

FINAL



**Date:** January 5<sup>th</sup>, 2015

**To:** Dean Wheatley, North Liberty City Planner

**From:** Darian Nagle-Gamm; Traffic Engineering Planner

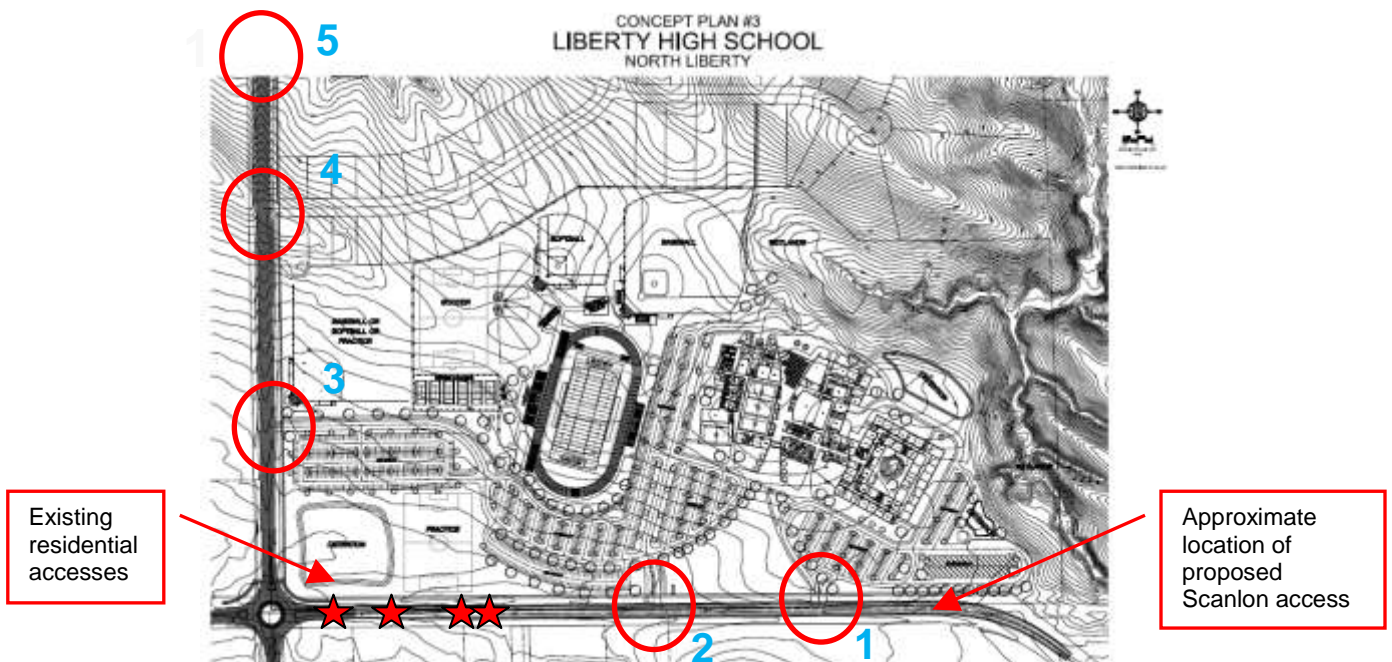
**Re:** Liberty High School Traffic Impact Analysis

Following is an analysis of what transportation improvements may be necessary as a result of a new high school being constructed in the northeast quadrant of the North Liberty Road / Dubuque Street NE intersection. A previous traffic impact study was completed in 2013 based upon an earlier concept of the high school site that is no longer applicable. This analysis was predicated upon the most recent concept for Liberty High School as reflected in **Figure 1**. This analysis covers potential turning lanes, pavement upgrades, signalization, and other traffic control measures that may be necessary. The MPOJC traffic forecast model and traffic generation estimates associated with the proposed school were utilized for this analysis.

### Access Points

Based on the most recent concept plan of Liberty High School, it is assumed that there will be a total of five new access points onto adjacent roadways. The concept includes two school access points on Dubuque Street NE - the staff / bus entrance (#1) and main entrance (#2) with one general purpose access point on North Liberty Road (#3). There are two planned residential access points (#4, #5) located north of the high school on North Liberty Road. Residential access point #5 is located just outside of the bounds of this map to the north of access point #4. Four existing residential driveways are located on Dubuque Street NE east of the North Liberty Road intersection (indicated with stars on the map below).

**Figure 1 – Proposed New Access Points**

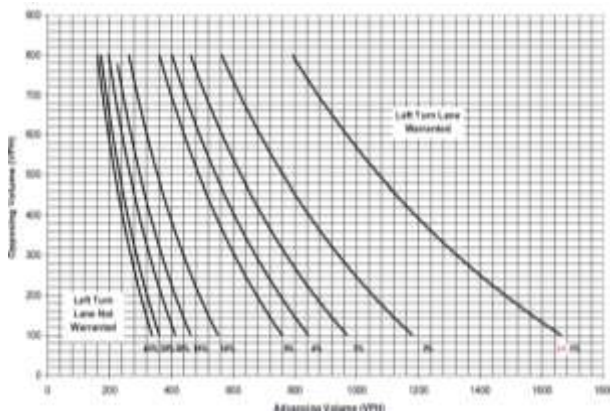


# Turn Lane Analyses

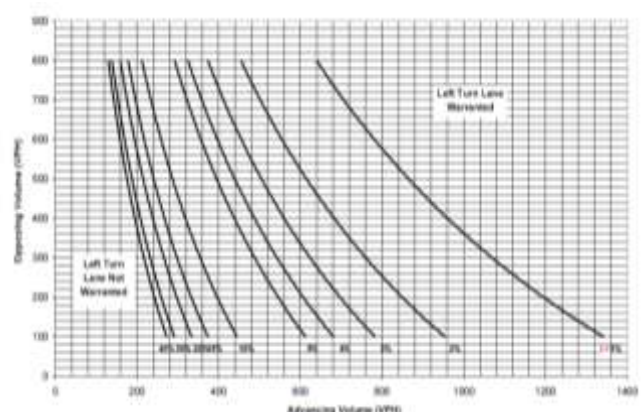
## Left-Turn Lanes

Based on the following left-turn lane warrants (Figures 2 & 3), estimates of school traffic generated by the new facility, residential traffic generated by the new subdivision, and estimates of opening day background traffic, the following analysis identifies where left-turn lanes will be warranted at the new access locations<sup>1</sup>. Left-turn lanes improve operations and safety at an intersection by removing left-turning motorists from through travel; thereby minimizing turn-related collisions and minimizing delay for through traffic.

**Figure 2:** Left Turn Lane Warrant – 35 mph  
North Liberty Road



**Figure 3:** Left Turn Lane Warrant – 50 mph  
Dubuque Street NE



**Table 1** provides an opening day left-turn lane warrant analysis for North Liberty Road and Dubuque Street NE at the proposed accesses to the school and at the proposed residential access points.

**Table 1:** Opening Day Left Turn Lane Warrant Analysis

| Access Point                  | Advancing Peak Volume |      | Opposing Peak Volume |     | Estimate of Left Turns |    | Warranted |     |
|-------------------------------|-----------------------|------|----------------------|-----|------------------------|----|-----------|-----|
|                               | AM                    | PM   | AM                   | PM  | AM                     | PM | AM        | PM  |
| Liberty High School Entrances |                       |      |                      |     |                        |    |           |     |
| #1 Dubuque St NE - East       | 235                   | 131  | 134                  | 277 | 75                     | 32 | Close     | No  |
| #2 Dubuque St NE - West       | 449                   | 226  | 108                  | 275 | 215                    | 95 | Yes       | Yes |
| #3 North Liberty Road         | 87                    | 108  | 146                  | 102 | 32                     | 18 | No        | No  |
| Residential Development       |                       |      |                      |     |                        |    |           |     |
| #4 South Access               | 195                   | 128* | 18                   | 50* | 2                      | 6* | No        | No  |
| #5 North Access               | 105                   | 125* | 17                   | 50* | 1                      | 3* | No        | No  |

- Based on AM peak hour and the school PM peak hour (3:00 - 4:00 PM)
- Assumes 4.5% daily volume for AM peak; 6.5% for PM School Peak (3:00 - 4:00 PM) except where noted
- Assumes 20% of school traffic will use Dubuque Street E entrance; 48% to use Dubuque Street W entrance; 32% to use North Liberty Road Entrance
- Assumes 700 - AM school trips; 500 inbound - 200 outbound. 50% from/to west, 30% from/to south, 10% from north and 10% from east
- Assumes 575 - PM school trips; 225 inbound - 350 outbound. 50% from/to west, 30% from/to south, 10% from north and 10% from east
- Assumes 500 ADT on North Liberty Road - 80% southbound / 20% northbound during AM; 70% southbound / 30% northbound during school PM peak
- Assumes .5% annual inflation for background traffic to anticipated build year
- Assumes 54 AM peak hour trips and 71 PM peak hour trips generated by 70 residential development households
- Assumes 30% of residential development traffic will use the north access and 70% will use the south access
- \* Evening PM peak hour estimates utilized for residential accesses

<sup>1</sup> Charts adapted from the following references: 1. Aspects of Traffic Control Devices, Volume Warrants for Left-Turn Storage Lanes at Unsignalized Grade Intersections, M.D. Harmelink, Highway Research Record Number 211, Highway Research Board, National Research Council, National Academy of Sciences, Publication 1554, 1967.

2. Guidelines for Left-Turn Lanes, J.C. Oppenlander and J.C. Bianchi, 1990 ITE Compendium of Technical Papers, Pages 191 through 196.  
 3. Left-Turn Treatments at Intersections, NCHRP Synthesis 225, Transportation Research Board, National Research Council, 1996.  
 4. Engineering Study Guide for Evaluating Intersection Improvements, NCHRP Report No. 457, Transportation Research Board, 2001.

**Access #1** is the proposed staff / bus access on Dubuque Street NE. Table 1 shows that Liberty High School opening day traffic levels at access #1 are close to warranting a dedicated eastbound left-turn lane during the AM, but a left-turn lane is not warranted in the PM. Using the MPOJC traffic model estimates for year 2040 (including Liberty High School traffic and general growth in the area), a left-turn lane is warranted during both the AM and the PM peak hours.

**Access #2** is the proposed main entrance on Dubuque Street NE. With the assumptions used, a dedicated eastbound left-turn lane is warranted on opening day during both the the AM and PM peak hours.

**Access #3** on North Liberty Road will be used as a general purpose or athletic facility access. A left-turn lane is not warranted on opening day or in the year 2040.

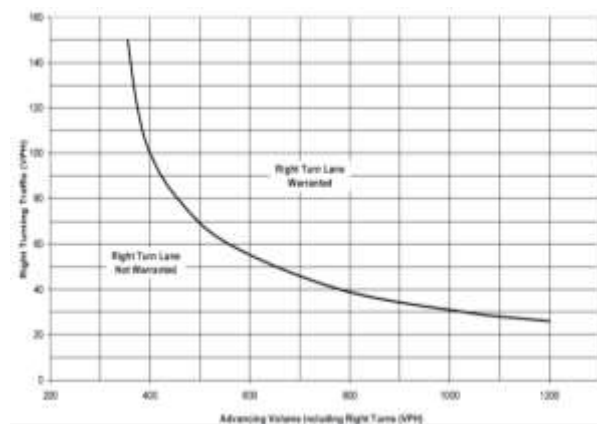
**Access #4** is the south proposed residential access. A dedicated left-turn lane for southbound North Liberty Road motorists at access #4 is not warranted on opening day or in the year 2040.

**Access #5** is the north proposed residential access. A dedicated left-turn lane for southbound North Liberty Road traffic at access #5 is not warranted on opening day or in the year 2040.

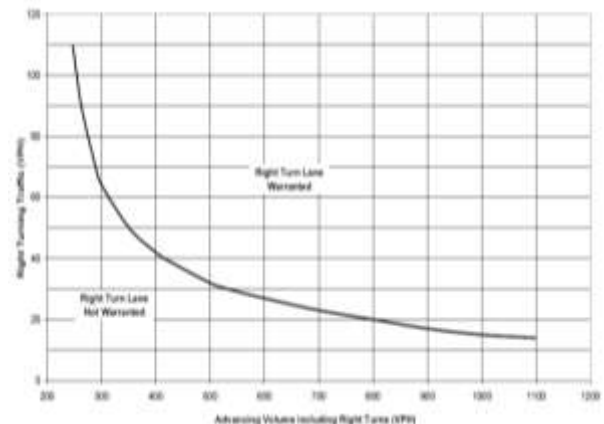
### Right-Turn Lanes

In addition to performing left-turn analyses for the proposed accesses, staff also considered the need for dedicated right-turn lanes for each of the 5 new access points. The analysis is based on estimates of school traffic generated by the new facility, residential traffic generated by the new subdivision, estimates of opening day background traffic, and the right-turn lane warrants reflected in **Figures 4 & 5**<sup>2</sup>. Right-turn lanes improve operations and safety at an intersection by removing right-turning motorists from through travel; thereby minimizing turn-related collisions and minimizing delay for through traffic.

**Figure 4:** Right Turn Lane Warrant – 35 mph  
North Liberty Road



**Figure 5:** Right Turn Lane Warrant – 50 mph  
Dubuque Street NE



As shown in Table 2, no right-turn lane would be warranted from a capacity standpoint on opening day. An analysis was also performed for the year 2040 and it was determined that right-turn lanes do not become warranted.

<sup>2</sup> Graphs adapted from Location and Design Manual, Volume 1, Section 400, Intersection Design, Ohio Department of Transportation, October 2004.

**Table 2 – Opening Day Right-Turn Lane Analysis**

| Access Point                  | Advancing Peak Volume |     | Estimate of Right Turns |     | Warranted |    |
|-------------------------------|-----------------------|-----|-------------------------|-----|-----------|----|
|                               | AM                    | PM  | AM                      | PM  | AM        | PM |
| Liberty High School Entrances |                       |     |                         |     |           |    |
| #1 Dubuque St NE - East       | 134                   | 277 | 25                      | 13  | No        | No |
| #2 Dubuque St NE - West       | 108                   | 275 | 25                      | 13  | No        | No |
| #3 North Liberty Road         | 146                   | 102 | 128                     | 38  | No        | No |
| Residential Development       |                       |     |                         |     |           |    |
| #4 South Access               | 18                    | 50* | 8                       | 25* | No        | No |
| #5 North Access               | 20                    | 50* | 3                       | 11* | No        | No |

- Based on AM peak hour and the school PM peak hour (3:00 - 4:00 PM)

- Assumes 4.5% daily volume for AM peak; 6.5% for PM School Peak (3:00 - 4:00 PM) except where noted

- Assumes 20% of school traffic will use Dubuque Street E entrance; 48% to use Dubuque Street W entrance; 32% to use North Liberty Road Entrance

- Assumes 700 - AM school trips; 500 inbound - 200 outbound. 50% from/to west, 30% from/to south, 10% from north and 10% from east

- Assumes 575 - PM school trips; 225 inbound - 350 outbound. 50% from/to west, 30% from/to south, 10% from north and 10% from east

- Assumes 1500 ADT on North Liberty Road - 80% southbound / 20% northbound during AM; 70% southbound / 30% northbound during school PM

- Assumes .5% annual inflation for background traffic to anticipated build year

- Assumes 54 AM peak hour trips and 71 PM peak hour trips generated by 70 residential development households

- Assumes 30% of residential development traffic will use the north access and 70% will use the south access

\* Evening PM peak hour estimates utilized for residential accesses

## North Liberty Road / Dubuque Street Intersection Analysis

The following analysis documents the findings of an all-way stop and traffic signal evaluation at the North Liberty Road and Dubuque Street NE intersection in unincorporated Johnson County. This study was initiated in response to the proposal to build Liberty High School in the northeast quadrant of the intersection. This analysis will identify if an all-way stop and/or traffic signal is currently warranted at the subject intersection or (if not currently warranted) if additional traffic volumes associated with the new high school and new residential development would satisfy the necessary thresholds.

There are specific traffic conditions that should exist for an all-way stop and/or traffic signal to be justified. The criteria (warrants) are based on traffic volumes, collision history, pedestrian volumes, and traffic speeds. Installing stop signs or traffic signals in locations where they are not warranted results in a greater chance of rear-end collisions, noncompliance by motorists, higher traffic speeds downstream of the intersection, and may degrade the overall level-of-service at the intersection. For these reasons, it is important for all-way stop and traffic signal requests to be carefully considered.

### Intersection Configuration

**Figure 6** shows an aerial view of the intersection of North Liberty Road (north-south) and Dubuque Street NE (east-west). The intersection is currently stop controlled on the north-south legs. There are no curb cuts or sidewalks at the intersection as it currently exists as a rural cross section. However, there is a trail crossing located on the north side of the intersection for east-west pedestrian/bicycle traffic. Sight distance and visibility at the intersection is reasonably good with little obstruction.

The immediate surrounding land-uses adjacent to the subject intersection are noted in **Figure 6**. The northeast quadrant is currently used for agriculture and is the future location of a high school.

**Figure 6** - Dubuque Street NE / North Liberty Road intersection

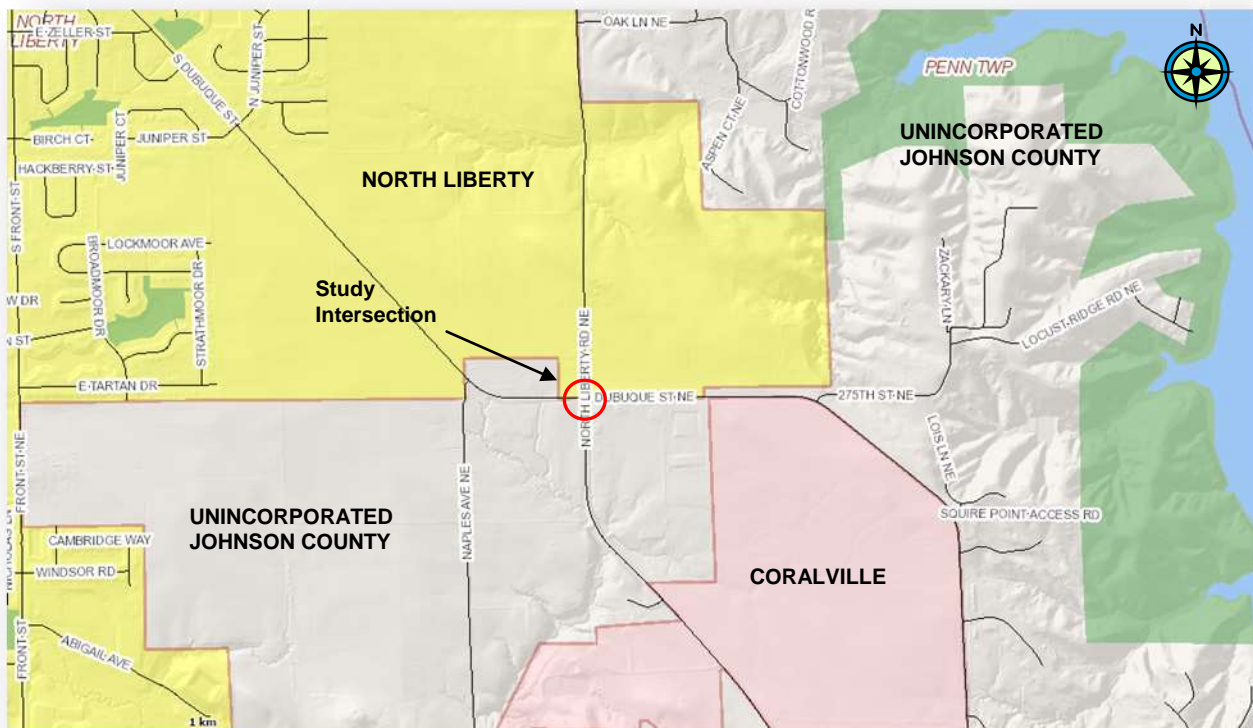


## Surrounding Area

The north half of the intersection is in the North Liberty city limits and the south half of the intersection is in unincorporated Johnson County. Both North Liberty Road (south of the intersection) and Dubuque Street NE are relatively high volume arterial corridors that connect North Liberty with Coralville and Iowa City. The corridors also connect a large number of residences located in the County with adjacent communities.

The east, west, and south legs of the intersection are currently paved as a rural cross section with open ditches, and the north leg of the intersection is a low-volume gravel road leading to rural subdivision and ultimately connecting with the North Liberty at the Front Street / Penn Street intersection.

**Figure 7 - Surrounding Area**

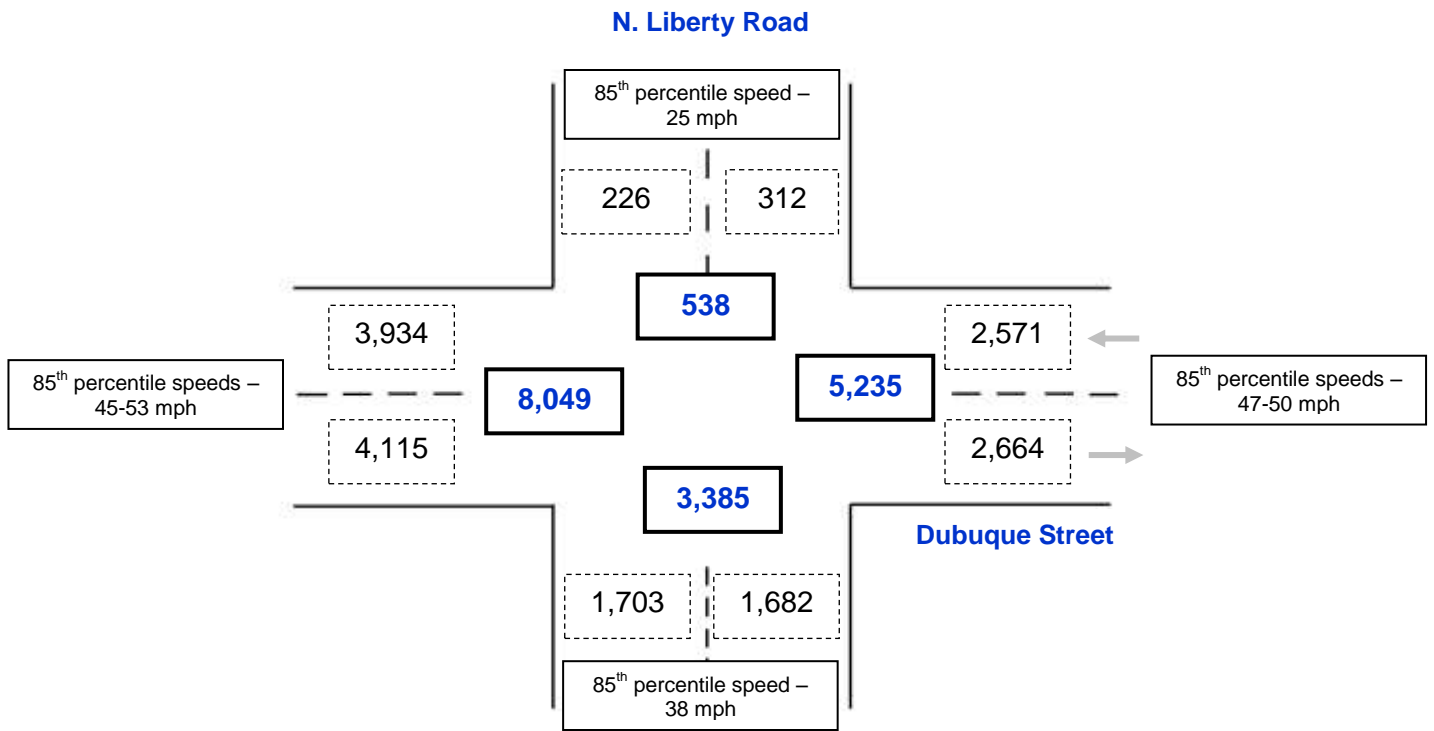


## Traffic Counts / Speeds

The average daily traffic counts and 85<sup>th</sup> percentile speeds were collected at the intersection October 8-11, 2013 (**Figure 8**). Traffic volumes just north of the intersection on North Liberty Road average 538 vehicles per day (vpd), while volumes just south of the intersection average 3,385 vpd. Dubuque Street NE traffic just east of the intersection averages 5,235 vpd and volumes west of the intersection average 8,049 vpd.

The 85<sup>th</sup> percentile speeds, on North Liberty Road were recorded at approximately 25 mph to the north of the intersection and approximately 38 mph to the south. The posted speed limit to the south of the intersection is 45 mph (the speed limit north of the intersection is not posted and is therefore 55 mph per County policy). The 85<sup>th</sup> percentile speeds on Dubuque Street NE were recorded between 47-50 mph to the east of the intersection and 45-53 mph to the west of the intersection. The posted speed limit on Dubuque Street NE is 50 mph.

**Figure 8: Average Daily Traffic Counts & 85<sup>th</sup> Percentile Speeds**  
 (Counts taken October 8-11, 2013)



## All-Way Stop Warrant Analysis – North Liberty Road / Dubuque Street Intersection

In order to warrant an all-way stop controlled intersection certain criteria must be met to facilitate efficient traffic flow. In analyzing the intersection, 1 of 4 of the following criteria from the Manual on Uniform Traffic Control Devices (MUTCD) must be satisfied in order to warrant an all-way stop controlled intersection.

A. Where traffic control signals are justified, the multi-way 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.

- A traffic signal is warranted at this location; therefore **Warrant A is met**.

B. A crash problem, as indicated by 5 or more reported crashes in a 12-month period that are susceptible to correction by a multi-way stop installation. Such crashes include right and left-turn collisions as well as right-angle collisions.

- Only two collisions occurred at the intersection between 2009-2012; neither would be correctable by adding stop signs on Dubuque Street (Table 3). **Warrant B is not met**.

Table 3 – Collision Analysis

| N. Liberty Road & Dubuque Street Collision History: 2009-2012 |                      |                           |
|---|----------------------|---------------------------|
| Type of Crash   | Number of Collisions | Warranted? (> 5 per year) |
| Rear-End  | 0                    | No                        |
| Broadside *   | 0                    | No                        |
| Non-Collision   | 1                    | No                        |
| Angle, oncoming left turn *                                   | 0                    | No                        |
| Sideswipe, same direction                                     | 1                    | No                        |
| <b>Total Collisions</b>                                       | <b>2</b>             | <b>No</b>                 |

\* Collisions types considered correctable using multi-way stop control

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

- Traffic entering the intersection on Dubuque Street, the major street, averages at least 300 vehicles per day for 12 hours per day, **therefore Warrant C1 is met** (Table 4).

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



- *Traffic entering from the minor street (N. Liberty Road) only meets the 200 vehicle per hour volume requirement for 1 hour of the day; therefore **Warrant C2 is not met.***
3. **If the 85<sup>th</sup>-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 in Items 1 and 2.**
- *Dubuque Street has 85<sup>th</sup> percentile speeds that exceed 40 mph. However, minimum vehicle volume warrants do not meet the 70% threshold of required values; therefore **Warrant C3 is not met.***
- D. **Where no single criterion is satisfied, but where Criteria B, C1, and C2 are all satisfied to 80 percent of the minimum values. Criterion C3 is excluded from this condition.**
- *Criteria C1 is met, but none of the other criteria are satisfied to 80 percent of the minimum values; therefore **Warrant D is not met.***

**Four additional optional criteria are available to use based on engineering judgment.**

- I. **The need to control left-turn conflicts**
- *There is a lack of left-turn collisions (zero between 2009 and 2012) at the intersection, therefore **optional Warrant I is not met.***
- II. **The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes;**
- *There are not high pedestrian volumes at this intersection; therefore **optional Warrant II is not met.***
- III. **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**
- *Sight distance is reasonably good at the intersection, a driver, after coming to a complete stop, is able to see conflicting traffic and safely negotiate the intersection, therefore **optional Warrant III is not met.***
- IV. **An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multi-way stop control would improve traffic operational characteristics of the intersection.**
- *This is an intersection of two arterial streets; therefore **optional Warrant IV is not met.***

**Table 4 - Warrant C – Minimum Traffic Volumes**

| N. Liberty Road & Dubuque Street Intersection |                       |                                   |                |           |                        |                    |                               |
|---|-----------------------|-----------------------------------|----------------|-----------|------------------------|--------------------|-------------------------------|
| Johnson Co., IA                               |                       | Data Gathered: October 8-11, 2013 |                |           |                        |                    |                               |
| Time  | Entering Traffic Only |                                   |                |           | Total Entering Traffic | Major Street Total | Highest Volume Minor Approach |
|   | N. Liberty Road       |                                   | Dubuque Street |           |                        |                    |                               |
|   | Southbound            | Northbound                        | Westbound      | Eastbound |                        |                    |                               |
| 0100  | 0                     | 5                                 | 8              | 7         | 20                     | 15                 | 5                             |
| 0200  | 0                     | 4                                 | 11             | 6         | 21                     | 17                 | 4                             |
| 0300  | 0                     | 2                                 | 6              | 2         | 10                     | 8                  | 2                             |
| 0400  | 0                     | 2                                 | 5              | 6         | 13                     | 11                 | 2                             |
| 0500  | 1                     | 4                                 | 4              | 12        | 21                     | 16                 | 4                             |
| 0600  | 1                     | 12                                | 15             | 74        | 101                    | 89                 | 12                            |
| 0700  | 5                     | 31                                | 68             | 295       | 398                    | 363                | 31                            |
| 0800  | 24                    | 73                                | 143            | 674       | 912                    | 816                | 73                            |
| 0900  | 9                     | 92                                | 150            | 467       | 717                    | 617                | 92                            |
| 1000  | 9                     | 59                                | 97             | 209       | 373                    | 306                | 59                            |
| 1100  | 12                    | 61                                | 104            | 165       | 342                    | 269                | 61                            |
| 1200  | 7                     | 60                                | 112            | 189       | 367                    | 301                | 60                            |
| 1300  | 6                     | 78                                | 131            | 177       | 391                    | 307                | 78                            |
| 1400  | 7                     | 82                                | 121            | 192       | 402                    | 313                | 82                            |
| 1500  | 8                     | 103                               | 161            | 189       | 461                    | 350                | 103                           |
| 1600  | 11                    | 161                               | 219            | 243       | 633                    | 461                | 161                           |
| 1700  | 10                    | 193                               | 296            | 280       | 779                    | 576                | 193                           |
| 1800  | 11                    | 206                               | 388            | 320       | 924                    | 708                | 206                           |
| 1900  | 12                    | 119                               | 196            | 246       | 572                    | 442                | 119                           |
| 2000  | 4                     | 93                                | 111            | 133       | 341                    | 244                | 93                            |
| 2100  | 2                     | 82                                | 97             | 86        | 267                    | 183                | 82                            |
| 2200  | 1                     | 50                                | 63             | 64        | 178                    | 127                | 50                            |
| 2300  | 2                     | 25                                | 42             | 37        | 105                    | 79                 | 25                            |
| 2400  | 0                     | 15                                | 21             | 26        | 62                     | 47                 | 15                            |

**All-Way Stop Control Warrant Summary**

Warrant A (using an all-way stop as a temporary measure) is satisfied since a traffic signal is currently warranted at the intersection. Warrant B is not met as there is not collision history that indicates there is a safety issue. Traffic volumes on Dubuque Street are high enough that Warrant C1 is met; however traffic volumes on N. Liberty Road do not currently meet the thresholds to satisfy Warrant C2. Traffic speeds satisfy the warrant for Warrant C3, but current traffic volumes do not. To meet Warrant C, all three criteria must be met; therefore Warrant C is also not met. Collisions on either street and traffic volumes on N. Liberty road do not approach 80% of the required criteria for B or C2, therefore Warrant D is not met. Optional warrants #1 through #4 are also not met.

**Table 5 – All-Way Stop Control Warrant Summary**

| Warrant     | Description                                 | Warrant Met? |
|-------------|---|--------------|
| <b>A</b>    | <b>Interim Measure for Traffic Signal</b>   | <b>Yes</b>   |
| B           | Collision History                           | No           |
| <b>C1</b>   | <b>Major Street Vehicle Volume</b>          | <b>Yes</b>   |
| C2          | Minor Street Ped, Bike, and Vehicle Volume  | No           |
| C3          | 85 <sup>th</sup> Percentile Speeds          | No           |
| D           | 80% of Criterion B, C1, and C2              | No           |
| Optional #1 | Control Left Turn Conflicts                 | No           |
| Optional #2 | Control Vehicle/Pedestrian Conflicts        | No           |
| Optional #3 | Sight Distance & Visibility                 | No           |
| Optional #4 | Improve Residential Area Op Characteristics | No           |

Upon completion of the new high school, it is possible that the volumes on North Liberty Road would increase to a level where Warrant C3 (minor street approach traffic) may be satisfied – which would result in an all-way stop becoming fully warranted (not just as a temporary measure). A traffic signal is also *currently* warranted under existing conditions; therefore an all-way stop can be used as a temporary measure to control traffic.

**Capacity Analysis – Existing Conditions and Stop Control Scenarios**

Synchro 9.0 and SimTraffic 9.0 traffic modeling software were used to represent how changes in stop control at the intersection of Dubuque Street NE / North Liberty Road would affect the flow of vehicular traffic during the AM and PM peak hours on opening day of Liberty High School and in the year 2040.

**Table 6 - Level of Service Criteria for 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                          |

*\*Existing intersection capacity was analyzed using unsignalized intersection capacity analysis methods outlined in the latest edition of the Highway Capacity Manual (HCM) and using Synchro/SimTraffic software. 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 6 (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 7** (below) shows the effect that an all-way stop would have on the capacity and delay at the intersection of North Liberty Road / Dubuque Street NE. As shown, on opening day an all-way stop would reduce delay for northbound and southbound AM motorists from a Level-of-Service (LOS) F to a LOS A. However, the eastbound AM movement is reduced from an LOS A to an F as a result of implementing all-way stop control.

Since the eastbound movement has average daily traffic volumes that are more than twice the northbound volumes, overall intersection delay on opening day would increase from 27.7 seconds/vehicle to 46.2 seconds/vehicle as a result of implementing an all-way stop at the intersection. However, since the AM peak period of school traffic would likely last less than 30 minutes and adding stop control could provide a safer, more predictable, environment at the intersection, it may be beneficial to implement all-way stop control at the intersection as a *temporary* measure. **Table 8**, which reflects year 2040 peak hour traffic volumes (estimated with the MPOJC travel demand model adopted in 2014) with two-way or all-way stop control, indicates that stop control is not sustainable in the long term at the intersection. By the year 2040, the overall intersection operations are expected to decline to LOS F with two-way stop control or all-way stop control.

**Table 7** - Existing conditions/control, opening day two-way stop control, and opening day all-way stop control

| Dubuque Street / North Liberty Road |                                |     |         |     |                                   |     |         |     |                                   |     |         |     |
|-------------------------------------|--------------------------------|-----|---------|-----|-----------------------------------|-----|---------|-----|-----------------------------------|-----|---------|-----|
| Movement                            | Existing: Two-Way Stop Control |     |         |     | Opening Day: Two-Way Stop Control |     |         |     | Opening Day: All-Way Stop Control |     |         |     |
|                                     | AM Peak                        |     | PM Peak |     | AM Peak                           |     | PM Peak |     | AM Peak                           |     | PM Peak |     |
|                                     | Delay                          | LOS | Delay   | LOS | Delay                             | LOS | Delay   | LOS | Delay                             | LOS | Delay   | LOS |
| <b>Dubuque Street NE</b>            |                                |     |         |     |                                   |     |         |     |                                   |     |         |     |
| Eastbound                           | 3.8                            | A   | 1.7     | A   | 7.3                               | A   | 1.8     | A   | 70.2                              | F   | 9.3     | A   |
| Westbound                           | 1.6                            | A   | 2.2     | A   | 4.5                               | A   | 2.6     | A   | 11.3                              | B   | 13.5    | B   |
| <b>North Liberty Road</b>           |                                |     |         |     |                                   |     |         |     |                                   |     |         |     |
| Northbound                          | 14.9                           | B   | 12.3    | B   | 103.2                             | F   | 12.8    | B   | 8.5                               | A   | 5.8     | A   |
| Southbound                          | 11.6                           | B   | 13.8    | B   | 62.7                              | F   | 7.8     | A   | 7.3                               | A   | 4.9     | A   |
| <b>Intersection</b>                 | 4.8                            | A   | 4.1     | A   | 27.7                              | D   | 4.4     | A   | 46.2                              | D   | 10.6    | B   |

- Peak hour counts taken in 2008, .5% annual growth factor applied
- AM figures include school traffic estimates
- PM figures *do not* include school traffic estimates as the peak school hour and peak hour do not coincide
- AM & PM figures include anticipated residential growth from new 70 unit subdivision north of the school
- Assumes .85 PHF and 2% trucks for all movements in the proposed scenarios

**Table 8** – Year 2040 Two-way stop control and All-way stop control

| Year 2040: Dubuque Street / North Liberty Road |                            |     |         |     |                            |     |         |     |  |  |
|--|----------------------------|-----|---------|-----|----------------------------|-----|---------|-----|--|--|
| Movement                                       | 2040: Two-Way Stop Control |     |         |     | 2040: All-Way Stop Control |     |         |     |  |  |
|  | AM Peak                    |     | PM Peak |     | AM Peak                    |     | PM Peak |     |  |  |
|  | Delay                      | LOS | Delay   | LOS | Delay                      | LOS | Delay   | LOS |  |  |
| <b>Dubuque Street NE</b>                       |                            |     |         |     |                            |     |         |     |  |  |
| Eastbound                                      | 27.8                       | C   | 2.8     | A   | 164.5                      | F   | 26.9    | C   |  |  |
| Westbound                                      | 89.5                       | F   | 4.2     | A   | 21.8                       | C   | 102.9   | F   |  |  |
| <b>North Liberty Road</b>                      |                            |     |         |     |                            |     |         |     |  |  |
| Northbound                                     | >300                       | F   | 221.2   | F   | 63.1                       | F   | 46.0    | D   |  |  |
| Southbound                                     | >300                       | F   | 49.4    | E   | 21.2                       | C   | 11.4    | B   |  |  |
| <b>Intersection</b>                            | 107.6                      | F   | 51.5    | F   | 75.6                       | F   | 60.8    | F   |  |  |

- AM figures include school traffic estimates
- PM figures *do not* include school traffic estimates as the peak school hour and peak hour do not coincide
- Assumes .85 PHF and 2% trucks for all movements in the proposed scenarios
- Percentage growth calculated from opening day estimated AADT and 2040 travel demand model adjusted daily traffic estimates; applied growth factor to opening day peak hour counts to develop 2040 peak hour counts

## Traffic Signal Warrant Analysis – North Liberty Road & Dubuque Street NE Intersection

A traffic signal warrant analysis is performed to determine the need for a traffic signal. At a minimum, at least 1 of the 9 warrants must be met, but the satisfaction of a warrant does not in itself require the installation of a traffic signal.

The 9 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
- 9) Intersection Near a Grade Crossing (*not evaluated*)

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 8-11, 2013.

Warrants 4, 5, 6, and 9 are not applicable to this intersection due to the following:

- Warrant 4 was not evaluated due to the low presence of pedestrians.
- Warrant 5 was not evaluated due to lack of a school in the area.
- Warrant 6 was not evaluated because current traffic control functions independent of other signalized intersections.
- Warrant 9 was not evaluated due to the lack of intersection adjacency to a grade crossing.

### Warrant 1 Analysis – Eight-Hour Vehicular Volume

#### ***Warrant 1a – Minimum Vehicular Volume***

Warrant 1a 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 85<sup>th</sup> percentile speed of over 40 mph, during each hour the major street (Dubuque Street) must have a total of 350 vehicles entering the intersection and the higher volume minor leg (N. Liberty Road) must have 105 vehicles entering the intersection to meet Warrant 1a. Data collected shows that only *five* 1-hour periods met the required volumes therefore ***Warrant 1a is not met*** under existing conditions (**Table 9**).

With estimates of additional school traffic as a result of the construction of the new high school, *six* 1-hour periods meet the required volumes using traffic estimates. Therefore Warrant 1a is close to meeting the minimum requirements and may be met after additional development occurs in the vicinity of the new school.

#### ***Warrant 1b – Interruption of Continuous Traffic***

Warrant 1b 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 85<sup>th</sup> percentile speed of over 40 mph, during each hour the major street (Dubuque Street) must have a total of 525 entering vehicles and the higher volume minor leg (N. Liberty Road) must have 53 vehicles entering the intersection to meet Warrant 1B. Data collected shows that only *four* 1-hour periods met the required volumes therefore **Warrant 1b is not met** (Table 9).

With estimates of additional school traffic as a result of the construction of the new high school, *six* 1-hour periods meet the required volumes using traffic estimates. Therefore Warrant 1b is close to meeting the minimum requirements and may be met after additional development occurs in the vicinity of the new school.

**Table 9 - Warrant 1 - Eight Hour Vehicular Volume**

| <b>Warrant 1 – Eight-Hour Vehicular Volume</b>   |                         |  |                       |              |                               |                           |                                      |                          |           |                                 |           |
|--|-------------------------|--|-----------------------|--------------|-------------------------------|---------------------------|--------------------------------------|--------------------------|-----------|---------------------------------|-----------|
| Condition A - Minimum Vehicular Volume           |                         |  |                       |              |                               |                           |                                      |                          |           |                                 |           |
| Condition B - Interruption of Continuous Traffic |                         |  |                       |              |                               |                           |                                      |                          |           |                                 |           |
| <b>Dubuque Street &amp; N. Liberty Road</b>      |                         |  |                       |              |                               |                           |                                      |                          |           |                                 |           |
| <b>Johnson Co., IA</b>                           |                         | <b>Data Gathered: October 8-11, 2013</b> |                       |              |                               |                           |                                      | <b>MPOJC</b>             |           |                                 |           |
| <b>Time</b>                                      | <b>Entering Traffic</b> |  |                       |              | <b>Total Entering Traffic</b> | <b>Major Street Total</b> | <b>Highest Volume Minor Approach</b> | <b>Warranted? (2013)</b> |           | <b>Warranted? (Opening Day)</b> |           |
|  | <b>N. Liberty Road</b>  |  | <b>Dubuque Street</b> |              |                               |                           |                                      | <b>1a</b>                | <b>1b</b> | <b>1a</b>                       | <b>1b</b> |
|  | <b>SB</b>               | <b>NB</b>                                | <b>WB</b>             | <b>EB</b>    |                               |                           |                                      |                          |           |                                 |           |
| 0100   | 0                       | 5  | 8                     | 7            | 20                            | 15                        | 5                                    |                          |           |                                 |           |
| 0200   | 0                       | 4  | 11                    | 6            | 21                            | 17                        | 4                                    |                          |           |                                 |           |
| 0300   | 0                       | 2  | 6                     | 2            | 10                            | 8                         | 2                                    |                          |           |                                 |           |
| 0400   | 0                       | 2  | 5                     | 6            | 13                            | 11                        | 2                                    |                          |           |                                 |           |
| 0500   | 1                       | 4  | 4                     | 12           | 21                            | 16                        | 4                                    |                          |           |                                 |           |
| 0600   | 1                       | 12                                       | 15                    | 74           | 101                           | 89                        | 12                                   |                          |           |                                 |           |
| 0700   | 5<br>(101)              | 31<br>(150)                              | 68<br>(117)           | 295<br>(250) | 398<br>(1,016)                | 363<br>(730)              | 31<br>(181)                          |                          |           | yes                             | yes       |
| 0800   | 24                      | 73                                       | 143                   | 674          | 912                           | 816                       | 73                                   |                          | yes       |                                 | yes       |
| 0900   | 9                       | 92                                       | 150                   | 467          | 717                           | 617                       | 92                                   |                          | yes       |                                 | yes       |
| 1000   | 9                       | 59                                       | 97                    | 209          | 373                           | 306                       | 59                                   |                          |           |                                 |           |
| 1100   | 12                      | 61                                       | 104                   | 165          | 342                           | 269                       | 61                                   |                          |           |                                 |           |
| 1200   | 7                       | 60                                       | 112                   | 189          | 367                           | 301                       | 60                                   |                          |           |                                 |           |
| 1300   | 6                       | 78                                       | 131                   | 177          | 391                           | 307                       | 78                                   |                          |           |                                 |           |
| 1400   | 7                       | 82                                       | 121                   | 192          | 402                           | 313                       | 82                                   |                          |           |                                 |           |
| 1500   | 8<br>(116)              | 103<br>(68)                              | 161<br>(205)          | 189<br>(112) | 461<br>(962)                  | 350<br>(667)              | 103*<br>(171)                        | yes                      |           | yes                             | yes       |
| 1600   | 11                      | 161                                      | 219                   | 243          | 633                           | 461                       | 161                                  | yes                      |           | yes                             |           |
| 1700   | 10                      | 193                                      | 296                   | 280          | 779                           | 576                       | 193                                  | yes                      | yes       | yes                             | yes       |
| 1800   | 11                      | 206                                      | 388                   | 320          | 924                           | 708                       | 206                                  | yes                      | yes       | yes                             | yes       |
| 1900   | 12                      | 119                                      | 196                   | 246          | 572                           | 442                       | 119                                  | yes                      |           | yes                             |           |
| 2000   | 4                       | 93                                       | 111                   | 133          | 341                           | 244                       | 93                                   |                          |           |                                 |           |
| 2100   | 2                       | 82                                       | 97                    | 86           | 267                           | 183                       | 82                                   |                          |           |                                 |           |
| 2200   | 1                       | 50                                       | 63                    | 64           | 178                           | 127                       | 50                                   |                          |           |                                 |           |
| 2300   | 2                       | 25                                       | 42                    | 37           | 105                           | 79                        | 25                                   |                          |           |                                 |           |
| 2400   | 0                       | 15                                       | 21                    | 26           | 62                            | 47                        | 15                                   |                          |           |                                 |           |

- Assumes 700 AM school trips, 500 inbound – 200 outbound. 50% from/to west, 30% from/to south & 10% from/to north and east  
 - Assumes 575 PM school trips, 225 inbound – 350 outbound. 50% from/to west, 30% from/to south & 10% from/to north and east  
 - Figures in **BLUE** represent estimates of additional traffic generated from the school \* Assumed to meet threshold, only 2 short

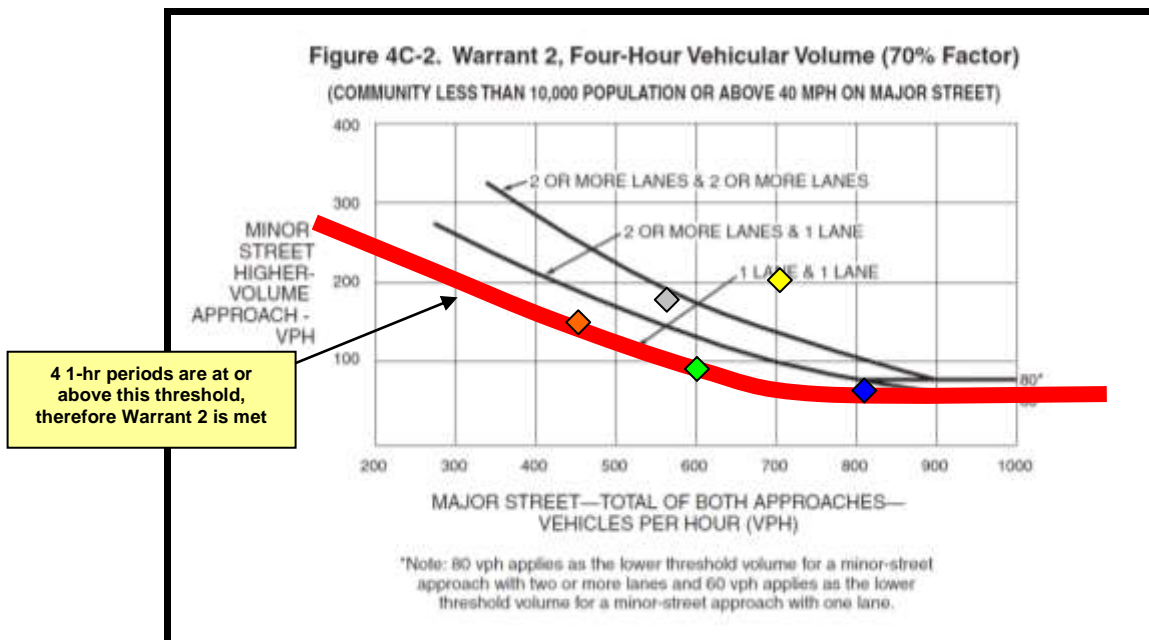
## Warrant 2 Analysis – Four-Hour Vehicular Volume

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 9** graphically depicts the required vehicular volume threshold for the major and minor streets (red line) in comparison to the observed volumes. *Five* 1-hour periods met the required volumes therefore **Warrant 2 is met** (Table 10). NOTE: The addition of estimated high school traffic would add an additional two hours where volumes for this warrant are met.

**Table 10:** Four-Hour Vehicular Volume

| Warrant 2, Four-Hour Vehicular Volume<br>Dubuque Street & N. Liberty Road |                   |                    |                               |        |
|---|-------------------|--------------------|-------------------------------|--------|
| Hour<br>threshold<br>met  | Entering Traffic  |                    | Meet's<br>volume<br>threshold | Legend |
|   | Dubuque<br>Street | N. Liberty<br>Road |                               |        |
|   | Major Street      | Minor Street       |                               |        |
| 0800  | 816               | 73                 | YES                           | ◆      |
| 0900  | 617               | 92                 | YES                           | ◆      |
| 1600  | 461               | 161                | YES                           | ◆      |
| 1700  | 576               | 193                | YES                           | ◆      |
| 1800  | 708               | 206                | YES                           | ◆      |

**Figure 9 -** Four-Hour Vehicular Volumes



## Warrant 3 Analysis - Peak Hour

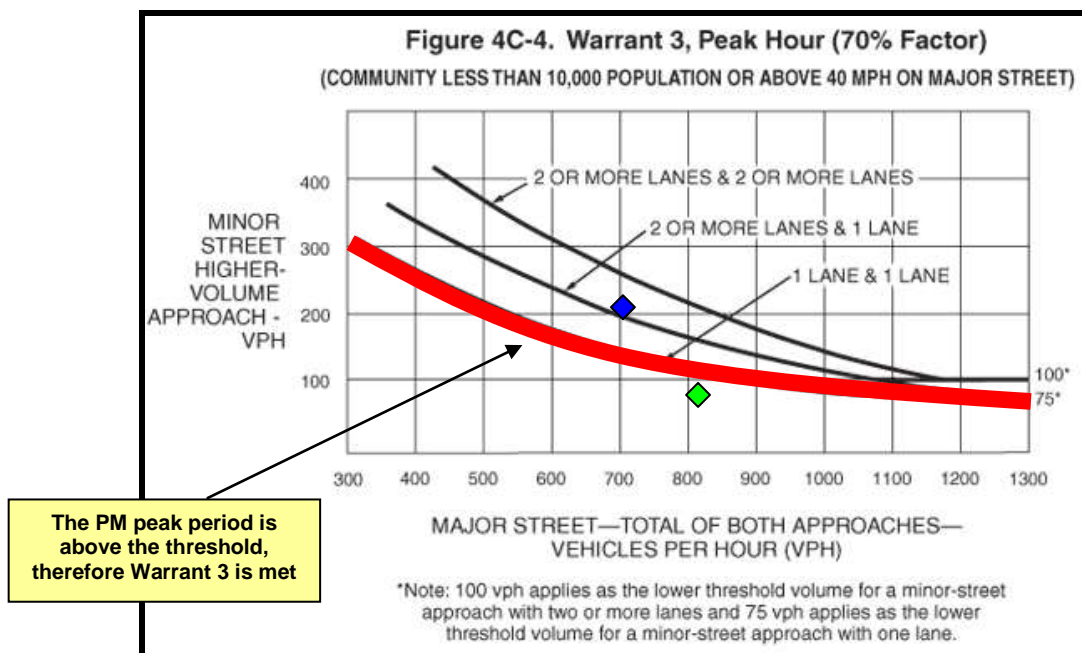
The peak hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of one hour on an average day, the minor street traffic suffers undue delay

when entering or crossing the major street. Peak hour traffic volumes on both streets must meet required thresholds under Warrant 3. **Figure 10** graphically depicts the required vehicular volume threshold for the major and minor streets (red line) in comparison to the observed volumes. As shown, the PM peak hour meets the required thresholds under existing conditions; therefore **Warrant 3 is met**.

**Table 11 - Peak Hour Warrant**

| Warrant 3, Peak Hour<br>Dubuque Street & N. Liberty Road |     |                                    |     |            |     |        |    |
|--|-----|------------------------------------|-----|------------|-----|--------|----|
| N. Liberty Road<br>Highest Vol. Approach                 |     | Dubuque Street<br>Entering Traffic |     | Warranted? |     | Legend |    |
| AM   | PM  | AM                                 | PM  | AM         | PM  | AM     | PM |
| 73   | 206 | 816                                | 708 | No         | Yes | ◆      | ◆  |

**Figure 10 - Peak Hour Warrant Threshold & Observed Volumes**



**Warrant 4 Analysis – Pedestrian Volume**

This warrant cannot be evaluated as there are no pedestrian crossings present on Dubuque Street NE.

**Warrant 5 Analysis – School Crossing**

This warrant cannot be evaluated due to the lack of school currently present adjacent to the intersection. However, upon completion of the proposed high school, it is likely that this warrant will be met due to the lack of adequate gaps in traffic for children to cross Dubuque Street during peak hours.

**Warrant 6 Analysis – Coordinated Signal System**

This warrant cannot be evaluated as there are no traffic signals present in the study area.



### 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 2009 – 2012 there were two total collisions and the minimum collision-per-year criteria was not met, therefore **Warrant 7 is not met.**

Table 12 - Collision Experience

| North Liberty Road & Dubuque Street NE Collision History: 2009-2012 |                      |                           |
|---|----------------------|---------------------------|
| Type of Crash   | Number of Collisions | Warranted? (> 5 per year) |
| Rear-End  | 0                    | No                        |
| Broadside   | 0                    | No                        |
| Non-Collision   | 1                    | No                        |
| Angle, oncoming left turn   | 0                    | No                        |
| Sideswipe, same direction   | 1                    | No                        |
| <b>Total Collisions</b>   | <b>2</b>             | <b>No</b>                 |

### 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 Dubuque Street / N. Liberty Road intersection has approximately 900+ entering vehicles per hour during both the AM and PM peak hours; therefore the intersection would easily exceed the 1,000 vehicle threshold upon completion of the school, 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 Dubuque Street / N. Liberty Road intersection is part of the County's primary street system and serves as part of the principal road network for through

traffic. Both Dubuque Street and N. Liberty Road are arterial streets that appear in major street planning documents; therefore major route **Characteristics A and C are met.**

As the intersection meets Criteria A and Characteristics A and C of Warrant 8, **Warrant 8 is met.**

**Warrant 9 Analysis – Intersection near a Grade Crossing**

This warrant cannot be evaluated as there is not a grade crossing present in the study area.

**Traffic Signal Warrant Summary**

Given that three of the five total warrants included in this analysis are warranted under existing conditions, **a traffic signal at the Dubuque Street NE / North Liberty Road is currently warranted (Table 13).** With the addition of traffic resulting from the proposed high school, thresholds for these warrants continue to be met both on opening day and in the year 2040.

Warrants 2, 3, and 8 are warranted while thresholds for Warrants 1a, 1b, and 7 were not met. Even though a traffic signal is warranted, installation of a traffic signal (alone) can degrade level-of-service for intersections as a whole. As such, the following capacity analysis was performed to determine the effects of intersection signalization and to determine what turn lane infrastructure would be necessary at the intersection to maintain acceptable overall level-of-service.

**Table 13 – Traffic Signal Warrant Summary**

| Warrant | Description                        | Warrant Met?        |
|---------|------------------------------------|---------------------|
| 1a      | Minimum Vehicular Volume           | No                  |
| 1b      | Interruption of Continuous Traffic | No                  |
| 2       | <b>Four Hour Vehicular Volumes</b> | <b>Yes (at 70%)</b> |
| 3       | <b>Peak Hour Volumes</b>           | <b>Yes (at 70%)</b> |
| 4       | Pedestrian Volume                  | N/A                 |
| 5       | School Crossing                    | N/A                 |
| 6       | Coordinated Signal System          | N/A                 |
| 7       | Crash Experience                   | No                  |
| 8       | <b>Roadway Network</b>             | <b>Yes</b>          |
| 9       | Intersection Near a Grade Crossing | N/A                 |

**Capacity Analysis – Signalized Conditions**

Intersection capacity under signalized conditions on opening day and in the year 2040 were analyzed using Synchro 9.0 and SimTraffic traffic modeling software. 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 14** (Synchro Exhibit 16-2) exhibits the LOS with its control delay ranges at signalized intersections.

**Table 14 - 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                          |

**Signalized Intersection with *Protected / Permitted* left-turns**

For this analysis it is assumed that each intersection approach has a 150 foot dedicated left-turn lane. On opening day under signalized conditions with *protected/permitted* left turns, the Dubuque Street NE / North Liberty Road intersection would operate efficiently in both the AM and PM peak periods, with an average per-vehicle delay of 17.3 and 9.1 seconds respectively. The greatest delay would be experienced by the northbound movement; however it would still operate well at a LOS C. All other movements would operate at a LOS B or better.

**Table 15** compares opening day delay and level of service under two-way stop control, all-way stop control, and signalized conditions with *protected/permitted* left-turns. If signalized, North Liberty Road traffic would experience a significant decrease in delay when compared to two-way stop control. Movements on Dubuque Street experience slight increases in delay under signalized conditions but maintain an LOS B or better. Signalizing the intersection would provide a significant improvement in delay during the AM peak when compared to all-way stop control. During the PM peak hour, the delay difference between an all-way stop and signals is negligible. *Staff also performed an analysis with 150' dedicated right-turn lanes for east and westbound traffic on Dubuque Street. The analysis showed little benefit to this arrangement and it was not further analyzed.*

**Table 16** compares year 2040 level of service and delay at the intersection with two-way stop control, all-way stop control, and signalization with *protected/permitted* left-turns. The assumptions used to generate the traffic estimates for the year 2040 are outlined in Appendix A. The intersection is expected to perform at LOS F by the year 2040 with any form of stop control. Under signalized conditions, the intersection is expected to perform at LOS E during the AM and LOS B during the PM.

**Table 15 – Opening day two-way stop control, all-way stop control, and traffic signals with protected / permissive left-turns**

| <b>Opening Day: Dubuque Street / North Liberty Road</b> |  |            |                |            |  |            |                |            |   |            |                |            |  |
|---|--|------------|----------------|------------|--|------------|----------------|------------|---|------------|----------------|------------|--|
| <b>Movement</b>   | <b>Opening Day: Two-Way Stop Control</b> |            |                |            | <b>Opening Day: All-Way Stop Control</b> |            |                |            | <b>Opening Day: Signals Protected/Permissive Left Turns</b> |            |                |            |  |
|   | <b>AM Peak</b>                           |            | <b>PM Peak</b> |            | <b>AM Peak</b>                           |            | <b>PM Peak</b> |            | <b>AM Peak</b>  |            | <b>PM Peak</b> |            |  |
|   | <b>Delay</b>                             | <b>LOS</b> | <b>Delay</b>   | <b>LOS</b> | <b>Delay</b>                             | <b>LOS</b> | <b>Delay</b>   | <b>LOS</b> | <b>Delay</b>  | <b>LOS</b> | <b>Delay</b>   | <b>LOS</b> |  |
| <b>Dubuque Street NE</b>                                |  |            |                |            |  |            |                |            |   |            |                |            |  |
| Eastbound   | 7.3                                      | A          | 1.8            | A          | 70.2                                     | F          | 9.3            | A          | 17.4  | B          | 7.0            | A          |  |
| Westbound   | 4.5                                      | A          | 2.6            | A          | 11.3                                     | B          | 13.5           | B          | 13.3  | B          | 10.6           | B          |  |
| <b>North Liberty Road</b>                               |  |            |                |            |  |            |                |            |   |            |                |            |  |
| Northbound  | 103.2                                    | F          | 12.8           | B          | 8.5                                      | A          | 5.8            | A          | 20.9  | C          | 8.6            | A          |  |
| Southbound  | 62.7                                     | F          | 7.8            | A          | 7.3                                      | A          | 4.9            | A          | 16.8  | B          | 4.8            | A          |  |
| <b>Intersection</b>                                     | <b>27.7</b>                              | <b>D</b>   | <b>4.4</b>     | <b>A</b>   | <b>46.2</b>                              | <b>D</b>   | <b>10.6</b>    | <b>B</b>   | <b>17.3</b>   | <b>B</b>   | <b>9.1</b>     | <b>A</b>   |  |

- Peak hour counts taken in 2008, .5% annual growth factor applied
- AM figures include school traffic estimates
- PM figures *do not* include school traffic estimates as the peak school hour and peak hour do not coincide
- AM & PM figures include anticipated residential growth from new 70 unit subdivision north of the school
- Assumes .85 PHF and 2% trucks for all movements in the proposed scenarios

**Table 16 – Year 2040 two-way stop control, year 2040 all-way stop control, and year 2040 traffic signals with protected / permissive left-turns**

| <b>Year 2040: Dubuque Street / North Liberty Road</b> |                                   |            |                |            |                                   |            |                |            |  |            |                |            |  |
|---|-----------------------------------|------------|----------------|------------|-----------------------------------|------------|----------------|------------|--|------------|----------------|------------|--|
| <b>Movement</b>                                       | <b>2040: Two-Way Stop Control</b> |            |                |            | <b>2040: All-Way Stop Control</b> |            |                |            | <b>2040: Signals Protected/Permissive Left Turns</b> |            |                |            |  |
|   | <b>AM Peak</b>                    |            | <b>PM Peak</b> |            | <b>AM Peak</b>                    |            | <b>PM Peak</b> |            | <b>AM Peak</b>                                       |            | <b>PM Peak</b> |            |  |
|   | <b>Delay</b>                      | <b>LOS</b> | <b>Delay</b>   | <b>LOS</b> | <b>Delay</b>                      | <b>LOS</b> | <b>Delay</b>   | <b>LOS</b> | <b>Delay</b>   | <b>LOS</b> | <b>Delay</b>   | <b>LOS</b> |  |
| <b>Dubuque Street NE</b>                              |                                   |            |                |            |                                   |            |                |            |  |            |                |            |  |
| Eastbound   | 27.8                              | D          | 2.8            | A          | 164.5                             | F          | 26.9           | D          | 64.1   | E          | 14.1           | B          |  |
| Westbound   | 89.5                              | F          | 4.2            | A          | 21.8                              | C          | 102.9          | F          | 29.1   | C          | 19.8           | B          |  |
| <b>North Liberty Road</b>                             |                                   |            |                |            |                                   |            |                |            |  |            |                |            |  |
| Northbound  | >300                              | F          | 221.2          | F          | 63.1                              | F          | 46.0           | E          | 96.1   | F          | 24.8           | C          |  |
| Southbound  | >300                              | F          | 49.4           | E          | 21.2                              | C          | 11.4           | B          | 93.8   | F          | 19.3           | B          |  |
| <b>Intersection</b>                                   | <b>107.6</b>                      | <b>F</b>   | <b>51.5</b>    | <b>F</b>   | <b>75.6</b>                       | <b>F</b>   | <b>60.8</b>    | <b>F</b>   | <b>71.7</b>  | <b>E</b>   | <b>19.7</b>    | <b>B</b>   |  |

- AM figures include school traffic estimates
- PM figures *do not* include school traffic estimates as the peak school hour and peak hour do not coincide
- Assumes .85 PHF and 2% trucks for all movements in the proposed scenarios
- Percentage growth calculated from opening day estimated AADT and 2040 travel demand model adjusted daily traffic estimates; applied growth factor to opening day peak hour counts to develop 2040 peak hour counts

## Capacity Analysis – Roundabout Configuration

**Table 17** shows that a one-lane roundabout would provide sufficient capacity during the AM and PM peak hours on opening day with LOS B during the AM and LOS A during the PM. The eastbound AM peak movement performs at an acceptable LOS C with 21.4 seconds of delay / vehicle with other movements operating at a LOS B or better. The eastbound delay is primarily a result of the large volumes of eastbound traffic funneling into the one-lane roundabout during the AM school peak.

**Table 17 – Opening Day One-Lane Roundabout**

| Opening Day: Dubuque Street / North Liberty Road |                     |     |         |     |
|--|---------------------|-----|---------|-----|
| Movement   | One Lane Roundabout |     |         |     |
|  | AM Peak             |     | PM Peak |     |
|  | Delay               | LOS | Delay   | LOS |
| <b>Dubuque Street NE</b>                         |                     |     |         |     |
| Eastbound  | 24.1                | C   | 6.8     | A   |
| Westbound  | 6.2                 | A   | 10.7    | B   |
| <b>North Liberty Road</b>                        |                     |     |         |     |
| Northbound                                       | 6.7                 | A   | 9.0     | A   |
| Southbound                                       | 4.0                 | A   | 4.5     | A   |
| <b>Intersection</b>                              | 17.1                | B   | 9.1     | A   |

- Peak hour counts taken in 2008, .5% annual growth factor applied
- AM figures include school traffic estimates
- PM figures *do not* include school traffic estimates as the peak school hour and peak hour do not coincide
- AM & PM figures include anticipated residential growth from new 70 unit subdivision north of the school
- Assumes .85 PHF and 2% trucks for all movements in the proposed scenarios

**Table 18** shows that in the year 2040, a one-lane roundabout is expected to perform at LOS F during the AM peak period due to eastbound and northbound congestion. A two-lane roundabout with 150 foot left-turn lanes on all approaches is expected to perform at an acceptable LOS D during the AM and PM peak hours, although the eastbound movement is still expected to fail during the AM peak hour. To improve the AM eastbound level of service, staff evaluated a scenario with eastbound dual-entry including a through-left and a through-right lane with dual exit lanes in addition to 150 foot left-turn lanes on the northbound, southbound, and westbound approaches. In this scenario, the overall intersection performs at an acceptable LOS D during the AM peak hour and LOS C during the PM peak hour. During the AM, the eastbound movement improves to LOS D at 38.5 seconds / vehicle; however it is at the expense of the northbound movement which performs at LOS F at 96.3 seconds / vehicle.

Given that the intersection of North Liberty Road and Dubuque Street NE is relatively rural in nature, the idea of utilizing a roundabout rather than a traffic signal or all-way stop has merit. Roundabouts in rural and suburban locations with higher traffic speeds can help to reduce the severity of accidents and do not require motorists to come to a complete stop as would be the case with a traffic signal or all-way stop. Coming to a complete stop in rural or suburban locations is often 'unexpected' by the motorist and may result in a loss of compliance. Roundabouts also work more efficiently than either stop control or signals in off-peak times as they do not require motorists to stop. The natural traffic calming effect that roundabouts can provide would also be beneficial adjacent to the school grounds.

**Table 18 – Year 2040 Roundabout Scenarios**

| Year 2040: Dubuque Street / North Liberty Road |                     |     |         |     |   |     |         |     |  |     |         |     |
|--|---------------------|-----|---------|-----|---|-----|---------|-----|--|-----|---------|-----|
| Movement                                       | One Lane Roundabout |     |         |     | Two Lane Roundabout w/ 150' LT Lanes all Approaches |     |         |     | Two Lane Roundabout with EB dual entry/dual exit lanes & 150' LT lanes for NB, SB, & WB approaches |     |         |     |
|  | AM Peak             |     | PM Peak |     | AM Peak   |     | PM Peak |     | AM Peak  |     | PM Peak |     |
|  | Delay               | LOS | Delay   | LOS | Delay   | LOS | Delay   | LOS | Delay  | LOS | Delay   | LOS |
| <b>Dubuque Street NE</b>                       |                     |     |         |     |   |     |         |     |  |     |         |     |
| Eastbound                                      | 112.6               | F   | 7.3     | A   | 105   | F   | 7.4     | A   | 28.5   | D   | 5.0     | A   |
| Westbound                                      | 8.7                 | A   | 35.9    | E   | 11.2  | B   | 45.1    | D   | 11.0   | B   | 43.6    | D   |
| <b>North Liberty Road</b>                      |                     |     |         |     |   |     |         |     |  |     |         |     |
| Northbound                                     | 73.2                | F   | 13.0    | B   | 25.1  | D   | 29.6    | D   | 96.3   | F   | 21.6    | C   |
| Southbound                                     | 14.3                | B   | 8.7     | A   | 12.4  | B   | 6.8     | A   | 11.9   | B   | 7.7     | A   |
| <b>Intersection</b>                            | 65.4                | F   | 20.4    | C   | 48.3  | D   | 28.5    | D   | 38.5   | D   | 25.4    | C   |

- AM figures include school traffic estimates
- PM figures *do not* include school traffic estimates as the peak school hour and peak hour do not coincide
- Assumes .85 PHF and 2% trucks for all movements in the proposed scenarios
- Percentage growth calculated from opening day estimated AADT and 2040 travel demand model adjusted daily traffic estimates; applied growth factor to opening day peak hour counts to develop 2040 peak hour counts

**Dubuque Street NE / North Liberty Road Capacity Analysis – Conclusions**

**Table 19** shows a comparison of the proposed traffic control options on opening day at the North Liberty Road / Dubuque Street NE intersection. When comparing all-way stop control, signalization, and roundabout configurations, the one-lane roundabout configuration has the lowest overall intersection delay at 17.1 seconds/vehicle and 9.1 seconds/vehicle respectively in the AM and PM peak hours.

**Table 20** shows a comparison of proposed traffic control options for the year 2040. It is anticipated that traffic levels will reach a point that a two-way or all-way stop would result in significant congestion and a LOS F at the intersection. Signalizing the intersection results in a LOS E during the AM and LOS B during the PM. A two-lane roundabout with 150 foot left-turn lanes on all approaches would provide LOS D during both the AM and PM peak hours. In this scenario, it is anticipated that the eastbound movement would perform at LOS F during the AM peak hour unless dual entry and dual exit lanes are constructed for the eastbound movement. Adding this additional eastbound capacity would improve the eastbound movement to LOS D, however it would be at the expense of the northbound movement which would subsequently perform at a LOS F. Dual exit lanes would also require additional paving to the east of the intersection and a merge at the location where the additional lane terminates.

As is the experience near the other area high schools, the confluence of commuter traffic and high school traffic near Liberty High in the morning would likely cause a 20 minute spike in traffic near the school. It would be reasonable to assume that corridors adjacent to City High and West High would also receive a LOS F if capacity was formally evaluated for the 15-20 minute AM peak school period. Outside of the “school spike” during the AM peak hour, traffic levels off somewhat but remains elevated due to commuter traffic.

Given that a roundabout is anticipated to operate most efficiently, provide additional traffic calming, reduce collision severity, and provide a more predictable driving environment for motorists in a rural setting, staff recommends conducting further analysis into the feasibility of constructing a roundabout at the Dubuque Street / North Liberty Road intersection. The size/design of the roundabout will need to be further analyzed by the project engineer to determine what roundabout features are most appropriate for the specific intersection.

**Table 19 – Opening Day: Scenario Comparison**

| <b>Dubuque Street NE / North Liberty Road</b>           |                |            |                |            |
|---|----------------|------------|----------------|------------|
| <b>Intersection Configuration</b>                       | <b>AM Peak</b> |            | <b>PM Peak</b> |            |
|   | <b>Delay</b>   | <b>LOS</b> | <b>Delay</b>   | <b>LOS</b> |
| Two-Way Stop Control                                    | 27.7           | <b>D</b>   | 4.4            | <b>A</b>   |
| All-Way Stop Control                                    | 46.2           | <b>D</b>   | 10.6           | <b>B</b>   |
| Signalized with <i>Protected / Permitted</i> Left Turns | 17.3           | <b>B</b>   | 9.1            | <b>A</b>   |
| One-Lane Roundabout                                     | 17.1           | <b>B</b>   | 9.1            | <b>A</b>   |

- AM figures include school traffic estimates

- PM figures *do not* include school traffic estimates as the peak school hour and peak hour do not coincide

**Table 20 – Year 2040: Scenario Comparison**

| <b>Dubuque Street NE / North Liberty Road</b>   |                |            |                |            |
|---|----------------|------------|----------------|------------|
| <b>Intersection Configuration</b>   | <b>AM Peak</b> |            | <b>PM Peak</b> |            |
|   | <b>Delay</b>   | <b>LOS</b> | <b>Delay</b>   | <b>LOS</b> |
| Two-Way Stop Control  | 107.6          | <b>F</b>   | 51.5           | <b>F</b>   |
| All-Way Stop Control  | 75.6           | <b>F</b>   | 60.8           | <b>F</b>   |
| Signalized with <i>Protected / Permitted</i> Left Turns   | 71.7           | <b>E</b>   | 19.7           | <b>B</b>   |
| One-Lane Roundabout   | 65.4           | <b>F</b>   | 20.4           | <b>C</b>   |
| Two-Lane Roundabout with 150' LT lane on all approaches   | 48.3           | <b>D</b>   | 28.5           | <b>D</b>   |
| Two-Lane Roundabout with EB dual entry/exit lanes and 150' LT lanes for NB, SB, and WB approaches | 38.5           | <b>D</b>   | 25.4           | <b>C</b>   |

## Traffic Signal Warrant Analysis – High School Entrances

A traffic signal warrant analysis for opening day performed to determine the need for a traffic signal at the three high school entrances. At a minimum, at least 1 of the 9 warrants must be met, but the satisfaction of a warrant does not in itself require the installation of a traffic signal. Warrant #3 (peak hour) was evaluated to determine if the signal would likely meet the minimum traffic volume criteria during the three busiest hours of the day adjacent to the school – the AM peak hour, school PM peak hour, and PM peak hour.

The 9 traffic signal warrants are as follows:

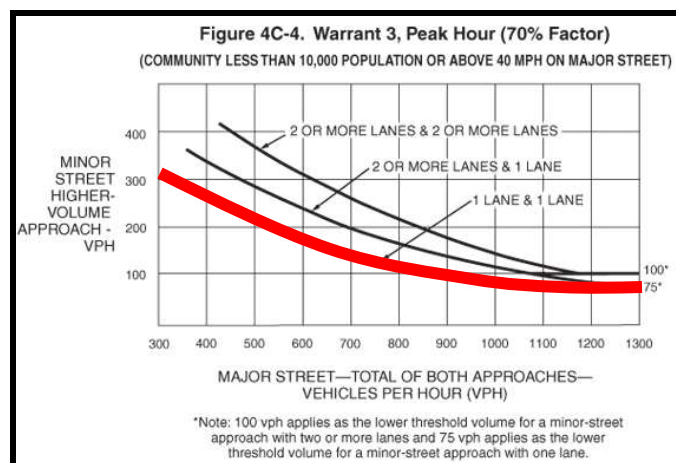
- 1) Eight-Hour Vehicular Volume (*not evaluated*)
- 2) Four-Hour Vehicular Volume (*not evaluated*)
- 3) **Peak Hour**
- 4) Pedestrian Volume (*not evaluated*)
- 5) School Crossing (*not evaluated*)
- 6) Coordinated Signal System (*not evaluated*)
- 7) Crash Experience
- 8) Roadway Network
- 9) Intersection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

### 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 shown in **Figure 11**. **Tables 21, 22, and 23** indicate that no entrance meets the minor and major street volume thresholds during the AM peak, school PM peak, or during the PM peak hour. No peak hour meets the required thresholds for a traffic signal under opening day conditions; therefore **Warrant 3 is not met**.

Because the peak hour warrants were not met, and school traffic generally occurs at specific peak periods, it is very unlikely that Warrant #1 (eight-hour volume) and Warrant #2 (four-hour volume) would be met. As such, a signal is not warranted on opening day at any of the high school entrances. It would be appropriate to periodically reevaluate the need for a signal at the high school entrances in the future as area traffic volumes grow.

**Figure 11 - Peak Hour Warrant Threshold**





**Table 21: High School Entrance #1**

| Warrant 3, Peak Hour<br>Liberty High School Entrance #1 – Dubuque Street E |              |      |                                    |              |     |            |              |    |
|--|--------------|------|------------------------------------|--------------|-----|------------|--------------|----|
| High School Entrance #1<br>Highest Vol. Approach                           |              |      | Dubuque Street<br>Entering Traffic |              |     | Warranted? |              |    |
| AM   | SCHOOL<br>PM | PM   | AM                                 | SCHOOL<br>PM | PM  | AM         | SCHOOL<br>PM | PM |
| 105  | 168          | 168* | 522                                | 407          | 532 | No         | No           | No |

**Table 22: High School Entrance #2**

| Warrant 3, Peak Hour<br>Liberty High School Entrance #2 – Dubuque Street W |              |     |                                    |              |     |            |              |    |
|--|--------------|-----|------------------------------------|--------------|-----|------------|--------------|----|
| High School Entrance #2<br>Highest Vol. Approach                           |              |     | Dubuque Street<br>Entering Traffic |              |     | Warranted? |              |    |
| AM   | SCHOOL<br>PM | PM  | AM                                 | SCHOOL<br>PM | PM  | AM         | SCHOOL<br>PM | PM |
| 40   | 71           | 71* | 522                                | 407          | 532 | No         | No           | No |

**Table 23: High School Entrance #3**

| Warrant 3, Peak Hour<br>Liberty High School Entrance #3 – North Liberty Road |              |      |  |              |     |            |              |    |
|--|--------------|------|--|--------------|-----|------------|--------------|----|
| High School Entrance #3<br>Highest Vol. Approach                             |              |      | North Liberty Road<br>Entering Traffic |              |     | Warranted? |              |    |
| AM   | SCHOOL<br>PM | PM   | AM                                     | SCHOOL<br>PM | PM  | AM         | SCHOOL<br>PM | PM |
| 64   | 112          | 112* | 228                                    | 174          | 204 | No         | No           | No |

- \* School PM exiting traffic was applied to the PM peak hour as worst-case scenario
- Opening Day ADT 6,270 ADT estimated for Dubuque Street NE
- Assumes Dubuque Street NE AM traffic distribution of 70% EB/30% WB; PM traffic distribution of 30% EB/70% WB
- Assumes North Liberty Rd AM traffic distribution of 80% SB/20% WB; PM traffic distribution of 70% SB/30% WB
- Opening Day ADT 1,500 ADT estimated for North Liberty Road
- Assumes AM peak hour 4.5% of ADT; School PM peak 6.5%, PM peak 8.5% plus trip generation estimates
- Assumes

**High School Entrance Intersection - Capacity Analysis**

The Liberty High School intersections are expected to function very well with little delay on opening day. In this scenario, left and right turn lanes are constructed on Dubuque Street NE and North Liberty Road at each entrance, along with dedicated left and right turn lanes for traffic exiting the high school property. While left and right turn lanes are not warranted in the public right-of-way at each entrance from a traffic volume perspective, the City of North Liberty has indicated that they intend to build left and right auxiliary lanes at all high school entrances as an additional safety factor and to increase capacity at the entrances. In terms of stop control, the major streets run free while traffic exiting the school will be required to stop. Overall intersection performance is expected to be an LOS A during both the AM and school PM peak hours. Traffic exiting Liberty High School, the movement with the greatest delay, will perform at a LOS B or better during both the AM and school PM peak hours.

**Table 24: High School Entrance Delay & Level of Service: Opening Day**

| High School Entrance Operations Analysis – Opening Day with Turn Lanes |                                    |     |         |     |                                       |     |         |     |                               |     |         |     |
|--|------------------------------------|-----|---------|-----|---------------------------------------|-----|---------|-----|-------------------------------|-----|---------|-----|
| Movement   | Entrance #1: Dubuque Street (East) |     |         |     | Entrance #2: Dubuque Street NE (West) |     |         |     | Entrance #3: North Liberty Rd |     |         |     |
|  | AM                                 |     | PM Peak |     | AM Peak                               |     | PM Peak |     | AM Peak                       |     | PM Peak |     |
|  | Delay                              | LOS | Delay   | LOS | Delay                                 | LOS | Delay   | LOS | Delay                         | LOS | Delay   | LOS |
| Eastbound  | 2.4                                | A   | 1.9     | A   | 3.8                                   | A   | 3.4     | A   | n/a                           | n/a | n/a     | n/a |
| Westbound  | 0.0                                | A   | 0.0     | A   | 0.0                                   | A   | 0.0     | A   | 9.5                           | A   | 10.0    | B   |
| Northbound   | n/a                                | n/a | n/a     | n/a | n/a                                   | n/a | n/a     | n/a | 0.0                           | A   | 0.0     | A   |
| Southbound   | 9.9                                | A   | 10.9    | B   | 11.1                                  | B   | 11.9    | B   | 2.7                           | A   | 1.2     | A   |
| <b>Intersection</b>  | 2.4                                | A   | 2.1     | A   | 4.3                                   | A   | 4.1     | A   | 2.8                           | A   | 3.9     | A   |

- Based on AM peak hour and school PM peak hour (3 – 4 PM)
- Assumes 4.5% daily volume for AM peak, 6.5% for PM school peak plus trip generation estimates
- Assumes 700 AM school trips; 500 inbound – 200 outbound, 50% from west, 30% from south, 10% from north and 10% from east
- Assumes 575 PM school trips; 225 inbound – 350 outbound, 50% 50% from west, 30% from south, 10% from north and 10% from east
- Assumes 20% of school traffic will use Entrance #1, 48% will use Entrance #2, and 32% will use Entrance #3
- Assumes 1500 ADT on North Liberty Road – 80% SB / 20% NB during AM; 70% SB / 30% NB during school PM
- PM figures *do not* include school traffic estimates as the peak school hour and peak hour do not coincide
- AM & PM figures include anticipated residential growth from new 70 unit subdivision north of the school
- Assumes .85 PHF and 2% trucks for all movements in the proposed scenarios
- Assumes .5% annual inflation for background traffic to anticipated build year
- Ent #1 – 200' LT lane, 150' RT lane on Dubq St, 110' LT/110' RT lane for exiting traffic on school property
- Ent #2 – 200' LT lane + 300' TWLTL, 150' RT lane on Dubq St, 160' LT/160' RT lane for exiting traffic on school property
- Ent #3 – 150' LT lane, 150' RT lane on N. Liberty Rd, 200' LT/200' RT lane for exiting traffic on school property

The capacity of the high school intersections was also evaluated for the year 2040 using traffic estimates derived from the MPOJC travel demand model. Additional information on the assumptions contained within the travel demand model can be found in Appendix A. Our findings indicate that the high school intersections are expected to function well in the future with overall level of service remaining at LOS A. Delay is expected to increase somewhat for traffic exiting the high school, however level of service will remain acceptable at LOS C or better.

## Recommendations

- A traffic signal or roundabout at the North Liberty Road / Dubuque Street intersection is recommended upon opening of the school (analysis shows that a roundabout would provide the best overall level-of-service). A one-lane roundabout would be sufficient for opening day traffic, however at minimum a two-lane roundabout with 150' left-turn lanes may be required to provide an acceptable overall level of service in 2040. An all-way stop is only recommended as an *interim* measure on opening day if a traffic signal or roundabout is not yet fully implemented.
- An eastbound left-turn lane is warranted at the Dubuque Street NE west entrance (#2) on opening day and an eastbound left-turn lane is close to being warranted during the AM at the Dubuque Street NE east entrance (#1). The left-turn lane at entrance #1 is expected to become fully warranted by the year 2040.
- The high school entrances are expected to perform well on opening day and well into the future with stop control for exiting traffic only. Dubuque Street NE and North Liberty Road, which carry the majority of the traffic at each intersection, should run free with no stop control.

## Further Observations/Considerations

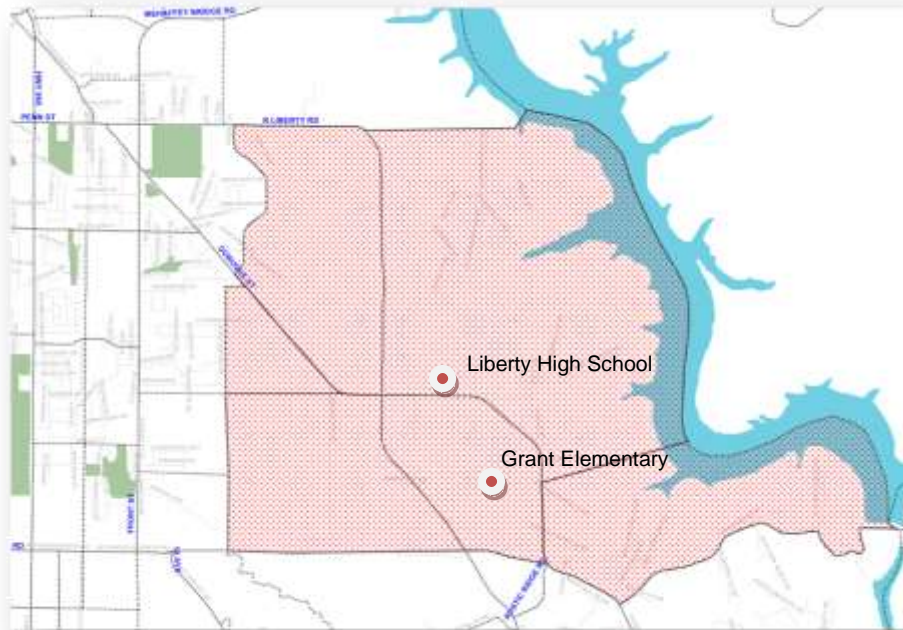
- There is a substantial elevation change from north to south on the proposed site with a high point occurring near the middle of the site (along North Liberty Road). As such, there is limited sight distance for north/south motorists which will require significant grading to resolve.
- A three-lane cross section (with dual center left-turn lane) may become necessary on Dubuque Street (and/or N. Liberty Road) adjacent to the school property, especially as there are plans to develop the Scanlon property located south of the proposed high school site. A three-lane cross section would allow for more efficient left-turn movements for properties located on both sides of Dubuque Street NE.
- Proposed access points for the Scanlon property (located to south of Liberty High School) should align with the entrances for Liberty High School.
- The future Tartan Drive access should be located opposite one of the proposed access points on North Liberty Road.
- *New* access points should be prohibited within 150' of the Dubuque Street / N. Liberty Road intersection.
- Paving the existing gravel portion of North Liberty Road in its entirety would be beneficial given the increased traffic volumes the school will generate.
- High schools have special events that generate traffic, mostly during the off-peak hours on evenings and weekends. Constructing left and right turn lanes at the entrances would help to facilitate traffic flow and increase safety for special events.

Staff is available to revise this analysis should further detail becomes available. Should the need arise to alter the assumptions used for this study, it will be important to ensure that the findings of this study remain accurate.

\*NOTE: MPO travel demand model data and Synchro/SimTraffic reports developed for this study are available upon request.

## APPENDIX A: MPOJC YEAR 2040 TRAVEL DEMAND MODEL ASSUMPTIONS

- As of November 2014, the travel demand model includes the future Liberty High School and the future Grant Elementary School which will be located approximately half-to-3/4 mile south of Dubuque Street NE / North Liberty Road intersection. The model is reflective of both schools being at maximum student and staffing capacity in the year 2040.
- The area shaded in red is expected to grow from 175 households in 2010 to over 2,500 by the year 2040. This information is based on growth assumptions provided by the communities expected to annex land in this area and by growth trends in the areas expected to stay unincorporated. The estimated growth in households is reflected in the year 2040 traffic forecasts derived from the model.



- The year 2040 forecasted traffic volumes developed with the travel demand model are as follows. The 2010 DOT AADT counts were included for comparison.

| <u>Dubuque Street NE</u>     | <u>2040 FORECAST</u> | <u>2010 DOT AADT</u> |
|------------------------------|----------------------|----------------------|
| ○ East of North Liberty Road | 9,300                | 4,830                |
| ○ West of North Liberty Road | 9,930                | 6,000                |
| ○ West of 275 <sup>th</sup>  | 8,570                | 4,830                |
| <u>North Liberty Road</u>    | <u>2040 FORECAST</u> | <u>2010 DOT AADT</u> |
| ○ North of Dubuque Street NE | 4,360                | 370                  |
| ○ South of Dubuque Street NE | 7,030                | 2,180                |
| ○ Near Penn Street           | 1,500                | 370                  |

- The model anticipates North Liberty Road will experience a greater increase in traffic growth than Dubuque Street NE as the area develops.

*Traffic analysis models are best used for general indications of traffic patterns in an area, but not for prediction of exact volumes. Future traffic volume data is generated with the best knowledge we have, but there is no model software that can predict specific land use decisions as well as the political, cultural, and economic decisions that influence future traffic.*