Queens Coast
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Region of Queens Municipality
Staff Report

To: Mayor and Council

From: Adam Grant, P.Eng., Director of Infrastructure

Date: September 10, 2024

Re: Market and Main Street Intersection Traffic Management

Background

At the May 14th Regular Council Meeting, the following motion was passed:

> "**THAT** the Council of the Region of Queens be directed to come back to a future meeting with a report and requirements outlining criteria for traffic lights at the Main and Market Street intersection."

The intention of that motion was understood to be for staff to provide Council with the criteria used by traffic engineers in their determination if the warrant for traffic signals exists at an intersection and a probable cost for the Main and Market Street intersection to be converted to a fully signalized intersection.

Details

The objective of transportation infrastructure should be to safely and efficiently move motorists and pedestrians to their destination(s) without incident. At intersections, paths cross and multiple options can be available to both user groups. Minor maneuvers will be in conflicting directions whereby it is important to emphasize awareness and remove distractions such that users can make informed decisions to determine when it is the safest time for them to make their maneuver through an intersection.

There are several potential treatment options for intersections to define who has the right of way and at which time. The intersection at Main and Market could have only a single stop sign on the market approach, all-way stop control (as it does now) or coordinated traffic signals as examples. The following conditions of an intersection are critical to properly selecting and designing the correct treatment for a successful intersection:

- Traffic volumes
  - Daytime vs nighttime variations
  - Weekday vs weekend variations
  - Seasonal variations
- Pedestrian volumes
  - Daytime vs nighttime variations
  - Weekday vs weekend variations
  - Seasonal variations
- Percentage of large vehicles, emergency vehicles or other motor vehicles with special requirements
- Motor vehicle and pedestrian accidents
- Volume of cyclists or other non-motor vehicles
- Pedestrian trip route, proximity to other crosswalks, and use
- Sign fatigue

The operational performance of an intersection is performed by a 'Level of Service (LOS) Analysis' which reviews intersection movements by looking at the characteristics of motorists to fluidly move through an intersection with a rating grade of A through F, where LOS A would indicate the lowest delay and LOS F would be the greatest. LOS rating is specific to a minor movement through an intersection and not the intersection as a whole, the 2015 Insight study computed ratings of LOS A or LOS B for all minor movements in the intersection which is considered acceptable.

Transportation Associate of Canada (TAC) has prepared the "Traffic Signal and Pedestrian Signal Head Warrant Handbook". This handbook uses a cumulative factor methodology to calculate a score. A combined score above 100 points would warrant a traffic signal. The methodology considers the following factors:

- Number and type of vehicle lanes
- Speed limits
- Bus routes
- Presence of medians
- Volume and types of vehicles

- Demographic factors, eg. presence of schools or mobility-challenged persons, senior's complexes, corridors to schools

A copy of the warrant formula is attached in Appendix A for information purposes.

The estimate for a warrant analysis to be completed for the Main and Market intersection by a 3rd party traffic engineering firm is estimated to cost less than $10,000. The warrant analysis would provide a clear answer on whether the intersection, meeting the TAC guidelines for traffic lights.

The cost of designing and constructing traffic signals is highly variable and depends on the factors listed above as well as other considerations such as vehicle sensing equipment, space constraints or emergency power. A simple 'T' intersection in an area with no space constraints could cost as much as $400,000 to design and install whereas more complicated installations in a similar intersection to Main and Market could cost as much as $900,000. Installation of traffic signals at this intersection would require the removal of existing overhead signage and may require some geometric re-alignment.

Should Council wish to proceed, it would be staff's professional advice to hire a consultant to conduct a comprehensive assessment of this intersection that looks at all aspects including the traffic signal warrant, proximity to other treatments in the area, nearby parking, as well as the preliminary cost estimates for any recommended upgrades and the impacts they may have in the area to ensure that all factors of this location are considered and a fulsome solution is offered.

If Council wanted to proceed with a comprehensive study, the following is a motion that could be made:

> **THAT** the Council of the Region of Queens direct staff to develop a scope for a comprehensive assessment of the Main and Market Street intersection and cost estimates of such a study.

Budget Impacts

There is no budget impact at this time.

Recommendation

(1) THAT Council of the Region of Queens Municipality receive the report titled Market and Main Street Intersection Traffic Management.

The expanded form of the warrant equation is shown below:

$$W = \left[\frac{C_{bt} \times X_{v\text{-}v}}{K_1} + \frac{X_{v\text{-}p} \times F \times L}{K_2} \right] \times C_i$$

W = Cumulative warrant points

C_{bt} = Side Street Bus/Truck Factor

$X_{v\text{-}v}$ = Sum of the individual cross product of the actual conflicting vehicle-vehicle movements

$X_{v\text{-}p}$ = Sum of the individual cross product of the actual conflicting vehicle-pedestrian movements

K_1 = Vehicle-Vehicle Denominator constant

K_2 = Vehicle-Pedestrian Denominator constant

F = Pedestrian Demographics Factor

L = Number of lanes on the main street

C_i = Product of the Roadway Characteristics Factors

B2.2.1 Side Street Bus/Truck Factor (C_{bt})

If the side street has either a high truck volume or is used as a bus route, there will be more risk (due to the inherent operating characteristics of these vehicles) in crossing the traffic stream on the main street.

C_{bt} is assigned a value of 1.05 if the side street either is a bus route (C_{sb}), or has more than 10% trucks (C_{st}), otherwise it has a value of 1.00. These conditions only affect the side street vehicles trying to cross the main street.

B2.2.2 Vehicle-Vehicle and Vehicle-Pedestrian Denominators (K_1) (K_2)

The Vehicle-Vehicle Denominator (K_1) and the Vehicle-Pedestrian Denominator (K_2) in the formula are calibrated to result in a cumulative threshold of 100 points for an intersection that warrants traffic signals, with an approximately 30 to 40% pedestrian component and 70 to 60% vehicle component depending on the number of lanes. The downward adjustment in the vehicle component and the corresponding upward adjustment in the pedestrian component weighting are in recognition of the increased pedestrian exposure risk of crossing wider roadways.

B2.2.3 Pedestrian Demographics Factor (F)

The Pedestrian Demographics Factor (F) is related to the adjacent land use. It is based on the idea that, rather than using actual pedestrian counts by hours of the day and age category, a surrogate adjustment factor based on the pedestrian demographics of the area near the intersection will be easier to identify and more consistently applied. The practitioner will use local judgment to determine if the demographics represent the mix of pedestrians at the intersection under analysis. The Pedestrian Demographics Factor is subjective based on engineering judgment of the impact of the following factors on the operation of the intersection:

a) Elementary school in the area,

b) Seniors centre or junior high school in the area,

c) Intersection crosswalk across the main street forms part of the "safe" walkway path to an elementary school,

d) There are mobility challenged pedestrians regularly using the intersection, and

e) All other cases.

The range of values is from 1.0, if there are no school children or seniors present, to 1.2 for mobility challenged pedestrians.

B2.2.4 Roadway Characteristics Factor (C_i)

The Roadway Characteristics Factor (C_i) is the cross-product of a number of individual factors that combine to identify the operating characteristics and the type of intersection being considered. C_i is the cross product of the individual Roadway Characteristics Factors. It can range from 0.90 to 1.59, depending on the applicability of each factor. The formula is $C_i = (C_s \times C_{mt} \times C_v \times C_p)$. Those factors are described below:

B2.2.4.1 Intersection Spacing Factor (C_S)

This factor is intended to correlate the progression of vehicles within a signal system with the spacing of intersections within the system. It should be noted that this factor is not normally used for intersections in the central business district (CBD), where C_S= 1.0. The factor is applied to the main street only, and to each of the two upstream intersections adjacent to the proposed signal location.

B2.2.4.2 Vehicle Classification Factor (C_{mt})

The Vehicle Classification Factor is intended to rationalize the impact of heavy vehicles on the main street and the safety implications they have on the side street traffic. Heavy vehicles (HV) can be considered either by a conversion to passenger car units (pcus) or by applying a factor that takes them into account. The latter is simpler, less data intensive and is recommended here. The range for this factor is based on percentage of trucks using an average equivalent passenger car unit value of 2.0 for trucks.

B2.2.4.3 Speed Factor (C_v)

The Speed Factor (C_v) represents the added difficulty that side street traffic may have when facing main street traffic at higher speeds. Speed (V) is either considered by using the posted speed limit on the main street or the 85th percentile operating speed.

B2.2.4.4 Population Demographic Factor (C_p)

Most signal warrant methodologies take into account the urban and/or rural nature of the intersection, indicating that driver expectation differs from large to small communities. The range for this factor is based on similar values and cutoff points used in other warrant procedures, namely: large city (greater than 250,000 population), small to medium city (10,000 to 250,000 population), and rural area or town (less than 10,000 population).

B2.2.4.5 Right-Turn Reduction Factor (RT_{rd})

The Canadian Traffic Signal Warrant Procedure provides a means of applying a special factor for side street right turns onto the main street. In order to deal with the side street right turns within the warrant analysis (to assist the engineering judgment component), a right-turn reduction factor has been developed.

The basic assumption is that, the relative ease to which the right-turning traffic can gain access to the main street is a function of the volume of the conflicting traffic in the curb lane on the main street. A review of the various factors that affect the capacity of the right-turn movement determined that a theoretical model based on gap acceptance theory is the most appropriate model to be used in a national context. A good model to use is one that is based on the proportion of free vehicles (a measure of the platoon dispersion) approaching the intersection on the main street. The right-turn reduction factor is assumed to be a function of the congestion created in the curb lane by the two movements (i.e., the sum of the side street right-turn traffic and the main street through traffic in the curb lane) and also a function of any platooning effects of an upstream traffic signal.

B2.2.5 Data Collection Requirements

Data collection requirements are minimal with the Canadian Traffic Signal Warrant Procedure. The input requirements consisting of four separate tables are shown in Figure B2-1, complete with sample data.

Support

For detailed insight into the traffic signal warrant procedure, refer to the TAC publication *Traffic Signal and Pedestrian Signal Head Warrant Handbook* (2014).

[redacted]

[redacted]

[redacted]

[redacted]

The CFM Pedestrian Matrix warrant equation is in the form as shown below:

$$W_{ped} = \sum i\text{-}j\ [F((X_{pedm})\ d_m) / K_2 + ((X_{peds})\ d_s) / K_3)]$$

W_{ped} = Cummulative warrant points

F = Pedestrian Demographics Factor

X_{pedm} = Adjusted pedestrian - vehicle cross product (pedestrians crossing main street)

X_{peds} = Adjusted pedestrian - vehicle cross product (pedestrians crossing side street)

d_m = Main street distance crossed by the pedestrian

d_s = Side street distance crossed by the pedestrian

K_2 = Pedestrian Signal Head Warrant Denominator constant for main street

K_3 = Pedestrian Signal Head Warrant Denominator constant for side street

Support

For detailed insight into the pedestrian signal head warrant procedure, refer to the TAC publication *Traffic Signal and Pedestrian Signal Head Warrant Handbook* (2014).