	1	9.1%
May	1	9.1%
Jun	2	18.2%
Jul	0	0%
Aug	1	9.1%
Sep	0	0%
Oct	1	9.1%
Nov	1	9.1%
Dec	3	27.3%
Total	11	100.0%

Weather Condition

0	unknown
5	clear
3	cloudy
1	fog/smke
1	rain
1	snow
0	sev wind
0	sleet
11	Total

Light Condition

0	unknown
8	day
1	dawn
0	dusk
2	dark/ltd
0	dark/unltd
0	other
11	Total

Road Condition

0	unknown
8	dry
2	wet
0	icy
1	snowy
0	muddy
0	slushy
0	debris
11	Total

Alcohol in Crashes

	Fatal	PIA	PDA	Total
Drinking	0	0	0	0
Not Drinking	0	3	8	11
Total	0	3	8	11

Crash Severity

	Fatal	Inj A	Inj B	Inj C	No Inj	Total
Persons	0	0	0	6	20	26
Crashes	0	0	0	3	8	11

Time Period	Sunday		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Unknown		Totals	
12am - 1am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
1am - 2am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
2am - 3am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
3am - 4am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
4am - 5am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
5am - 6am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
6am - 7am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
7am - 8am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
8am - 9am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	9.1%	0	0.0%	0	0.0%	1	9.1%
9am - 10am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
10am - 11am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
11am - 12pm	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	9.1%	0	0.0%	0	0.0%	1	9.1%
12pm - 1pm	1	9.1%	1	9.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	2	18.2%
1pm - 2pm	0	0.0%	1	9.1%	0	0.0%	0	0.0%	0	0.0%	1	9.1%	0	0.0%	0	0.0%	2	18.2%
2pm - 3pm	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
3pm - 4pm	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
4pm - 5pm	0	0.0%	0	0.0%	1	9.1%	0	0.0%	1	9.1%	0	0.0%	0	0.0%	0	0.0%	2	18.2%
5pm - 6pm	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
6pm - 7pm	0	0.0%	0	0.0%	0	0.0%	1	9.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	9.1%
7pm - 8pm	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	9.1%	0	0.0%	1	9.1%
8pm - 9pm	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
9pm - 10pm	0	0.0%	1	9.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	9.1%
10pm - 11pm	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
11pm - 12am	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Unknown	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Totals	1	9.1%	3	27.3%	1	9.1%	1	9.1%	1	9.1%	3	27.3%	1	9.1%	0	0.0%	11	100%

Traffic Crash Reporting Association

Crash Report

Dominique Malich

CRASH_ID: 227903
FROM_DATE: 1/1/2008
TO_DATE: 6/30/2009
LOCATION: W 11 Mile Rd AT Town Center Dr

Printed On: 8/21/2009

#1 Location: E 11 MILE RD (0.00) 3 feet S of TOWN CENTER DR — Crash ID: 6948615

Crash Date: 03/04/2008 Day: Tue Hour: 12pm Weather: cloudy Roadway: dry Light: day
Injuries K: 0 Inj A: 0 Inj B: 0 Inj C: 0 Inj 0: 3 How: angle
CVT: Novi Area: w/i intersection HBD: N Drugs: N Complaint No: 0810308

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	start on rdwy	veh in transpt	none	none	none	failed to yeild	sm truck	rtfront
2	N	go straight	veh in transpt	none	none	none	none	car	ctrfront

UD-10: [illegible]

#2 Location: TOWN CENTER ST (0.12) 10 feet W of 11 MILE RD — Crash ID: 6984431

Crash Date: 04/13/2008 Day: Sun Hour: 10am Weather: snow Roadway: wet Light: day
Injuries K: 0 Inj A: 0 Inj B: 0 Inj C: 3 Inj 0: 0 How: angle
CVT: Novi Area: straight HBD: N Drugs: N Complaint No: 80017253

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	N	go straight	veh in transpt	none	none	none	none	car	ctrfront
2	E	go straight	veh in transpt	none	none	none	failed to yeild	car	rtfront

UD-10: [illegible]

#3 Location: 11 MILE RD (0.00) 10 feet W of TOWNCENTER — Crash ID: 7077427

Crash Date: 08/23/2008 Day: Sat Hour: 12pm Weather: clear Roadway: dry Light: day
Injuries K: 0 Inj A: 0 Inj B: 0 Inj C: 0 Inj 0: 3 How: unknown
CVT: Novi Area: inter other HBD: N Drugs: N Complaint No: 80044187

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	go straight	veh in transpt	ran off road/r	other fixed obj	none	failed to yeild	car	ctrfront
2	N	go straight	veh in transpt	none	none	none	none	car	lftfront
3	W	stop on road	veh in transpt	none	none	none	none	car	ctrfront

UD-10: [illegible]

#4 Location: 11 MILE RD (0.00) 0 feet X of TOWN CENTER — Crash ID: 7242516

Crash Date: 01/26/2009 Day: Mon Hour: 8am Weather: clear Roadway: dry Light: day
Injuries K: 0 Inj A: 0 Inj B: 0 Inj C: 0 Inj 0: 2 How: angle
CVT: Novi Area: w/i intersection HBD: N Drugs: N Complaint No: 90005323

Unit No	Veh Dir	Action Prior	Event 1	Event 2	Event 3	Event 4	Haz Action	Veh Type	Damage
1	E	go straight	veh in transpt	none	none	none	failed to yeild	van	rtside
2	N	go straight	veh in transpt	none	none	none	none	car	ctrfront

UD-10: [illegible]

Crash Type

0	uncoded
0	single
0	head-on
0	head-on/lt
3	angle
0	rr-end
0	rr-end/lt
0	rr-end/rt
0	ss-same
0	ss-opp
1	unknown

Light Conditions

0	uncoded
4	day
0	dawn
0	dusk
0	dark/ltd
0	dark/unltd
0	unknown

Weather

0	uncoded
2	clear
1	cloudy
0	fog/smoke
0	rain
1	snow
0	wind
0	sleet/hail
0	unknown

Road Condition

0	uncoded
3	dry
1	wet
0	icy
0	snowy
0	muddy
0	slushy
0	debris
0	unknown

Vehicle Type

0	uncoded
7	car
0	other
0	truck/bus
1	van
0	pickup
1	sm truck
0	motorcycle
0	moped
0	go-cart
0	snowmobile
0	off-rd veh

Crashes By Month

1	January
0	February
1	March
1	April
0	May
0	June
0	July
1	August
0	September
0	October
0	November
0	December

Hazardous Action

5	none
0	speeding
0	imprp/no signal
0	imprp backing
0	unable to stop
0	other
0	unknown
0	reckls driving
0	negl driving
0	spd too slow
4	failed to yeild
0	disrgd traffic cntrl
0	wrong way
0	left of center
0	imprp passing
0	imprp lane use
0	imprp turn

Crash Severity

	FATAL	A	B	C	Mo Inj	Total
Persons	0	0	0	3	3	11
Crashes	0	0	0	1	3	4

Alcohol in Crashes

	FATAL	PI	PD	Total
Drinking	0	0	0	0
Not Drinking	0	1	3	4
Total	0	1	3	4

Crashes per Hour by Day

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12a - 1a	0	0	0	0	0	0	0	0	0
1a - 2a	0	0	0	0	0	0	0	0	0
2a - 3a	0	0	0	0	0	0	0	0	0
3a - 4a	0	0	0	0	0	0	0	0	0
4a - 5a	0	0	0	0	0	0	0	0	0
5a - 6a	0	0	0	0	0	0	0	0	0
6a - 7a	0	0	0	0	0	0	0	0	0
7a - 8a	0	0	0	0	0	0	0	0	0
8a - 9a	0	1	0	0	0	0	0	0	1
9a - 10a	0	0	0	0	0	0	0	0	0
10a - 11a	1	0	0	0	0	0	0	0	1
11a - 12p	0	0	0	0	0	0	0	0	0
12p - 1p	0	0	1	0	0	0	1	0	2
1p - 2p	0	0	0	0	0	0	0	0	0
2p - 3p	0	0	0	0	0	0	0	0	0
3p - 4p	0	0	0	0	0	0	0	0	0
4p - 5p	0	0	0	0	0	0	0	0	0
5p - 6p	0	0	0	0	0	0	0	0	0
6p - 7p	0	0	0	0	0	0	0	0	0
7p - 8p	0	0	0	0	0	0	0	0	0
8p - 9p	0	0	0	0	0	0	0	0	0
9p - 10p	0	0	0	0	0	0	0	0	0
10p - 11p	0	0	0	0	0	0	0	0	0
11p - 12a	0	0	0	0	0	0	0	0	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

APPENDIX B:

AUTOMATED (HOSE) COUNTS

Table B-1. Intersection Approach Volumes on an Average (Tuesday-Thursday) Weekday

Hour Ending	Eastbound				Westbound				Northbound				Southbound				Total of Averages
	9/22	9/23	9/24	Avg.	9/22	9/23	9/24	Avg.	9/22	9/23	9/24	Avg.	9/22	9/23	9/24	Avg.	
1 am		0	2	1		4	11	8		2	13	8		3	5	4	20
2 am		1	2	2		8	4	6		4	4	4		4	6	5	17
3 am		0	0	0		0	3	2		3	8	6		0	1	1	8
4 am		2	1	2		4	1	3		0	3	2		0	0	0	6
5 am		0	0	0		2	2	2		3	0	2		2	1	2	5
6 am		6	7	7		17	21	19		12	10	11		7	10	9	45
7 am		22	22	22		64	70	67		27	34	31		30	41	36	155
8 am		44	41	43		148	134	141		74	53	64		83	81	82	329
9 am		48	58	53		158	158	158		108	84	96		92	99	96	403
10 am		65	58	62		123	109	116		121	98	110		93	83	88	375
11 am		57	57	57		106	96	101		105	77	91		110	86	98	347
12 pm		126	139	133		213	190	202		151	172	162		185	140	163	658
1 pm	204	210		207	259	290		275	277	188		233	233	241		237	951
2 pm	155	164		160	244	235		240	202	159		181	209	224		217	796
3 pm	91	118		105	162	169		166	155	136		146	166	179		173	588
4 pm	76	92		84	122	173		148	147	157		152	106	195		151	534
5 pm	85	103		94	171	178		175	134	159		147	152	202		177	592
6 pm	131	121		126	209	192		201	183	206		195	168	213		191	712
7 pm	126	149		138	173	169		171	182	185		184	163	215		189	681
8 pm	105	82		94	123	123		123	147	135		141	173	176		175	532
9 pm	59	72		66	79	113		96	77	100		89	125	153		139	389
10 pm	34	22		28	60	44		52	55	42		49	67	82		75	203
11 pm	11	13		12	25	30		28	28	26		28	42	54		48	116
12 am	2	4		3	16	12		14	13	10		12	14	28		21	50
Total	1079	1521	387	1494	1643	2575	799	2509	1601	2113	556	2135	1618	2571	553	2371	8508

Table B-2. Intersection Approach Volumes over a Typical (Friday-Sunday) Weekend

Hour Ending	Eastbound				Westbound				Northbound				Southbound				Total for Saturday
	10/02	10/03	10/04	Avg.	10/02	10/03	10/04	Avg.	10/02	10/03	10/04	Avg.	10/02	10/03	10/04	Avg.	
1 am	9	8	12	10	3	3	3	3	5	12	11	9	8	23	25	19	46
2 am	0	9	5	5	1	2	3	2	7	12	11	10	4	53	39	32	76
3 am	1	0	2	1	1	0	3	1	5	7	11	8	4	3	5	4	10
4 am	2	2	1	2	0	0	0	0	2	2	1	2	0	3	2	2	7
5 am	1	0	1	1	1	1	0	1	0	2	1	1	3	0	0	1	3
6 am	7	2	0	3	5	4	1	3	16	1	2	6	4	1	0	2	8
7 am	28	10	6	15	9	7	5	7	23	17	7	16	26	4	5	12	30
8 am	70	19	11	33	42	23	14	26	49	24	20	31	55	9	12	25	75
9 am	69	13	8	30	69	31	20	40	87	45	26	53	75	41	31	49	130
10 am	48	29	31	36	89	64	40	64	128	100	45	91	87	67	46	67	260
11 am	55	55	28	46	84	68	51	68	102	119	74	98	84	114	60	86	356
12 pm	118	87	33	79	169	94	78	114	178	192	102	157	139	145	92	125	518
1 pm	176	92	70	113	173	100	80	118	196	220	151	189	200	149	127	159	581
2 pm	173	108	78	120	129	92	83	101	193	209	165	189	189	158	129	159	567
3 pm	133	95	90	106	121	72	55	83	142	214	208	188	150	151	153	151	532
4 pm	99	102	115	105	133	80	81	98	129	225	210	188	179	175	171	175	582
5 pm	93	103	103	100	192	78	59	110	148	260	181	196	167	157	137	154	560
6 pm	106	151	79	112	231	87	71	130	216	313	148	226	173	171	172	172	722
7 pm	92	174	93	120	141	98	64	101	172	263	101	179	187	204	130	174	739
8 pm	116	153	74	114	67	61	20	49	145	194	67	135	143	209	118	157	617
9 pm	97	103	38	79	39	31	10	27	78	88	34	67	129	139	69	112	361
10 pm	77	74	21	57	15	14	5	11	57	46	20	41	98	78	28	68	212
11 pm	37	42	11	30	9	13	6	9	62	76	11	50	61	90	22	58	221
12 am	24	19	6	16	4	1	4	3	19	24	6	16	21	28	15	21	72
Total	1631	1450	916	1332	1727	1024	756	1169	2159	2665	1613	2146	2186	2172	1588	1982	7311

APPENDIX C:

MANUAL (TURNING-MOVEMENT) COUNTS

TRAFFIC STUDY OF ELEVEN MILE / TOWN CENTER INTERSECTION
EARLY PM Turning-Movement Count
Thursday, 10-08-09

Cumulative Turning-Movement Count

15 MINUTES ENDING (Enter Data)	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
12:15	5	13	15	12	26	26	20	35	5	10	33	7	207
12:30	8	25	34	19	44	49	31	54	13	28	74	7	386
12:45	17	51	50	28	70	72	44	77	21	50	128	8	616
1:00	25	74	74	43	85	95	49	101	29	74	164	11	824
1:15	32	98	89	57	101	114	59	128	38	86	200	15	1017
1:30	36	123	110	62	110	140	69	166	46	98	235	17	1212
1:45	39	132	119	72	123	154	75	192	55	112	253	18	1344
2:00	41	145	132	76	132	169	78	214	57	124	272	20	1460

Turning-Movement Count by 15-Minute Interval

15 MINUTES ENDING	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
12:15	5	13	15	12	26	26	20	35	5	10	33	7	207
12:30	3	12	19	7	18	23	11	19	8	18	41	0	179
12:45	9	26	16	9	26	23	13	23	8	22	54	1	230
1:00	8	23	24	15	15	23	5	24	8	24	36	3	208
1:15	7	24	15	14	16	19	10	27	9	12	36	4	193
1:30	4	25	21	5	9	26	10	38	8	12	35	2	195
1:45	3	9	9	10	13	14	6	26	9	14	18	1	132
2:00	2	13	13	4	9	15	3	22	2	12	19	2	116
TOTAL	41	145	132	76	132	169	78	214	57	124	272	20	1460

Hourly Total

HOUR BEGINNING	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
12:00	25	74	74	43	85	95	49	101	29	74	164	11	824
12:15	27	85	74	45	75	88	39	93	33	76	167	8	810
12:30	28	98	76	43	66	91	38	112	33	70	161	10	826
12:45	22	81	69	44	53	82	31	115	34	62	125	10	728
1:00	16	71	58	33	47	74	29	113	28	50	108	9	636

Early PM Peak Hour

HOUR BEGINNING	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
12:30	28	98	76	43	66	91	38	112	33	70	161	10	826
PHF (Peak-Hour Factor)	0.78	0.94	0.79	0.72	0.63	0.88	0.73	0.74	0.92	0.73	0.75	0.63	0.90
	0.92			0.86			0.82			0.78			

TRAFFIC STUDY OF ELEVEN MILE / TOWN CENTER INTERSECTION
LATE PM Turning-Movement Count
Thursday, 10-08-09

Cumulative Turning-Movement Count

15 MINUTES ENDING (Enter Data)	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
5:15	3	8	10	33	18	31	12	39	9	10	39	2	214
5:30	6	12	26	74	43	57	25	81	15	26	83	5	435
5:45	6	17	46	109	62	73	35	123	17	45	107	8	648
6:00	9	29	65	119	77	89	43	164	19	54	136	6	810
6:15	10	40	66	132	90	105	59	195	26	66	173	9	994
6:30	13	47	99	138	100	120	70	213	26	77	207	13	1123
6:45	17	52	110	144	115	139	81	251	27	89	245	16	1286
7:00	17	57	122	152	124	156	89	277	30	97	273	18	1415

Turning-Movemsnt Count by 15-Minute Interval

15 MINUTES ENDING	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
5:15	3	8	10	33	18	31	12	39	9	10	39	2	214
5:30	3	4	16	39	27	26	13	42	6	16	25	3	221
5:45	2	5	18	35	19	16	10	42	2	19	44	1	213
6:00	1	12	19	10	15	16	8	41	2	9	29	0	162
6:15	1	11	21	13	13	19	16	31	7	12	37	3	184
6:30	3	7	13	6	10	12	11	18	0	11	34	4	129
6:45	4	5	11	6	15	19	11	38	1	12	38	3	163
7:00	0	5	12	8	9	19	8	26	3	8	28	3	129
TOTAL	17	57	122	152	124	156	89	277	30	97	273	18	1415

Hourly Total

HOUR BEGINNING	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
5:00	9	29	65	119	77	89	43	164	19	54	136	6	810
5:15	7	32	76	98	74	77	47	158	17	58	135	7	780
5:30	7	35	71	84	67	63	45	132	11	51	144	8	668
5:45	9	35	64	35	53	68	48	128	10	44	136	10	638
6:00	8	29	57	33	47	69	46	113	11	43	137	13	605

Late PM Peak Hour

HOUR BEGINNING	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
5:00	9	29	65	119	77	89	43	164	19	54	136	6	810
PHF (Peak-Hour Factor)	0.75	0.60	0.86	0.78	0.71	0.72	0.83	0.96	0.53	0.71	0.77	0.50	0.92
		0.80			0.78			0.93			0.77		

TRAFFIC STUDY OF ELEVEN MILE / TOWN CENTER INTERSECTION
LATE PM Turning-Movement Count
Saturday, 10-10-09

Cumulative Turning-Movement Count

15 MINUTES ENDING (Enter Data)	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
5:15	4	8	19	5	10	17	3	25	4	8	19	1	123
5:30	11	13	36	15	13	29	7	42	7	16	45	2	239
5:45	16	23	49	20	25	37	22	68	10	27	63	2	363
6:00	18	28	61	25	32	53	32	95	14	30	97	3	468
6:15	23	44	77	26	43	64	48	123	17	41	124	5	635
6:30	25	54	98	30	51	74	65	149	21	47	155	5	775
6:45	26	66	117	32	56	84	84	173	27	56	202	9	954
7:00	28	75	134	37	67	99	97	193	29	65	230	11	1074

Turning-Movement Count by 15-Minute Interval

15 MINUTES ENDING	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
5:15	4	8	19	5	10	17	3	25	4	8	19	1	123
5:30	7	5	17	10	6	12	4	17	3	8	26	1	116
5:45	5	10	13	5	10	8	18	26	3	11	18	0	124
6:00	2	5	12	5	6	16	10	27	4	3	34	1	125
6:15	5	16	16	1	11	11	16	28	3	11	27	2	147
6:30	2	10	19	4	8	10	17	26	4	6	31	1	138
6:45	1	12	21	2	7	10	19	24	6	9	47	3	161
7:00	2	9	17	6	9	15	13	20	2	9	37	2	140
TOTAL	28	75	134	37	67	99	97	193	29	65	239	11	1074

Hourly Total

HOUR BEGINNING	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
5:00	18	28	61	25	32	53	32	95	14	30	97	3	468
5:15	19	36	56	21	33	47	45	98	13	33	105	4	512
5:30	14	41	60	15	35	45	58	107	14	31	110	4	534
5:45	10	43	68	12	32	47	62	103	17	29	139	7	571
6:00	10	47	73	12	35	46	65	98	15	35	142	8	586

Late PM Peak Hour

HOUR BEGINNING	EB			WB			NB			SB			TOTAL
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
6:00	**10**	**47**	**73**	**12**	**35**	**46**	**65**	**98**	**15**	**35**	**142**	**8**	**586**
PHF (Peak-Hour Factor)	0.50	0.73	0.87	0.60	0.80	0.77	0.86	0.88	0.83	0.80	0.76	0.67	0.91
	0.88			0.80			0.91			0.75			

APPENDIX D:

CAPACITY ANALYSES

INTERSECTION CAPACITY ANALYSES

Intersection capacity analyses were conducted using *Synchro 7* software, based on methodologies contained in the *Highway Capacity Manual* (*HCM*, Transportation Research Board, 2000). The primary objective of such analyses is to determine level of service, a qualitative measure of the "ease" of traffic flow based on average vehicular delay. Analytical models are used to estimate the average delay per vehicle for specific movements, minor multilane approaches – and in the case of all-way stop-controlled and signalized intersections -- major multilane approaches and the overall intersection as well. These models account for lane configuration, grade, type of traffic control, traffic volume and composition, and other traffic flow parameters.

Level of service (LOS) is expressed using a letter grading scale, with A being the highest level and F being the lowest level. Achieving an overall intersection LOS of D is generally acceptable, although individual movements experiencing (or expected to experience) LOS E or F may be considered for mitigation.

The following table defines LOS, in terms of average delay per vehicle, for unsignalized intersections (intersections include junctions of driveways and roads as well as roads and roads).

Level of Service Criteria for Unsignalized Intersections

Level of Service	Control Delay per Vehicle (seconds)
A	≤ 10
B	> 10 and ≤ 15
C	> 15 and ≤ 25
D	> 25 and ≤ 35
E	> 35 and ≤ 50
F	> 50

According to the *Highway Capacity Manual*, level of service at a two-way stop-controlled intersection is defined only for minor movements (i.e., minor approach left and right turns and major approach left turns). LOS is not defined for the intersection as a whole, since most vehicles pass through the intersection without stopping and thus experience negligible delay.

It is important to realize how *HCM* methodology computes average approach delay and average intersection delay at a one- or two-way-stop-controlled intersection where left turns from the major road share a single lane with through (and possibly right-turning) traffic. In applying the equations for weighted average delay, the methodology assumes zero delay for major-road through and right-turning traffic (believing them to be negligible), but then divides by the total approach (or intersection volume). Hence, the resulting average delay per vehicle is generally significantly lower than what the average left-turn delay per left-turn vehicle would be if, in fact, the latter was actually reported by the software (it is not). Caution should therefore be used in interpreting the reported average delay per vehicle on approaches and at intersections having shared (left-through or left-through-right) lanes on the major road.

EXISTING TWO-WAY STOP CONTROL

HCM Unsignalized Intersection Capacity Analysis
3: 11 Mile Rd & Town Center Dr

10/16/2009

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	28	98	76	43	66	91	38	112	33	70	161	10
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.86	0.86	0.86	0.82	0.82	0.82	0.78	0.78	0.78
Hourly flow rate (vph)	30	107	83	50	77	106	46	137	40	90	206	13
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	766	662	213	751	628	137	219			177		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	766	662	213	751	628	137	219			177		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	86	69	90	76	79	88	97			94		
cM capacity (veh/h)	220	345	827	208	361	912	1350			1399		

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	220	50	183	46	137	40	90	219
Volume Left	30	50	0	46	0	0	90	0
Volume Right	83	0	106	0	0	40	0	13
cSH	402	208	556	1350	1700	1700	1399	1700
Volume to Capacity	0.55	0.24	0.33	0.03	0.08	0.02	0.06	0.13
Queue Length 95th (ft)	79	23	36	3	0	0	5	0
Control Delay (s)	24.3	27.6	14.6	7.8	0.0	0.0	7.7	0.0
Lane LOS	C	D	B	A			A	
Approach Delay (s)	24.3	17.4		1.6			2.3	
Approach LOS	C	C						

Intersection Summary

Average Delay	10.6			
Intersection Capacity Utilization	44.7%	ICU Level of Service	A	
Analysis Period (min)	15			

HCM Unsignalized Intersection Capacity Analysis
3: 11 Mile Rd & Town Center Dr

10/16/2009

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	9	29	65	119	77	69	43	164	19	54	136	6
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.80	0.80	0.80	0.78	0.78	0.78	0.93	0.93	0.93	0.77	0.77	0.77
Hourly flow rate (vph)	11	36	81	153	99	114	46	176	20	70	177	8
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	753	610	181	685	593	176	184			197		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	753	610	181	685	593	176	184			197		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	95	90	91	46	74	87	97			95		
cM capacity (veh/h)	213	375	862	285	384	867	1390			1376		

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	129	153	213	46	176	20	70	184
Volume Left	11	153	0	46	0	0	70	0
Volume Right	81	0	114	0	0	20	0	8
cSH	529	285	547	1390	1700	1700	1376	1700
Volume to Capacity	0.24	0.54	0.39	0.03	0.10	0.01	0.05	0.11
Queue Length 95th (ft)	24	73	46	3	0	0	4	0
Control Delay (s)	14.0	31.3	15.7	7.7	0.0	0.0	7.8	0.0
Lane LOS	B	D	C	A			A	
Approach Delay (s)	14.0	22.2		1.5			2.1	
Approach LOS	B	C						

Intersection Summary

Average Delay	10.9		
Intersection Capacity Utilization	34.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
3: 11 Mile Rd & Town Center Dr

10/16/2009

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	47	73	12	35	46	65	98	15	35	142	8
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.80	0.80	0.80	0.91	0.91	0.91	0.78	0.78	0.78
Hourly flow rate (vph)	11	53	83	15	44	58	71	108	16	45	182	10
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	607	544	187	632	533	108	192			124		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	607	544	187	632	533	108	192			124		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	87	90	95	89	94	95			97		
cM capacity (veh/h)	331	410	855	300	416	946	1381			1463		

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	148	15	101	71	108	16	45	192
Volume Left	11	15	0	71	0	0	45	0
Volume Right	83	0	58	0	0	16	0	10
cSH	565	300	611	1381	1700	1700	1463	1700
Volume to Capacity	0.26	0.05	0.17	0.05	0.06	0.01	0.03	0.11
Queue Length 95th (ft)	26	4	15	4	0	0	2	0
Control Delay (s)	13.6	17.6	12.1	7.7	0.0	0.0	7.5	0.0
Lane LOS	B	C	B	A			A	
Approach Delay (s)	13.6	12.8		2.8			1.4	
Approach LOS	B	B						

Intersection Summary

Average Delay	6.3		
Intersection Capacity Utilization	34.8%	ICU Level of Service	A
Analysis Period (min)	15		

POTENTIAL FOUR-WAY STOP CONTROL

HCM Unsignalized Intersection Capacity Analysis
3: 11 Mile Rd & Town Center Dr

10/16/2009

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	28	98	76	43	66	91	38	112	33	70	161	10
Peak Hour Factor	0.92	0.92	0.92	0.86	0.86	0.86	0.82	0.82	0.82	0.78	0.78	0.78
Hourly flow rate (vph)	30	107	83	50	77	106	46	137	40	90	206	13

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	220	50	183	46	177	90	219
Volume Left (vph)	30	50	0	46	0	90	0
Volume Right (vph)	83	0	106	0	40	0	13
Hadj (s)	-0.16	0.53	-0.37	0.53	-0.13	0.53	-0.01
Departure Headway (s)	6.2	7.0	6.0	6.9	6.3	6.8	6.2
Degree Utilization, x	0.38	0.10	0.31	0.09	0.31	0.17	0.38
Capacity (veh/h)	542	480	553	484	536	498	545
Control Delay (s)	13.0	9.5	10.5	9.4	10.8	10.0	11.8
Approach Delay (s)	13.0	10.3		10.5		11.3	
Approach LOS	B	B		B		B	

Intersection Summary

Delay	11.3			
HCM Level of Service	B			
Intersection Capacity Utilization	44.7%	ICU Level of Service	A	
Analysis Period (min)	15			

HCM Unsignalized Intersection Capacity Analysis
3: 11 Mile Rd & Town Center Dr

10/16/2009

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	9	29	85	119	77	89	43	164	19	54	136	6
Peak Hour Factor	0.80	0.80	0.80	0.78	0.78	0.78	0.93	0.93	0.93	0.77	0.77	0.77
Hourly flow rate (vph)	11	36	81	153	99	114	46	176	20	70	177	8

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	129	153	213	46	197	70	184
Volume Left (vph)	11	153	0	46	0	70	0
Volume Right (vph)	81	0	114	0	20	0	8
Hadj (s)	-0.33	0.53	-0.34	0.53	-0.04	0.53	0.00
Departure Headway (s)	6.2	6.7	5.8	6.9	6.3	6.9	6.3
Degree Utilization, x	0.22	0.28	0.34	0.09	0.35	0.13	0.32
Capacity (veh/h)	536	508	585	490	537	491	535
Control Delay (s)	10.9	11.1	10.7	9.4	11.4	9.7	11.2
Approach Delay (s)	10.9	10.9		11.0		10.8	
Approach LOS	B	B		B		B	

Intersection Summary

Delay	10.9		
HCM Level of Service	B		
Intersection Capacity Utilization	35.7%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
3: 11 Mile Rd & Town Center Dr

10/16/2009

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	47	73	12	35	46	65	98	15	35	142	8
Peak Hour Factor	0.88	0.88	0.88	0.80	0.80	0.80	0.91	0.91	0.91	0.78	0.78	0.78
Hourly flow rate (vph)	11	53	83	15	44	58	71	108	16	45	182	10

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	148	15	101	71	124	45	192
Volume Left (vph)	11	15	0	71	0	45	0
Volume Right (vph)	83	0	58	0	16	0	10
Hadj (s)	-0.29	0.53	-0.36	0.53	-0.06	0.53	0.00
Departure Headway (s)	5.5	6.4	5.5	6.1	5.5	6.0	5.5
Degree Utilization, x	0.22	0.03	0.15	0.12	0.19	0.07	0.29
Capacity (veh/h)	611	523	608	565	625	568	628
Control Delay (s)	10.1	8.3	9.2	9.7	8.5	8.3	9.5
Approach Delay (s)	10.1	8.3		8.6		9.3	
Approach LOS	B	A		A		A	

Intersection Summary

Delay	9.1		
HCM Level of Service	A		
Intersection Capacity Utilization	34.8%	ICU Level of Service	A
Analysis Period (min)	15		

APPENDIX E:

MMUTCD CRITERIA FOR MULTI-WAY STOP CONTROL

Once the decision has been made to install two-way stop control, the decision regarding the appropriate street to stop should be based on engineering judgment. In most cases, the street carrying the lowest volume of traffic should be stopped.

A STOP sign should not be installed on the major street unless justified by a traffic engineering study.

Support:

The following are considerations that might influence the decision regarding the appropriate street upon which to install a STOP sign where two streets with relatively equal volumes and/or characteristics intersect:

A. Stopping the direction that conflicts the most with established pedestrian crossing activity or school walking routes;
B. Stopping the direction that has obscured vision, dips, or bumps that already require drivers to use lower operating speeds;
C. Stopping the direction that has the longest distance of uninterrupted flow approaching the intersection; and
D. Stopping the direction that has the best sight distance to conflicting traffic.

The use of the STOP sign at highway-railroad grade crossings is described in Section 8B.08. The use of the STOP sign at highway-light rail transit grade crossings is described in Section 10C.04.

Section 2B.06 STOP Sign Placement

Standard:

The STOP sign shall be installed on the right side of the approach to which it applies. When the STOP sign is installed at this required location and the sign visibility is restricted, a Stop Ahead sign (see Section 2C.29) shall be installed in advance of the STOP sign.

The STOP sign shall be located as close as practical to the intersection it regulates, while optimizing its visibility to the road user it is intended to regulate.

STOP signs and YIELD signs shall not be mounted on the same post.

Guidance:

Other than a DO NOT ENTER sign, no sign should be mounted back-to-back with a STOP sign in a manner that obscures the shape of the STOP sign.

Support:

Section 2A.16 contains additional information about separate and combined mounting of other signs with STOP signs.

Guidance:

Stop lines, when used to supplement a STOP sign, should be located at the point where the road user should stop (see Section 3B.16).

If only one STOP sign is installed on an approach, the STOP sign should not be placed on the far side of the intersection.

Where two roads intersect at an acute angle, the STOP sign should be positioned at an angle, or shielded, so that the legend is out of view of traffic to which it does not apply.

Where there is a marked crosswalk at the intersection, the STOP sign should be installed in advance of the crosswalk line nearest to the approaching traffic.

Option:

At wide-throat intersections or where two or more approach lanes of traffic exist on the signed approach, observance of the stop control may be improved by the installation of an additional STOP sign on the left side of the road and/or the use of a stop line. At channelized intersections, the additional STOP sign may be effectively placed on a channelizing island.

Support:

Figure 2A-2 shows examples of some typical placements of STOP signs.

Section 2B.07 Multiway Stop Applications

Support:

Multiway stop control can be useful as a safety measure at intersections if certain traffic conditions exist. Safety concerns associated with multiway stops include pedestrians, bicyclists, and all road users expecting other road users to stop. Multiway stop control is used where the volume of traffic on the intersecting roads is approximately equal.

The restrictions on the use of STOP signs described in Section 2B.05 also apply to multiway stop applications.

Guidance:

The decision to install multiway stop control should be based on an engineering study.

The following criteria should be considered in the engineering study for a multiway STOP sign installation:

A. Where traffic control signals are justified, the multiway stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of the traffic control signal.
B. A crash problem, as indicated by 5 or more reported crashes in a 12-month period that are susceptible to correction by a multiway stop installation. Such crashes include right- and left-turn collisions as well as right-angle collisions.
C. Minimum volumes:
   1. The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day, and
   2. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour, but
   3. If the 85th-percentile approach speed of the major-street traffic exceeds 65 km/h or exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the above values.
D. Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition.

Option:

Other criteria that may be considered in an engineering study include:

A. The need to control left-turn conflicts;
B. The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes;
C. Locations where a road user, after stopping, cannot see conflicting traffic and is not able to reasonably safely negotiate the intersection unless conflicting cross traffic is also required to stop; and
D. An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multiway stop control would improve traffic operational characteristics of the intersection.

Section 2B.08 YIELD Sign (R1-2)

Standard:

The YIELD (R1-2) sign (see Figure 2B-1) shall be a downward-pointing equilateral triangle with a wide red border and the legend YIELD in red on a white background.

Support:

The YIELD sign assigns right-of-way to traffic on certain approaches to an intersection. Vehicles controlled by a YIELD sign need to slow down or stop when necessary to avoid interfering with conflicting traffic.

Section 2B.09 YIELD Sign Applications

Option:

YIELD signs may be used instead of STOP signs if engineering judgment indicates that one or more of the following conditions exist:

A. When the ability to see all potentially conflicting traffic is sufficient to allow a road user traveling at the posted speed, the 85th-percentile speed, or the statutory speed to pass through the intersection or to stop in a reasonably safe manner.
B. If controlling a merge-type movement on the entering roadway where acceleration geometry and/or sight distance is not adequate for merging traffic operation.
C. The second crossroad of a divided highway, where the median width at the intersection is 9 m (30 ft) or greater. In this case, a STOP sign may be installed at the entrance to the first roadway of a divided highway, and a YIELD sign may be installed at the entrance to the second roadway.
D. An intersection where a special problem exists and where engineering judgment indicates the problem to be susceptible to correction by the use of the YIELD sign.

Standard:

A YIELD (R1-2) sign shall be used to assign right-of-way at the entrance to a roundabout intersection.