

March 9, 2015

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Subject: North Street/High Street Intersection Improvement Traffic Analysis

Hi Jennifer:

T.Y. Lin International (TYLI) is pleased to submit this letter that summarizes our traffic analysis conducted at the North Street/High Street intersection in support of roadway improvements being designed for North Street. Our analysis consisted of a review of existing traffic volumes, safety information, assessment of traffic control requirements, and a general review of the improvement details from a traffic engineering perspective.

TRAFFIC VOLUMES

A turning movement count was conducted by the City of Bath at the North Street/High Street intersection between 6:00AM to 10:00AM, 10:45AM to 2:00PM and 3:00PM to 5:00PM. According to the count, the AM peak hour occurred between 7:45AM and 8:45AM and the PM peak hour occurred between 3:00PM and 4:00PM. The following table summarizes the AM and PM peak hour volumes.

Time Period/Movement	North St. EB			North St. WB			High St. NB			High St. SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
AM Peak Hour	48	46	9	3	62	18	9	57	4	6	70	74
PM Peak Hour	42	78	18	6	99	19	6	74	6	11	70	82

SAFETY ANALYSIS

Crash data was obtained from MaineDOT for the most recent available three-year period (2011-2013) for the North Street/High Street intersection. The subject intersection is not classified as a High Crash Location (HCL) per MaineDOT criteria (8 or more crashes and a Critical Rate Factor greater than or equal to 1.0). A summary of the crash data is summarized below:

- Five (5) crashes were reported over the 2011 to 2013 three-year period.
- The Critical Rate Factor is 2.15.
- All crashes involved motor vehicles. There were no pedestrian or bicycle crashes.
- Crashes occurred between Noon and 6:00PM.

- Of the 5 crashes, 1 occurred in 2011, 2 in 2012 and 2 in 2013.
- Four of the 5 crashes were property damaged crashes only with no injuries.

Based upon the MaineDOT information, there is not either a crash frequency or pattern that would warrant special mitigation action. A few comments that I would like to elaborate on related to safety conditions.

- The City conducted vehicle speed data on North Street in February and March of 2014. According to the survey, average travel speeds do exceed the regulatory speed limit of 25 MPH, but average speeds were noted to be less than 30 MPH. It should be noted that the survey did note some vehicles traveling in excess of 30 MPH. In my professional opinion the proposed improvement plan will have a “traffic calming” effect on vehicle speeds as a result of the visual streetscape and roadway cross-section changes. The corresponding slowing of vehicles should have a positive effect on traffic safety at this intersection.
- Sight distance is restricted and is likely a contributing factor in the crashes. A few comments on this issue:
 - For northbound High Street motorists looking left, parked vehicles can impact sight lines. Accordingly, the proposed curb extension should be extended to increase sight lines. I would note that curb extensions physically prevent a vehicle from blocking sight lines, which is a positive benefit. Nothing significant is changing for motorists looking right, although the curb extension will ease the comfort of drivers to ease into the intersection for obtaining better sight lines and it appears the utility pole is being relocated and thus will eliminate a visual distraction.
 - For southbound High Street motorists, the elimination of on-street parking spaces on the north side of North Street, looking to the right will be improved. Looking to the left, minimal improvement in sight conditions is expected, although the curb is being adjusted and therefore will allow motorists to pull out slightly.
 - As noted later in the report, warrants for a four-way STOP controlled intersection are not met. I would note that the proposed design does not preclude the installation of such traffic control if deemed necessary in the future
 - My general sense is that the current intersection blends in with the surrounding area and motorists on North Street are not expecting intersection movements. Intersection Ahead warning signs could be installed, but in my professional opinion the recommended changes will frame and highlight the intersection with High Street and accordingly expectations for turning conflicts will be heightened. At this time I do not recommend any warning devices. I would monitor conditions after completion of the project and assess warning sign needs at that time.

INTERSECTION OPERATIONS/CAPACITY ANALYSIS

The standard used to evaluate traffic operating conditions of the transportation system is referred to as the Level of Service (LOS). This is a qualitative assessment of the quantitative effect of factors such as speed, volume of traffic, geometric features, traffic interruptions, delays, and freedom to maneuver. LOS analysis was based upon procedures detailed in the 2000 Highway Capacity Manual, Transportation Research Board. Signalized intersection LOS is based on average stopping delay per vehicle. The following table summarizes LOS categories and their associated delay.

UNSIGNALIZED INTERSECTIONS		
Level of Service	Average Delay Per Vehicle (sec.)	General Description
A	≤ 10	No delays at intersections with continuous flow of traffic. Uncongested operations: high frequency of long gaps available for all left and right turning traffic. No observable queues.
B	>10 and ≤ 20	Same as A
C	>20 and ≤ 30	Moderate delays at intersections with satisfactory to good traffic flow. Light congestion; infrequent backups on critical approaches
D	>30 and ≤ 40	Increased probability of delays along every approach. Significant congestion on critical approaches, but intersection functional. No standing long lines formed.
E	>40 and ≤ 50	Heavy traffic flow condition. Heavy delays probable. No available gaps for cross-street traffic or main street turning traffic. Limit of stable flow.
F	>50	Unstable traffic flow. Heavy congestion. Traffic moves in forced flow condition. Average delays greater than one minute highly probable. Total breakdown.

The following table summarizes each movement - providing the delay (in seconds) followed by the Level of Service (A-F) for each movement. An overall Level of Service is also provided. The analysis was conducted for both the weekday AM and PM peak hours. Additionally, 95th% queues were estimated and provided in the following tables. The 95th% queue is a queue length that is exceeded only 5% of the time and is commonly used for design purposes. It should be

noted that the conclusions represent traffic control where movements from High Street are STOP controlled.

North Street/High Street Existing Conditions xxx – AM Peak Hour/(xxx) – PM Peak Hour			
Movement	Level of Service	Delay (sec/veh)	95 th % Queue (feet)
North Street EB Left	A (A)	0 (0)	17 (28)
North Street EB Through	A (A)	0 (0)	
North Street EB Right	A (A)	0 (0)	
North Street WB Left	A (A)	0 (0)	6 (5)
North Street WB Through	A (A)	0 (0)	
North Street WB Right	A (A)	0 (0)	
High Street NB Left	A (A)	4 (4)	52 (51)
High Street NB Through	A (A)	3 (4)	
High Street NB Right	A (A)	2 (3)	
High Street SB Left	A (A)	4 (4)	59 (67)
High Street SB Through	A (A)	3 (4)	
High Street SB Right	A (A)	3 (3)	
Overall	A (A)	2 (2)	N/A

Conclusion: The North Street/High Street operates with little delay and has limited vehicle queuing on the STOP approaches. No capacity enhancement are required.

MUTCD WARRANTS FOR A MULT-WAY STOP INTERSECTION

An evaluation of the need for a four-way STOP sign control condition was evaluated. Accordingly, a review of procedures contained in the Manual on Uniform Traffic Control Devices, Federal Highway Administration (MUTCD) was performed. As specified in the MUTCD, the following criteria should be considered in the engineering study for a multi-way STOP sign installation:

- 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.
- 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.
- C. Minimum Volumes:

1. The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day, and
 2. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour, but
 3. If the 85th-percentile approach speed of the major-street traffic exceeds 65 km/h (40 mph), the minimum vehicular volume warrants are 70 percent of the above values.
- D. Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criteria C.3 is excluded from this condition.

ANALYSIS CONCLUSIONS:

- 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.

There are no plans for the installation of a traffic signal. Therefore this warrant 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 right-angle collisions.

According to crash reports from MaineDOT, five crashes were reported over a three-year period and therefore this warrant is not met.

- C. Minimum Volumes:

1. The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day, and
2. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour, but
3. If the 85th-percentile approach speed of the major-street traffic exceeds 65 km/h (40 mph), the minimum vehicular volume warrants are 70 percent of the above values.

Less than 300 vehicles per hour were recorded on North Street during the peak hour and less than 200 vehicles were recorded on High Street , and speeds are less than 40 MPH. This warrant is not met.

- D. Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criteria C.3 is excluded from this condition.

Less than 240 vehicles per hour were recorded on North Street during the peak hour and less than 160 vehicles were recorded on High Street. This warrant is not met.

In general I find the improvements to be excellent and will have a positive impact to multi-modal transportation and safety along the corridor. I have no suggested changes, other than those noted previously in this letter as it relates to sight distance.

Please contact me if you have any questions.

Best regards,

T.Y. LIN INTERNATIONAL



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