Metropolitan Planning Organization of Johnson County

Date: May 1st, 2014

To: Dan Holderness; City Engineer; City of Coralville
Scott Larson; Assistant City Engineer; City of Coralville

From: Darian Nagle-Gamm; Traffic Engineering Planner
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Re: First Avenue & Oakdale Boulevard Traffic Signal Warrant and Roundabout Analysis Update - 2014

INTRODUCTION

This memorandum is an update to the 2010 traffic signal warrant study and roundabout analysis for the intersection of Oakdale Boulevard and 1st Avenue in Coralville. The update was requested by the City of Coralville to determine how traffic patterns and/or volumes have changed since the last study was completed.

EXISTING CONDITIONS

Figure 1 shows an aerial view of the intersection of Oakdale Boulevard (east-west) and 1st Avenue (north-south). The intersection is currently stop controlled for Oakdale Boulevard traffic. Both Oakdale Boulevard and 1st Avenue are posted at 35 mph within the study area.

The study area is located on the east side of Coralville, north of Interstate 80. The northwest, southwest, and southeast quadrants include open space, while the northeast quadrant is predominantly occupied by commercial development. The undeveloped parcels to the northwest, southwest, and southeast of the intersection are mostly municipally owned properties and are unlikely to develop in the future. There is also privately held open space to the southeast, which is part of a quarry and also likely to remain undeveloped.

Figure 1: Oakdale Boulevard and 1st Avenue intersection

Oakdale Boulevard is a two-lane arterial connecting Highway 965 on the west to Dubuque Street on the east. An extension of Oakdale Boulevard (which runs from Pembrokeshire to Dubuque Street NE) completed in the fall of 2013 has increased traffic at the intersection. 1st Avenue also functions as an arterial street and provides access from Coralville and Iowa City to the south and North Liberty to the north.

TRAFFIC COUNTS 2012 vs 2013

MPOJC collected 24-hour traffic counts at the intersection from October 2nd – 5th, 2012 (before the Oakdale extension was completed), and again from October 29th – November 1st, November 5th – 8th, and November 13th – 15th, 2013 (after construction was completed). **Figure 2** and **Figure 3** depict the recorded traffic counts at the intersection. The east leg of the intersection experienced the greatest increase in volumes at 32%, followed by an 11% increase on the west leg. The north leg of the intersection increased 3% and the south leg's traffic volumes remained the same.

Figure 2: 2012 24- Hour Average Daily Traffic (ADT) Counts (before Oakdale extension completed)

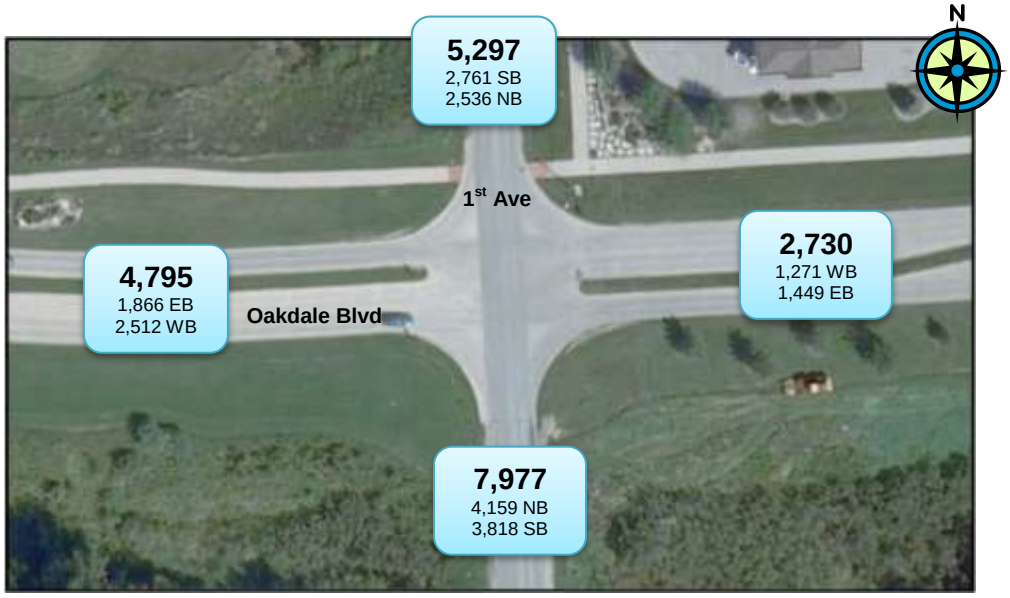
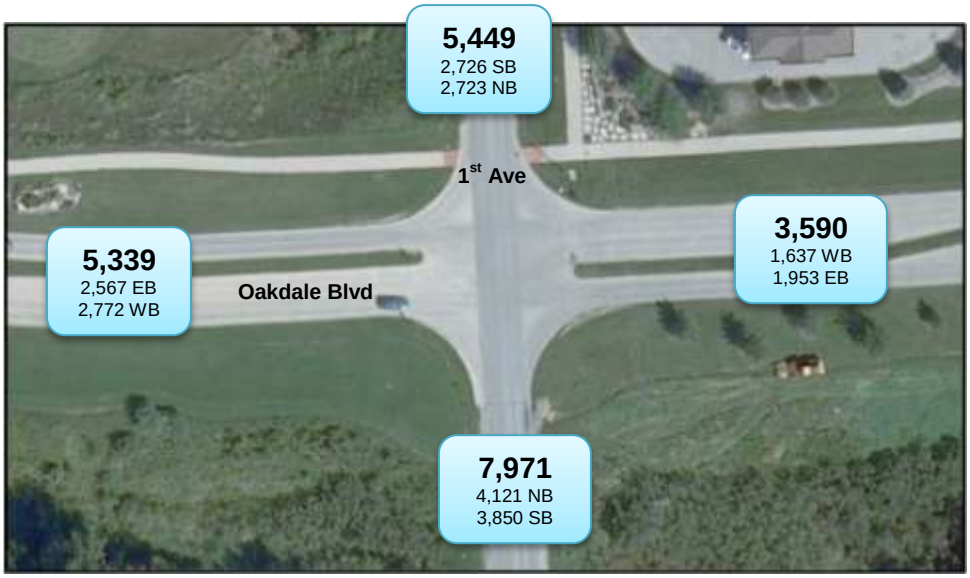


Figure 3: 2013 24- Hour Average Daily Traffic (ADT) Counts (after Oakdale extension completed)



TRAFFIC SIGNAL WARRANT ANALYSIS

A traffic signal warrant analysis is performed to determine the need for a traffic signal. At a minimum, at least 1 of the 8 warrants must be met, but the satisfaction of a warrant does not in itself require the installation of a traffic signal.

The 8 traffic signal warrants are as follows:

1) Eight-Hour Vehicular Volume
2) Four-Hour Vehicular Volume
3) Peak Hour
4) Pedestrian Volume *(not evaluated)*
5) School Crossing *(not evaluated)*
6) Coordinated Signal System *(not evaluated)*
7) Crash Experience
8) Roadway Network

Please see the Manual on Uniform Traffic Control Devices (MUTCD) for further detail of each warrant. Traffic signal warrants 1-3, 7, and 8 of the MUTCD were evaluated with respect to the observed traffic volumes. Twenty-four hour traffic counts used in Warrants 2 and 3 were performed between October 29th – November 1, November 5th – 8th, and November 13th – 15th, 2013.

Warrants 4, 5, and 6 are not applicable to this intersection due to the following:

- Warrant 4 was not evaluated due to the relatively low presence of pedestrians.
- Warrant 5 was not evaluated due to lack of a school immediately adjacent to the intersection
- Warrant 6 was not evaluated because current traffic control functions independent of other signalized intersections.

Warrant 1 Analysis – Eight-Hour Vehicular Volume

Warrant 1a – Minimum Vehicular Volume

Warrant 1a **(Table 1)** examines whether the intersection meets the minimum vehicular volume per hour to warrant a traffic signal. Eight 1-hour periods must meet appropriate traffic volumes. With a one-lane approach at each leg of the intersection and an 85th percentile speed of over 40 mph, during each hour the major street (1st Avenue) must have a total of 350 vehicles entering the intersection and the higher volume minor leg (Oakdale Boulevard) must have 105 vehicles entering the intersection to meet Warrant 1a. In 2010, nine 1-hour periods met these required volumes therefore Warrant 1a was met. In 2012, eight 1-hour periods met the required volumes therefore Warrant 1a was met. In 2013, after the Oakdale extension was completed, the table shows that seven 1-hour periods met the required thresholds; however there was 1 hour that missed the major-street warrant by only 9 vehicles. Due to counting equipment issues, we were only able to gather a 24 hour count (we typically gather 72 hour counts) on 1st Avenue. Based on this we assume that 8 1-hr periods likely met the threshold, therefore **Warrant 1a is met**.

Warrant 1b – Interruption of Continuous Traffic

Warrant 1b **(Table 1)** examines whether the traffic on the major street is so heavy that traffic on a minor street suffers excessive delay or conflict in entering or crossing the major street. With a one-lane approach at each leg of the intersection and an 85th percentile speed of over 40 mph, during each hour the major street (1st Avenue) must have a total of 525 entering vehicles and

the higher volume minor leg (Oakdale Boulevard) must have 53 vehicles entering the intersection to meet Warrant 1b. During 2010, Only *three* 1-hour periods met the required volumes therefore Warrant 1b was not met. During 2012, *five* 1-hour periods meet the required volumes therefore Warrant 1b was met. In 2013, only *one* 1-hour period met the required volumes therefore **Warrant 1b is not met**.

Table 1: Warrant 1 - Eight Hour Vehicular Volume

Warrant 1 – Eight-Hour Vehicular Volume Condition A - Minimum Vehicular Volume Condition B - Interruption of Continuous Traffic									
Oakdale Boulevard & 1st Avenue									
Coralville, IA	**Data Gathered: November 13th – 15th, 2013**							**MPOJC**	
Time	**Entering Traffic**				**Total Entering Traffic**	**Major Street Total**	**Highest Volume Minor Approach**	**Warranted?**	
	First Avenue		**Oakdale Blvd.**						
	Northbound	**Southbound**	**Eastbound**	**Westbound**				**1a**	**1b**
0100	1	0	4	0	5	1	4		
0200	3	2	1	1	7	5	1		
0300	2	1	1	4	8	3	4		
0400	13	14	10	14	51	27	14		
0500	85	69	29	46	229	154	46		
0600	**297**	**212**	**108**	**54**	**671**	**509**	**108**	**Yes**	
0700	**717**	**535**	**249**	**41**	**1542**	**1252**	**249**	**Yes**	**Yes**
0800	**367**	**121**	**180**	**39**	**707**	**488**	**180**	**Yes**	
0900	117	84	119	49	368	201	119		
1000	102	28	113	48	291	130	113		
1100	**193**	**148**	**128**	**44**	**512**	**341**	**128**	**Yes**	
1200	188	135	133	43	499	323	133		
1300	153	129	105	62	449	282	105		
1400	186	137	109	70	501	323	109		
1500	**216**	**172**	**151**	**90**	**629**	**388**	**151**	**Yes**	
1600	**230**	**165**	**174**	**57**	**626**	**395**	**174**	**Yes**	
1700	**250**	**175**	**178**	**44**	**646**	**425**	**178**	**Yes**	
1800	**212**	**138**	**121**	**25**	**496**	**350**	**121**	**Yes**	
1900	115	84	79	14	292	199	79		
2000	89	67	57	5	218	156	57		
2100	40	29	41	1	111	69	41		
2200	23	15	18	2	58	38	18		
2300	9	8	7	1	25	17	7		
2400	6	5	3	1	15	11	3		

Warrant 2 Analysis – Four-Hour Vehicular Volume

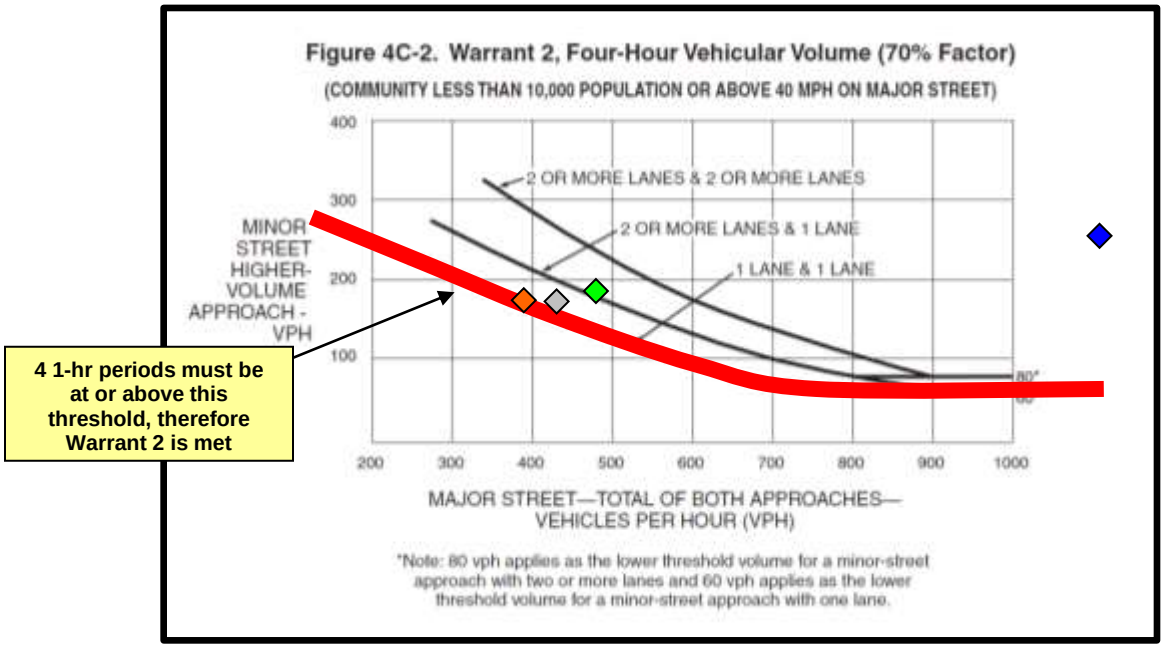
The four-hour vehicle volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is a principal reason to consider installing a traffic control signal. To meet Warrant 2, traffic volumes on both streets must meet the required volume threshold for four 1-hour periods. **Figure 4** graphically depicts the required vehicular volume threshold for the major and minor streets (red line) in comparison to the observed volumes. During 2010, *four* 1-hour periods met the required volumes therefore Warrant 2 was met. During 2012, five 1-hour periods met the required volumes therefore Warrant 2 was met. During 2013, both **Figure 4** and **Table 2** show that four 1-hr periods met the required vehicular volumes threshold, therefore **Warrant 2 is met**.

Table 2: Four-Hour Vehicular Volume*

Warrant 2, Four-Hour Vehicular Volume Oakdale Boulevard & 1st Avenue				
Hour threshold met	Entering Traffic		Meet's volume threshold	Legend
	1st Avenue	Oakdale Boulevard		
	Major Street	Minor Street		
0700	1252	249	YES	◆
0800	488	180	YES	◆
1600	395	174	YES	◆
1700	425	178	YES	◆

*This table contains only the observed hours that met the required minimum vehicular volumes

Figure 4: Four-Hour Vehicular



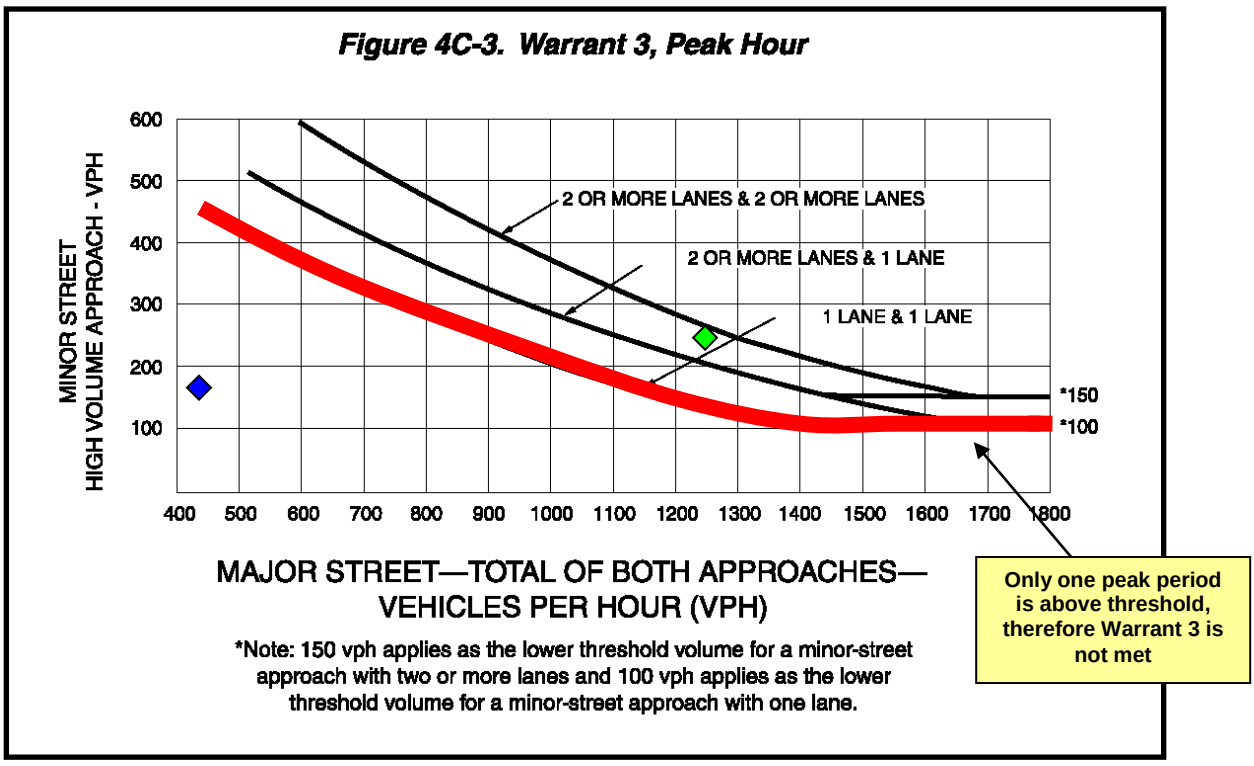
Warrant 3 Analysis – Peak Hour

The peak hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of one hour on an average day, the minor street traffic suffers undue delay when entering or crossing the major street. Peak hour traffic volumes on both streets must meet required thresholds under Warrant 3. **Figure 5** graphically depicts the required vehicular volume threshold for the major and minor streets (red line) in comparison to the observed volumes. Neither the AM or PM peak hours met the required thresholds in 2010 or in 2012. During 2013, only the AM peak hour met the required threshold, but the PM peak hour did not meet the required thresholds; therefore **Warrant 3 is not met**.

Table 3: Peak Hour Warrant

Warrant 3, Peak Hour Oakdale Boulevard & 1st Avenue							
Oakdale Boulevard Highest Vol. Approach		1st Avenue Entering Traffic		Warranted?		Legend	
AM	PM	AM	PM	AM	PM	AM	PM
249	178	1252	425	YES	No	◆	◆

Figure 5: Peak Hour Warrant Threshold & Observed Volumes



Warrant 7 Analysis – Collision Experience

Because the installation of traffic signals often results in a trade of one type of collision for another, Warrant 7 states that there must be 5 crashes of a type correctable by a signal in twelve months. Between 2007 – 2009 (years of analysis for the 2010 signal warrant study) there were eight total collisions and the minimum collision-per-year criteria was not met, therefore Warrant 7 was not met. In 2012, the collisions between 2009 – 2011 were evaluated. There were a total of 9 collisions at the intersection, averaging 3 per year. In 2013, the collisions between 2010 – 2012 were evaluated. There were a total of 9 collisions at the intersection, averaging 3 per year. **Table 4** shows that the majority of the collisions (88%) were broadside collisions, which are correctable by a traffic signal. While there were 8 collisions during the reporting period that meet the collision type criterion; the most broadside collisions occurring in one single year was 4. Therefore in 2013 **Warrant 7 is not met**.

Table 4: Collision Experience

Warrant 7 – Crash Experience Oakdale Boulevard & 1st Avenue: 2009 - 2011			
Type of Crash	**Number of Collisions**	**Crash Type Correctable By Traffic Signal**	**Warranted? (> 5 per year)**
Rear-End	0	No	No
Broadside	8	**Yes**	No
Non-Collision	0	No	No
Angle, oncoming left turn	0	**Yes**	No
Sideswipe, same direction	1	No	No
Total Number of Collisions	**9**	-----	No

Warrant 8 Analysis – Roadway Network

Warrant 8 is used when evaluating whether a traffic signal at an intersection might be justified to encourage concentration and organization of traffic flow on a roadway network. Warrant 8 is met when one or both of the following criteria are met:

A. *The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2 and 3 during an average weekday; or*
B. *The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).*

A major route as used in this signal warrant shall have one or more of the following characteristics:

A. *It is part of the street or highway system that serves as the principal roadway network for through traffic flow; or*
B. *It includes rural or suburban highways outside, entering, or traversing a City; or*
C. *It appears as a major route on an official plan, such as a major street plan in an urban traffic and transportation study.*

The Oakdale Boulevard / 1st Avenue intersection has approximately 1,000 entering vehicles per hour during both the AM and PM peak hours; therefore the intersection meets Criteria A. Based on the adjacent land uses (there are no large scale commercial activities in the area), it is highly unlikely that the intersection has more than 1,000 vehicles per hour for any 5 hours on a Saturday or Sunday, therefore the intersection does *not* meet Criteria B.

Under major route characteristics, the Oakdale Boulevard / 1st Avenue intersection is part of the Coralville arterial street system. Oakdale Boulevard is an east-west arterial street and 1st Avenue is a north-south arterial street linking Coralville with the City of North Liberty. Both streets serve as part of the principal roadway network for through traffic flow in Coralville, therefore major route Characteristic A is met.

To the north of the intersection, 1st Avenue turns into North Liberty Road which is a rural Johnson County corridor that provides access to the City of North Liberty, but it is not considered a rural highway, therefore Characteristic B is *not* met.

Both Oakdale Boulevard and 1st Avenue appear in the adopted MPOJC Long Range Transportation Plan as part of the official arterial street network, therefore Characteristic C is met.

As the Oakdale Boulevard / 1st Avenue intersection meets Criteria A and Characteristics A and C of Warrant 8, therefore **Warrant 8 is met.**

CAPACITY ANALYSIS – EXISTING CONDITIONS; TWO-WAY STOP-CONTROLLED INTERSECTION

Existing intersection capacity was analyzed using unsignalized intersection capacity analysis methods outlined in the latest edition of the Highway Capacity Manual (HCM) using Synchro 8.0 and SimTraffic software. After comparing the results to observations at the intersection, we determined that SimTraffic produced more reasonable results. As such, SimTraffic delay calculations are reported throughout this section.

By using HCM methods, control delay is calculated as seconds of delay per vehicle and a corresponding level of service (LOS) is also shown. Level of Service describes operating conditions based on a number of factors including speed and travel time, freedom to maneuver, traffic interruptions, and comfort & convenience. **Table 5** (Synchro Exhibit 17-2) exhibits the LOS with its control delay ranges at two-way stop-controlled intersections. A LOS A represents the best operating conditions (free-flow movement) and LOS F represents the worst conditions, i.e. extreme congestion and stop-and-go conditions.

Table 5: Level of Service Criteria for Two-Way Stop-Controlled Intersections

Level of Service	Average Control Delay (s/veh)
A	0 - 10
B	> 10 - 15
C	> 15 - 25
D	> 25 - 35
E	> 35 - 50
F	> 50

The morning (AM) and evening (PM) peak periods were analyzed for all approaches of the intersection. The intersection as a whole performs at a LOS C (15.5 seconds / vehicle or s/v) during the AM and LOS B (13.1 s/v) during the PM peak hour **(Table 6)**. Delays are greater during the AM peak hour as there is a greater concentration of vehicles at that time.

The northbound and southbound traffic operates at LOS A with negligible delay, whereas the east and west approaches experience moderate to significant delay. The eastbound through movement performs at a LOS E during the AM and PM peak hours with 46.1 s/v and 36.3 s/v respectively. Eastbound left turning traffic performs at a LOS C during both peak periods, with average delays near 17 s/v. The westbound through movement performs at a LOS B (15 s/v) during the AM and LOS D (26.8 s/v) during the PM. Westbound left turning traffic performs at LOS C during both peak hours with average delays of 17 – 20 s/v.

Table 6: Existing Delay and Level of Service

Existing Conditions: Two-Way Stop Control Summary Oakdale Boulevard & 1st Avenue, Coralville, IA				
Direction	Control Delay (s/veh)		LOS	
	AM	PM	AM	PM
Oakdale Boulevard				
Eastbound				
Through	46.1	36.3	E	E
Right	41.2	26.9	E	D
Left	17.9	16.9	C	C
Westbound				
Through	15.0	26.8	B	D
Right	6.1	14.8	A	B
Left	17.0	22.0	C	C
1st Avenue				
Northbound				
Through	1.8	4.5	A	A
Right	1.1	2.4	A	A
Left	5.7	5.5	A	A
Southbound				
Through	2.0	1.8	A	A
Right	1.4	0.9	A	A
Left	3.0	4.6	A	A
Total Intersection Delay/LOS	15.5	13.1	C	B

CAPACITY ANALYSIS – SIGNALIZED INTERSECTION

Delay and LOS are calculated using the same methodology as unsignalized intersections, but the delay parameters are a little longer. Longer delays are acceptable at signalized intersections because the driver has a longer delay expectancy than at unsignalized intersections. **Table 7** (Synchro Exhibit 16-2) exhibits the LOS with its control delay ranges at signalized intersections.

Table 7: Level of Service Criteria for Signalized Intersections

Level of Service	Average Control Delay (s/veh)
A	< 10
B	> 10 - 20
C	> 20 - 35
D	> 35 -55
E	> 55 - 80
F	> 80

Three scenarios were developed to evaluate signalization at the 1st / Oakdale intersection – permissive left-turn signaling, permissive / protected left-turn signaling, and protected-only left turn signaling. The morning (AM) and evening (PM) peak travel periods were analyzed for all

approaches of the intersection. As it is typical for arterial street intersections in the metro area have dedicated left-turn turn lanes, these scenarios were developed with the inclusion of 200' northbound and southbound left-turn lanes. Without the left-turn lanes, level of service for the northbound and southbound movements degrades significantly.

Scenario #1: Permissive Left-Turns
Signalizing with permissive left-turns on all approaches would provide an overall intersection LOS of B (10.4 s/v) during the AM peak hour and LOS B (11.1 s/v) during the PM peak **(Table 8)**. Permissive left-turn signaling would result in the least amount of overall delay under signalized conditions.

Scenario #2: Permissive / Protected Left-Turns
Adding a protected left-turn phase prior to a permissive left-turn phase would allow many left-turning vehicles protected passage across the intersection, while not adding undue delay **(Table 8)**. SIM traffic modeling indicates that protective / permissive left-turn signaling would result in a LOS B (12.4 s/v) during the AM and LOS B (13.2 s/v) during the PM peak hour.

Scenario #3: Protected Left-Turns
Signalizing and protecting all left-turning movements would result in a LOS B (17.0 s/v) during the AM peak hour and LOS B (18.4) during the PM peak hour **(Table 8)**. The northbound and southbound left turn movements would experience LOS C during both peak hours, with delays averaging between 22 and 28 s/v. As there is not a collision history that indicates that protective left-turns are necessary, this scenario is not recommended at this time.

Table 8: Proposed Signalized Conditions Delay and LOS

Proposed Signalized Conditions – 3 Scenarios Oakdale Boulevard & 1st Avenue, Coralville, IA with Northbound & Southbound Dedicated Left-Turn Lanes												
	Permissive Left Turns				Permissive & Protected				Protected Left Turns			
Direction	Delay (s/veh)		LOS		Delay (s/veh)		LOS		Delay (s/veh)		LOS	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Oakdale Blvd												
Eastbound												
Through	11.7	17.3	B	B	18.1	19.9	B	B	20.5	17.4	B	B
Right	7.1	8.5	A	A	11.0	9.7	B	A	14.3	8.5	B	A
Left	14.1	19.6	B	B	16.6	21.1	B	C	27.9	26.9	C	C
Westbound												
Through	7.1	14.4	A	B	10.6	19.7	B	B	14.7	18.7	B	B
Right	2.2	9.1	A	A	10.3	16.4	B	B	7.9	9.1	A	A
Left	14.1	25.6	B	C	11.0	19.9	B	B	23.7	22.0	C	C
1st Avenue												
Northbound												
Through	5.8	7.0	A	A	7.0	10.2	A	B	8.2	10.9	A	B
Right	2.7	4.1	A	A	3.5	6.0	A	A	3.7	7.5	A	A
Left	18.6	11.5	B	B	11.7	10.3	B	B	25.5	41.4	C	D
Southbound												
Through	11.2	7.1	B	A	12.4	11.4	B	B	16.9	10.8	B	B
Right	7.3	4.2	A	A	8.8	5.5	A	A	12.9	6.7	B	A
Left	10.9	10.9	B	B	9.8	10.2	A	B	23.9	21.6	C	C
Intersection	10.4	11.1	B	B	12.4	13.2	B	B	17.0	18.4	B	B

CAPACITY ANALYSIS – ROUNDABOUT

Delay and LOS are calculated using HCM methods outlined in the 2010 manual. **Table 9** (Synchro Exhibit 16-2) exhibits the LOS with its control delay ranges at signalized intersections.

Table 9: Level of Service Criteria for Roundabouts

Level of Service	Average Control Delay (s/veh)
A	0 - 10
B	> 10 - 15
C	> 15 - 25
D	> 25 - 35
E	> 35 - 50
F	> 50

The intersection was modeled both as a single-lane and two-lane roundabout with the inclusion of a northbound and a southbound left-turn lane. A single-lane roundabout did not provide a reasonable level of service at the intersection; therefore this analysis reflects a two-lane roundabout. The morning (AM) and evening (PM) peak periods were analyzed for all approaches of the intersection. During both peak periods, the intersection is expected to function very well at LOS A (6.4 s/v) during the AM and LOS A (4.7 s/v) during the PM **(Table 10)**.

Table 10: Proposed Roundabout Delay and LOS

Proposed Two-Lane Roundabout with NB/SB Left Turn Lanes Oakdale Boulevard & 1st Avenue, Coralville, IA				
Direction	Control Delay (s/veh)		LOS	
	AM	PM	AM	PM
Oakdale Boulevard				
Eastbound				
Through	7.2	7.4	A	A
Right	4.5	3.7	A	A
Left	5.2	3.2	A	A
Westbound				
Through	5.7	6.3	A	A
Right	4.3	3.2	A	A
Left	5.0	13.9	A	B
1st Avenue				
Northbound				
Through	5.0	6.7	A	A
Right	2.5	3.9	A	A
Left	4.1	5.7	A	A
Southbound				
Through	8.0	6.3	A	A
Right	6.5	3.1	A	A
Left	6.4	4.7	A	A
Total Intersection Delay/LOS	7.3	7.0	A	A

CAPACITY ANALYSIS – COMPARISON BETWEEN EXISTING CONDITIONS, SIGNALS WITH PROTECTED/PERMISSIVE LEFT TURNS, AND 2-LANE ROUNDABOUT

Table 11 compares the existing LOS and delay at the intersection with signalized conditions (protected/permissive left-turn signaling) and a two-lane roundabout. Northbound and southbound dedicated left-turn lanes were included in the analysis. Signalizing the intersection would improve delay significantly for the eastbound and westbound movements, and would increase overall level of service at the intersection from a LOS C (15.5 s/v) during the AM to LOS B (12.4 s/v), and level of service would remain virtually the same during the PM at LOS B (10.8). That said, the eastbound and westbound through and right-turning movements would benefit from a notable decrease in delay and improvement in LOS. A two-lane roundabout would provide the best level of service at the intersection. Overall delay would be cut in half with drivers experiencing LOS A (7.3 s/v) during the AM peak hour and LOS A (7.0 s/v) during the PM peak hour.

Table 11: Comparison of Existing Conditions to Alternatives

Comparison of Existing Conditions, Signalization, and a Two-Lane Roundabout Oakdale Boulevard & 1st Avenue, Coralville, IA												
	Existing				Signalized with Permissive & Protected Left-Turns (LT lanes all approaches)				Two-Lane Roundabout (LT lanes all approaches)			
Direction	Delay (s/veh)		LOS		Delay (s/veh)		LOS		Delay (s/veh)		LOS	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Oakdale Blvd												
Eastbound												
Through	46.1	36.3	E	E	18.1	19.1	B	B	7.2	7.4	A	A
Right	41.2	27.3	E	D	11.0	9.1	B	A	4.5	3.7	A	A
Left	17.9	13.1	C	B	16.6	16.9	B	B	5.2	3.2	A	A
Westbound												
Through	15.0	20.1	B	C	10.6	15.2	B	B	5.7	6.3	A	A
Right	6.1	16.7	A	C	10.3	6.9	B	A	4.3	3.2	A	A
Left	17.0	19.4	C	C	11.0	12.9	B	B	5.0	13.9	A	B
1st Avenue												
Northbound												
Through	1.8	4.3	A	A	7.0	7.7	A	A	5.0	6.7	A	A
Right	1.1	3.0	A	A	3.5	5.3	A	A	2.5	3.9	A	A
Left	5.7	4.8	A	A	11.7	9.4	B	A	4.1	5.7	A	A
Southbound												
Through	2.0	1.7	A	A	12.4	12.0	B	B	8.0	6.3	A	A
Right	1.4	0.8	A	A	8.8	6.9	A	A	6.5	3.1	A	A
Left	3.0	7.2	A	A	9.8	12.4	A	B	6.4	4.7	A	A
Intersection	15.5	11.0	C	B	12.4	10.8	B	B	7.3	7.0	A	A

ENVIRONMENTAL EFFECT – FUEL USAGE

Fuel Usage

Annual fuel usage for vehicles using the 1st Avenue / Oakdale Avenue intersection was estimated using SimTraffic 8.0 traffic modeling software for existing conditions, signalized (protected / permissive left turn signaling) conditions, and for a dual lane roundabout **(Table 12)**. SimTraffic develops fuel consumption estimates by considering vehicle volumes, vehicle types, delay, traffic speeds, queues, and average consumption rates.

It is estimated that over 63,300 gallons of fuel are used annually during the AM and PM peak hours today. If signalized, fuel consumption is expected to increase by 6% during the AM peak hours (+3,800 gallons) and increase by 29% (+18,400 gallons) during the PM peak hours. If a dual-lane roundabout was constructed, annual fuel consumption is expected to *decrease* by 6% (- 4000 gallons) during the AM peak hours and *decrease* by 12% (- 8500 gallons) during the PM peak hours.

Table 12: Annual Peak Hour Fuel Usage

Existing		Signals - Prot / Perm		Dual Lane Roundabout	
# Annual Gallons		# Annual Gallons		# Annual Gallons	
AM	PM	AM	PM	AM	PM
63,335	**63,335**	**67,191**	**81,747**	**59,310**	**60,298**
Diff. from today's fuel usage		+ 3,856	+ 18,412	- 4025	- 8507
% Change		+ 6%	+ 29%	- 6%	-12%

CONCLUSIONS

Based on analysis of the MUTCD traffic signal warrants; Warrant 1a, 2 and 8 are met at the intersection of Oakdale Boulevard / 1st Avenue, while Warrants 1b, 3, and 7 are *not* met **(Table 15)**, however the intersection was close to meeting the collision warrant (7) in 2013. With the existing two-way stop control, Oakdale Boulevard is currently functioning at a LOS C during the AM peak period; however the eastbound through movement performs poorly at a LOS E. The overall intersection is performing at LOS B during the PM peak period, while both the eastbound and westbound through movements performing at LOS D and E respectively.

Table 15: Summary of Examined Warrants

Warrant	Description	Warrant Met?
1a	Minimum Vehicular Volume	**Yes**
1b	Interruption of Continuous Traffic	No
2	Four Hour Vehicular Volumes	**Yes**
3	Peak Hour Volumes	No
4	Pedestrian Volume	n/a
5	School Crossing	n/a
6	Coordinated Signal System	n/a
7	Crash Experience	No
8	Roadway Network	**Yes**

Signalizing the intersection with protected / permissive left-turns would redistribute delay more equitably amongst all legs and would help reduce broadside collisions. Overall intersection delay would be improved by about 20% during the AM peak, increasing from LOS C to a B. Delay would remain nearly the same during the PM peak hour, at LOS B. The eastbound and westbound movements, which experience the greatest delays today at LOS D or LOS E, would improve (generally) to LOS B. As vehicles on 1st Avenue would no longer "run free", annual fuel usage by vehicles using the intersection is expected to increase by 6% in the AM and 29% during the PM peak periods. At $3.50 / gallon, this would translate into $14,000 in additional annual fuel costs during the AM peak periods and $65,300 in additional annual fuel costs during the PM peak periods.

As an alternative to signalization, the City could consider the installation of a two-lane roundabout with left-turn lanes upon entry. Collisions would be expected to decrease and reduce in severity due to low speed of vehicles travelling through the roundabout. Delay would be reduced by nearly 50% with level of service improving from LOS C during the AM or LOS B during the PM to a LOS A during both peak periods. The delay savings also translates into fuel savings and emissions reductions. Annual fuel usage during the AM peak period is expected to *decrease* by 6% during the AM peak periods and decrease by 12% during the PM peak periods. At $3.50 / gallon, this would translate into a $14,000 *reduction* in annual fuel costs during the AM peak periods (compared with existing conditions) and a $29,800 *reduction* of annual fuel costs during the PM peak periods.

Signalizing the intersection or constructing a two-lane roundabout would distribute delay more equitably amongst all legs of the intersection; however a roundabout would provide the best level of service, least amount of delay and unnecessary stopping, least fuel consumption/emissions, and would likely have fewer (and less severe) collisions.

We do not believe that the topography near the intersection, specifically the grade of the southbound approach, will bear a significant impact on intersection operations nor would it preclude either signals or roundabout from being installed/constructed. There is good visibility to the intersection in all directions which should provide enough reaction time for drivers. That

said, a roundabout may be better suited to handle the occasional vehicle that may be travelling too fast for conditions. If a driver cannot stop/yield in time when entering a roundabout, there is a chance they may strike another vehicle, but it would be at lower speeds. If there is a truck-mountable curb, they may be able to maneuver directly through the roundabout. As drivers *in* roundabouts tend to be more aware of other vehicles approaching the roundabout, they also have the potential to maneuver to avoid collisions; whereas drivers approaching signalized intersections often pay little attention to cross-traffic and tend to focus solely on the traffic signal. Mostly due to red-light running, signalization increases the potential for higher-speed broadside collisions when compared to a roundabout.

It is recommended that an engineering study be completed to determine if adequate land is available for the construction of a dual-lane roundabout with left-turn lanes upon entry. If it is determined that roundabout can be constructed, it is recommended that the City evaluate installing temporary traffic signals with northbound and southbound left-turn lanes as an interim measure rather than an all-way stop. Installing an all-way stop significantly increases delay and traffic back-ups on 1st Avenue (which currently runs free and carries the majority of traffic at the intersection) and causes the overall intersection performance to drop to a LOS E during the AM (currently LOS C) and LOS F (currently LOS B) during the PM. Temporarily signalizing the intersection with northbound and southbound left-turn lanes would result in a LOS B during both peak hours, with delay better distributed between 1st Avenue and Oakdale Boulevard.