

**Date:** April 18th, 2018

**To:** Dean Wheatley; City Planner  
Kevin Trom; City Engineer

**From:** Emily Bothell; Senior Transportation Engineering Planner

**Re:** All-Way Stop Analysis at the intersection of Cherry Street and Front Street

This memorandum documents the findings of an all-way stop analysis at the intersection of Cherry Street and Front Street in North Liberty. This study was requested by the City after receiving resident concerns related to poor sight distance for north- and southbound vehicles on Front Street.

As identified in the Manual on Uniform Traffic Control Devices (MUTCD), there is a set of criteria to determine if multi-way stop control should be installed at an intersection. The major criteria considered include traffic volumes, collision history, pedestrian volumes, intersection visibility, and traffic speeds.

**Existing Conditions**

**Figure 1** shows an aerial view of the intersection which is currently stop-controlled for north- and southbound traffic on Front Street, and uncontrolled for east- and westbound traffic on Cherry Street. Front Street is classified as a collector street and Cherry Street is a local street. Both streets have a posted speed limit of 25-mph. Each leg of the intersection is marked with a pedestrian crosswalk and curb ramps are present on all corners.

**Sight Distance**

The recommended stopping sight distance for roadways with a posted speed limit of 25-mph is 152-feet (AASHTO). As measured, the sight distance for north- and southbound motorists, after coming to a complete stop, is approximately 75-feet to the east (when vehicles are parked along Cherry Street) and unlimited to the west. Sight distance is limited due to the on-street parking along Cherry Street, which is heavily used throughout the day.

**Figure 1: Intersection Configuration**



## Surrounding Area

As shown in **Figure 2**, this intersection is surrounded by a mix of land uses and is within close proximity to Penn Elementary School and Penn Meadows Park. North Liberty's Fire Station is located on the southwest corner of the intersection and North Liberty's Police Department is located on the southeast corner, as shown in **Figure 1**. Commercial uses make up the northeast and northwest corners of the intersection.

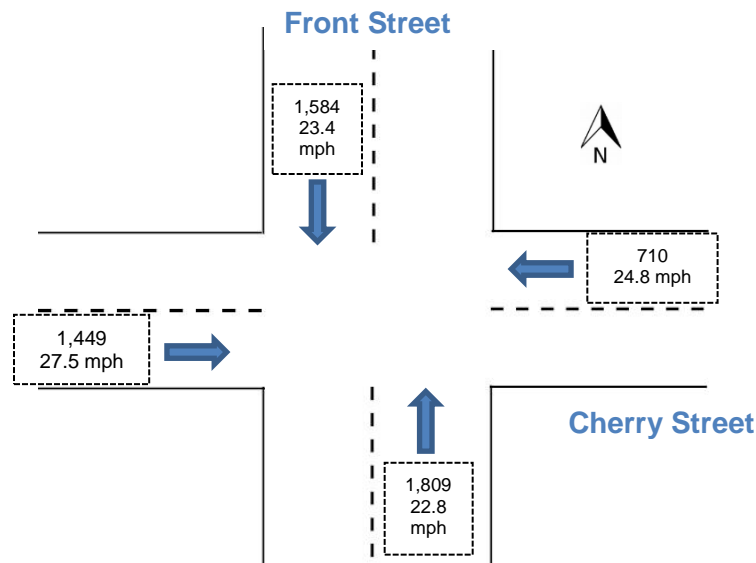
**Figure 2: Surrounding Area**



## Traffic Counts and Speed Data

Average daily traffic (ADT) counts and 85<sup>th</sup>-percentile speeds were recorded at the intersection November 7<sup>th</sup> – 9<sup>th</sup>, 2017 and are reflected in **Figure 3**. The ADT on Front Street was recorded at 3,393 vehicles, whereas ADT on Cherry Street was recorded at 2,159 vehicles. The 85<sup>th</sup>-percentile speeds on Cherry Street were recorded at approximately 25-mph for westbound traffic and 28-mph for eastbound traffic. The 85<sup>th</sup>-percentile speeds on Front Street were recorded at approximately 23-mph for north- and southbound traffic.

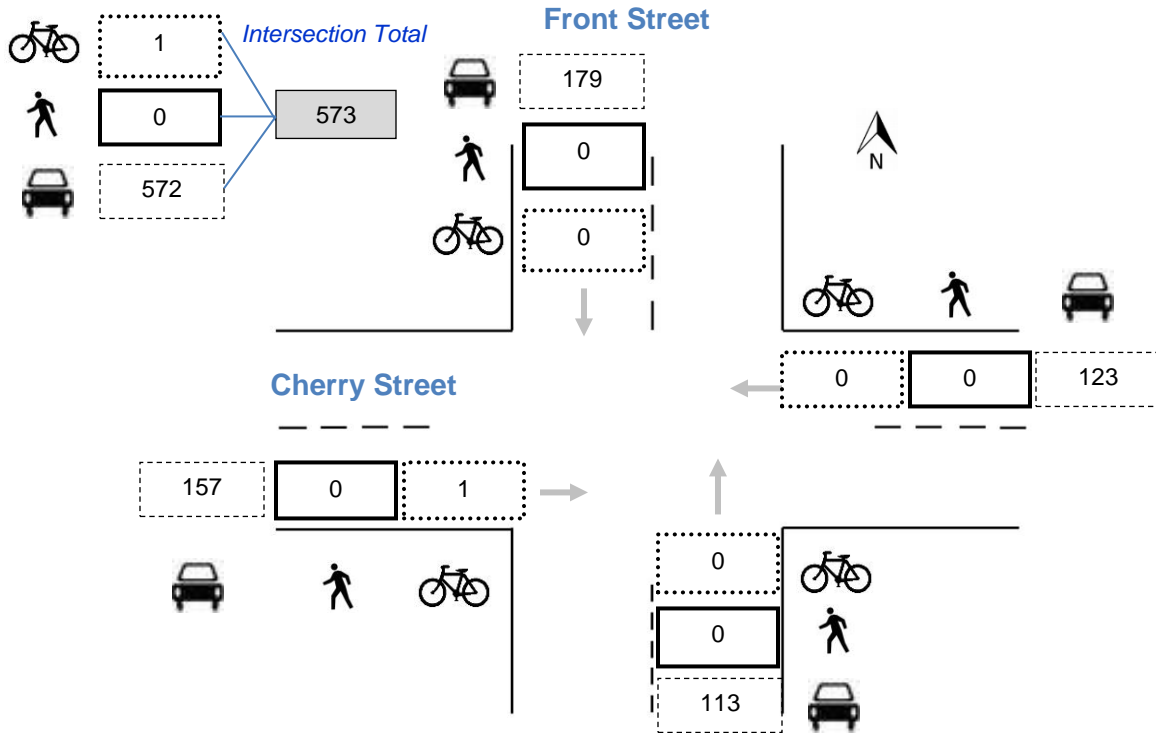
**Figure 3: ADT and 85<sup>th</sup>-percentile Traffic Speeds**



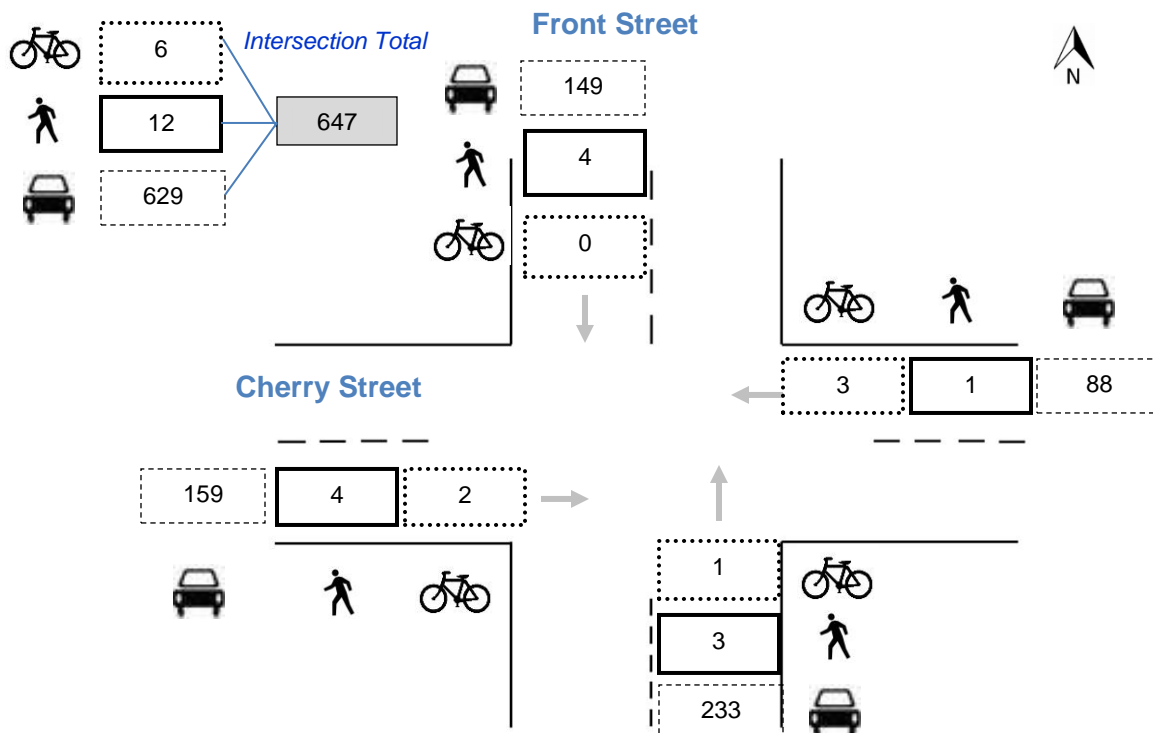
### Peak Hour Traffic Volumes

Figures 4 and 5 display the vehicular traffic volumes during the AM and PM peak hours at the intersection of Cherry and Front Streets. Peak hour counts were collected on February 15<sup>th</sup> and February 30<sup>th</sup> in 2018. During the AM peak hour there were 572 vehicles and one bicycle observed at the intersection, whereas during the PM peak hour there were 629 vehicles, six bicycles, and 12 pedestrians observed at the intersection, whereas during the PM peak hour there were 629 vehicles, six bicycles, and 12 pedestrians.

**Figure 4: AM Peak Hour Vehicular Traffic Volumes**  
7:15 a.m. – 8:15 a.m.



**Figure 5: PM Peak Hour Vehicular Traffic Volumes**  
4:45 p.m. – 5:45 p.m.



## MUTCD All-Way Stop Warrant Analysis

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 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 not planned at this location; therefore **Warrant A is not 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 failure to yield the right-of-way collisions.**
- *Six collisions (susceptible to correction by a multi-way stop installation) occurred at the intersection between 2008 and 2017 as shown in **Table 1**. Of these collisions, there were not more than five in a 12-month period; therefore **Warrant B is not met.***

**Table 1: Collision Analysis by Type of Crash**

<b>Cherry Street &amp; Front Street Collision History: 2008-2017</b>		
<b>Major Cause</b>	<b>Number of Collisions</b>	<b>Warranted? (&gt; 5 per year)</b>
Failure to yield right-of-way from stop sign *	6	No
Failure to yield right-of-way making left turn *	0	No
Failure to yield right-of-way from parked position	1	No
Failure to yield right-of-way other	1	No
Driving too fast for conditions	2	No
Ran Stop Sign	2	No
Ran Off Road - Straight	0	No
Lost Control	0	No
Vision Obstructed	0	No
Made Improper Turn	0	No
No Improper Action	0	No
Unknown	1	No
<b>Total Collisions</b>	<b>13</b>	<b>No</b>

\*Type of collision 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**
  - *The total vehicular volumes entering the intersection from Front Street exceed 300 vehicles per hour for eleven hours of an average day; therefore **Warrant C1 is met (Appendix A).***

2. The combined vehicular, pedestrian, and bicycle volumes 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
    - *The total vehicular volumes on Cherry Street exceed 200 vehicles for nine of the same eleven hours on Front Street, but delay to minor street traffic does not exceed 30 sec/vehicle during the PM peak hour (highest hour); therefore **Warrant C2 is not met** (Appendix A / Table 3).*
  3. If the 85<sup>th</sup>-percentile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the above values.
    - *Both Front and Cherry Streets are posted at 25-mph and the 85<sup>th</sup>-percentile speeds near the intersection did not exceeded 40-mph. The 85<sup>th</sup>-percentile speeds on Front Street were recorded at approximately 23-mph for north- and southbound traffic; therefore **Warrant C3 is not applicable**.*
- 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.
- *Warrant D was analyzed as criteria B, C1 and C2 are not all satisfied. Warrant B is not satisfied to 80 of minimum values because there were not 4 collisions, susceptible to correction by a multi-way stop control, in a 12-month period. While criterion C1 is met, delay to minor-street traffic is not satisfied to 80 percent of the minimum value as specified in criterion C2; therefore **Warrant D is not met**.*

The Manual on Uniform Traffic Control Devices (MUTCD) offers four additional optional criteria to be used based on engineering judgment.

- I. The need to control left-turn conflicts;
  - *In the past ten years (2008-2017) there've been six failure-to-yield collisions at the intersection. This results in a rate of 0.6 per year which is not indicative of a significant left-turn conflict; therefore **Optional Warrant I is not met**.*
- II. The need to control vehicle / pedestrian conflicts near locations that generate high pedestrian volumes;
  - *There have been zero vehicle / pedestrian collisions at the intersection between 2008 and 2017; therefore **Optional Warrant II is not met**.*
- III. Locations where a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop; and
  - *As measured, the sight distance for north- and southbound traffic on Front Street is limited to approximately 75-feet when vehicles are parked on Cherry Street. As such, drivers coming to a complete stop along Front Street are unable to safely negotiate the intersection without pulling further out into the intersection; therefore **Optional Warrant III is 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.**

- *Although Cherry Street is classified as a local street it functions as a collector street at this location due to the volume and connectivity between two arterials. As such, Cherry Street and Front Street are classified as two residential neighborhood collector streets with similar operating characteristics. While neither north- or southbound traffic experiences more than 16 sec/veh delay during peak hours, all-way stop control will marginally improve operating characteristics (**Table 3**); therefore **Optional Warrant IV is met**.*

**Capacity Analysis**

***Vehicular Delay and Level of Service (LOS)***

Existing intersection delay and Level of Service (LOS) was evaluated using *Synchro 10.0* Traffic Modeling Software. Traffic congestion is expressed in terms of LOS as defined by the Highway Capacity Manual (HCM). Level of service describes operating conditions based on a number of factors including speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience. **Table 2** displays LOS with control delay ranges at unsignalized intersections. 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 2: Level of Service Criteria for Stop Controlled Intersections**

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

***Existing Conditions***

Under existing conditions, the overall intersection performs well at LOS A during both peak periods (**Table 3**). The east- and westbound movements on Cherry Street experience the least amount of delay as these movement are currently uncontrolled. The north- and southbound movements experience average delay of approximately 14 s/veh during both peak periods at LOS B.

***Proposed All-Way Stop Conditions***

Under all-way stop conditions, the intersection would continue to operate well at LOS A during both peak periods, with an average per-vehicle delay of 9.2 to 9.7 s/veh as shown in **Table 3**. The north- and southbound movements would experience a slight decrease in delay as the all-way stop would introduce more gaps that are otherwise not available. The east- and westbound movements would experience a marginal increase in delay because these movements would no longer be uncontrolled.

**Table 3: LOS and Delay**

Direction	Existing Conditions TWSC				Proposed Conditions AWSC			
	Control Delay (s/veh)		LOS		Control Delay (s/veh)		LOS	
	AM	PM	AM	PM	AM	PM	AM	PM
<b>Cherry Street</b>								
<b>Eastbound</b>	0.7	0.8	A	A	9.2	9.4	A	A
<b>Westbound</b>	1.9	1.5	A	A	9.2	9.1	A	A
<b>Front Street</b>								
<b>Northbound</b>	13.7	15.6	B	B	8.9	10.3	A	B
<b>Southbound</b>	14.5	13	B	B	9.5	9.3	A	A
<b>Intersection</b>	7.8	9.3	A	A	9.2	9.7	A	A

**Queues**

*SimTraffic* was used in order to generate queue lengths for the westbound movement on Cherry Street. *SimTraffic* is a simulation program that “observes” the queues and reports whenever a vehicle is traveling less than 10 ft/sec and is behind a queue of vehicles.

At the end of the simulation period, *SimTraffic* determines the maximum queue, the average of two-minute maximum queues, and the 95<sup>th</sup>-percentile queue. As shown in **Table 4**, the queue lengths do not exceed the available storage length of the east-leg which was measured at approximately 155 feet.

**Table 4: Queue Lengths for westbound movement**

Queue Type	AM	PM
<i>Maximum Queue (feet)</i>	54	30
<i>Average Queue (feet)</i>	34	21
<i>95% Queue (feet)</i>	51	41

**Conclusion**

Based on the analysis of the MUTCD all-way stop warrants; none of the letter warrant are met at the intersection of Cherry Street and Front Street (**Table 5**). Because none of the letter warrants were met, the additional optional criteria were analyzed. Of the optional criteria, Optional Warrant III and IV are met due to the limited sight distance at the intersection and because all-way stop control will improve area operational characteristics, though marginally. Because Optional Warrants III and IV are met, all-way stop control is warranted at the intersection of Cherry Street and Front Street.

The capacity analysis shows the intersection currently operates well at LOS A. Under all-way stop conditions, the intersection experiences a slight increase in delay for east- and westbound movements and a slight decrease in delay for north- and southbound movements, with a negligible increase in overall intersection delay. An all-way stop at this intersection would improve visibility for north- and southbound motorists while introducing a slight increase in delay for east- and westbound motorists.

North Liberty Staff should consider whether an all-way stop is necessary as only two of the optional warrants are met. Alternatively, Staff could consider removing parking on the northeast and southeast corners of the intersection to improve visibility.

**Table 5: Summary of Warrant Findings**

<b>Warrant</b>	<b>Description</b>	<b>Warrant Met?</b>
A	Interim Measure for Traffic Signal	<b>No</b>
B	Collision History	<b>No</b>
C1	Major Street Vehicle Volume	<b>Yes</b>
C2	Minor Street Ped, Bike, and Vehicle Volume and Delay	<b>No (but close)</b>
C3	85 <sup>th</sup> Percentile Speeds	<b>n/a</b>
D	80% of Criterion B, C1, and C2	<b>No</b>
Optional #I	Control Left Turn Conflicts	<b>No</b>
Optional #II	Control Vehicle / Pedestrian Conflicts	<b>No</b>
Optional #III	Sight Distance & Visibility	<b>Yes</b>
Optional #IV	Improve Residential Area Operational Characteristics	<b>Yes</b>



Appendix A: Minimum Volumes

<b>All Way Stop Warrant Analysis</b>									
<b>Cherry Street and Front Street</b>									
<b>North Liberty, IA</b>		<b>Dates Data Gathered: November 7th - 9th, 2017</b>						<b>MPOJC</b>	
<b>Time</b>	<b>Entering Traffic</b>				<b>Total Entering Traffic</b>	<b>Minor Street Total</b>	<b>Major Street Total</b>	<b>All Way Stop Warranted?</b>	
	<b>Cherry Street (Minor)</b>		<b>Front Street (Major)</b>					<b>C.1</b>	<b>C.2</b>
	<b>Eastbound</b>	<b>Westbound</b>	<b>Northbound</b>	<b>Southbound</b>					
100	4	5	4	3	16	9	7	No	No
200	1	1	5	2	9	2	7	No	No
300	3	2	2	3	10	5	5	No	No
400	3	0	5	17	25	3	22	No	No
500	7	1	31	40	79	8	71	No	No
600	14	17	49	159	239	31	208	No	No
700	54	24	93	345	516	78	438	Yes	No
800	305	193	209	256	963	498	465	Yes	Yes
900	170	82	221	147	620	252	368	Yes	Yes
1000	116	73	136	132	457	189	268	No	No
1100	92	56	136	148	432	148	284	No	No
1200	146	66	174	175	561	212	349	Yes	Yes
1300	140	60	185	152	537	200	337	Yes	Yes
1400	114	59	139	193	505	173	332	Yes	No
1500	199	60	150	199	608	259	349	Yes	Yes
1600	231	156	278	263	928	387	541	Yes	Yes
1700	304	154	140	245	843	458	385	Yes	Yes
1800	379	165	420	190	1154	544	610	Yes	Yes
1900	220	90	282	122	714	310	404	Yes	Yes
2000	130	32	160	97	419	162	257	No	No
2100	91	13	130	62	296	104	192	No	No
2200	52	19	75	30	176	71	105	No	No
2300	13	5	29	16	63	18	45	No	No
2400	11	7	4	14	36	18	18	No	No