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# Traffic & Safety Review of Pedestrian Priority Signal

Pelham Street and Church Hill
Fonthill, Ontario

Prepared for Town of Pelham

March 2018

17 Atlantic Avenue
Toronto, Ontario, Canada, M6K 3E7
1 (647) 931-7383, 1 (877) 668-8784
admin@trans-plan.com
www.trans-plan.com

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Transportation Engineering

17 Atlantic Avenue, Toronto, Ontario, M6K 3E7 | Telephone: 1 (877) 668 8784 | Web: www.trans-plan.com

February 9, 2018

Ms. Andrea Clemenico
Director, Public Works
Town of Pelham
20 Pelham Town Square, P.O Box 400
Foothill, ON L0S 1E0

Project file: TPI-2017P148

Re: Pelham Street and Church Hill, Fonthill, Ontario, Pedestrian Priority Signal Review

Dear Ms. Clemenico,

TRANS-PLAN is pleased to submit this traffic and safety review to the Town of Pelham for the pedestrian priority signal located at the Church Hill and Pelham Street in Fonthill, Ontario.

Our review includes current traffic counts and surveys at the study area intersections along Pelham Street and a detailed review of the PPS, including a pedestrian crossing study, driver sight distance review, vehicle queuing study, a vehicle collision history review and all-way stop and traffic signal warrant reviews. Traffic operations were also reviewed in our Synchro traffic analysis model for existing and future conditions. The results of our all-way stop and traffic signal warrant analyses indicate that neither control type is warranted for the intersection. Given the survey and analysis results and observations (as well as the Town's By-law requirements), we suggest that on-street parking be removed within a minimum of 10m from the intersection at the approaches. A raised crosswalk design would also enhance the PPS crossing location for increased vehicle – pedestrian safety.

Sincerely,

Anil Seegobin, P.Eng.
Partner, Engineer

Trans-Plan Transportation Inc.
Transportation Consultants

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# 1. INTRODUCTION

Trans-Plan has been retained by Town of Pelham's Public Works Department to complete a review of the Pedestrian Priority Signal (PPS) at the intersection of Pelham Street and Churchill in Fonthill, and to advise on the recommended control type / improvements for the intersection. This assessment includes the following studies and tasks:

- a review of background documentation, including:
  - Fonthill Traffic Study, Final Report, R&R Associates Inc., September 2009
  - Traffic Brief, 1440 Pelham Street, Paradigm, February 6, 2017
  - Safer Pedestrian Crossing on Pelham Street, Town of Pelham Public Works, June 5, 2017
  - Committee of the Whole (CoW) Meeting Minutes, June 5, 2017
  - Memo re: Stacking of Southbound Vehicles on Pelham Street, Rusit and Associates LTD, July 31, 2017
- traffic surveys and an assessment of the existing roadway network conditions along Pelham Street, including operations of the PPS, including:
  - Turning movement counts for the study area intersections
  - Vehicle queue and delay study at the Pelham Street and Church Hill intersection
  - Collision history review at the Pelham Street and Church Hill intersection
  - A pedestrian crossing survey for volumes, compliance and observations of safety issues
  - A driver sight-distance review for vehicles exiting Church Hill onto Pelham Street
- a review of any planned development applications and roadway improvements along Pelham Street to obtain future traffic conditions
- an analysis of future operating conditions along Pelham Street using Synchro and SimTraffic analysis software, to review traffic level-of-service, capacity and queuing (modelling the Pelham Street and Church Hill intersection as an all-way stop and signalization control)
- a warrant analysis, using the Ontario Traffic Manual guidelines, based on the future traffic volumes, to review traffic control for the intersection as a PPS, all-way stop or signalization)
- recommendations for traffic improvements and/or mitigation measures at the Pelham Street and Church Hill intersection based our review and traffic assessment

This study was requested because ever since the installation of the PPS, the Town has received continued safety complaints from numerous parties, including (what has been described as) near misses with Town staff attempting to cross with the light activated. Public Works recommended that the PPS be changed to a full signalized intersection. Council has not approved the recommendation (when it was brought forward to the CoW on June 5, 2017), and instead requested a three-way stop be installed at the intersection. Town staff; however, are of the opinion that a three-way stop may not be the best option in consideration of spacing to adjacent intersections and traffic progression through the downtown area.

# 2. BACKGROUND REVIEW

## 2.1 Town Comments

Since the installation of the PPS in year 2015, the main issue noted by the Town is that it consistently stops all vehicles heading both northbound and southbound on Pelham Street; however, it does not consistently stop all vehicles making eastbound left turns from Church Hill onto Pelham. Drivers approaching northbound onto Pelham Street from Church Hill may not see the traffic signal on the north leg of Pelham due to the placement of the PPS. Therefore, in the case of a red light when the traffic signal is activated, drivers proceeding to make a rushed left turn must be cautious of pedestrians crossing in both directions of the intersection.

An installation of a temporary Pilot Pedestrian Cross Over (PXO) was installed over the summer of 2017 by the Town for a duration of two weeks. The main objective of the installation was to simulate a mid-block crossing, observe the effect of pedestrians crossing the roadway and the drivers' responses to the activation of the flashing lights. Overall, the Pelham Active Transportation Committee did not choose to proceed with the mid-block crossing pilot as another alternative to the PPS as a result of safety issues and visibility issues of the sign when the adjacent on-street parking spots were occupied.

Excerpts from previous studies in the study area are provided in Appendix A and are summarized as follows:

## 2.2 R&R Associates Inc. Study Findings

The R&R Associates study included observations and traffic count data. The total number of vehicles per day (VPD) on Pelham Street is 10,251 and on Church Hill is 2,847. Historical and recent spot speed surveys suggested that drivers on these roads generally disregard speed limits, endangering pedestrians. The study noted that installing traffic signals would help to slow traffic and likely reduce the probability and severity of collisions involving right of way conflicts, as well as improving safety conditions for pedestrians. Future modifications for the existing 45 on-street parking spaces on Pelham Street should be reviewed and analyzed in order improve sightlines at the cross streets of Pelham Town Square, Church Hill, and Regional Road 20.

## 2.3 Paradigm Study Findings

The findings from the Paradigm Transportation Solutions Limited study recommended a pedestrian signal be installed at the Pelham Street and Church Hill intersection with the following stipulations; the on-street parking lane, within 30m of the signalized intersection, should be removed to alleviate sightline problems for both the northbound and southbound directions. Signage should be included to warn drivers of the new signal and pedestrian activity. This will help to protect pedestrians crossing at the new signal. Paradigm also recommended that designated bicycle routes (i.e. shared auto and cycle lanes) be added along Pelham Street to improve safety for cyclists.

## 2.4 Rusit and Associates Study Findings

The findings from the Rusit & Associates Ltd. study noted that a signalized intersection at Church Hill would be below the minimum separation distance to the northerly existing signalized intersection at Highway 20. The intersection spacing is 179m, which is below the minimum of spacing requirement of 215m between signalized intersections (in urban settings). The findings also indicate that installing new traffic signals at

the intersection would improve left turn movements from Pelham Town Square to Pelham Road. It was also noted from field observations that southbound vehicle queues on Pelham Road extend approximately 150m from the Church Hill intersection, as far as the Highway 20 intersection.

# 3. EXISTING TRAFFIC CONDITIONS

## 3.1 Study Area

Fonthill is a community in the town of Pelham, Ontario. The study area, for analysis of the Pelham Street and Church Hill intersection, includes Pelham Street from College Street to Highway 20. The site location is shown in Figure 1 and a photograph of the PPS is shown in Figure 2. The surrounding area contains a number of retail, commercial and restaurant uses which stretch between Pelham Town Square Street and College Street, as well as the Fonthill Baptist Church.

## 3.2 Road Network

Based on discussions with Town's staff and a review of the Town's By-law #89-2000 for speed limits, the study area roadways are described as follows:

Highway 20 is a provincial highway under the jurisdiction of Niagara Region. Highway 20 generally runs in a northeast-to-southwest direction, connecting to Highway 406 to the east. Highway 20 has two travel lanes per direction in the vicinity of the site. The posted speed limit on Pelham Street, in the vicinity of the site, is 50 km/h (with some road sections reduced to 40 km/h).

Pelham Street is classified as an arterial road under the jurisdiction of the Town of Pelham. It consists of two travel lanes, one in each direction and generally runs in a north-south direction. At the Highway 20 signalized intersection, there are exclusive left turn lanes at the approaches. The posted speed limit on Pelham Street is 50 km/h.

Pelham Town Square is a local road under the jurisdiction of the Town of Pelham. It consists of two travel lanes, one in each direction. The roadway curves around Peace Park to the east of the study area. Pelham Town Square has an assumed speed limit of 40 km/h.

Church Hill is classified as a local street under the jurisdiction of the Town of Pelham. It contains two travel lanes and generally runs in an east-west direction. The assumed speed limit on Church Hill is also 40 km/h. The north leg of the intersection has the PPS and the west leg of the intersection has a stop control.

College Street is classified as a local street under the jurisdiction of the Town of Pelham. It contains two travel lanes and generally runs in an east-west direction. The assumed speed limit on College Street is assumed to be 50 km/h.

The study area roadway characteristics are shown in Figure 3. A drawing of the Pelham Street and Church Hill intersection, showing the PPS, is provided in Appendix B.

## 3.3 Transit Services

Pelham Transit provides morning / midday / evening bus service within the study area. The nearest bus stops are located at the Pelham Street and College Street intersection. Services times are approximately every 40 minutes during weekdays from approximately 7:00am to 6:00pm.

## 3.4 Existing Traffic Counts

To determine existing operating conditions in the study area, Trans-Plan conducted intersection turning movement counts (TMCs) for the study area roadways. Additionally, Trans-Plan obtained current signal timing plans and historical AADT traffic data (2009 and 2017) from the town of Pelham. Table 1 provides a summary of the dates, count hours and peak hours obtained for each intersection counted. Detailed TMC data and current signal timing plans provided by the Town are included in Appendix C.

Table 1 – Intersection Turning Movement Count Details

| Intersection | Count Date | Count Hours | Peak Hours |
|---|---|---|---|
| Pelham Street and Highway 20 | Tuesday, February 6, 2017 | 7:00 am -9:00 am<br>3:00 pm - 6:00 pm | 8:00 am - 9:00 am<br>4:30 pm - 5:30 pm |
| Pelham Street and Pelham Town Square | Tuesday, February 6, 2017 | 7:00 am -9:00 am<br>3:00 pm - 6:00 pm | 8:00 am - 9:00 am<br>4:30 pm - 5:30 pm |
| Pelham Street and Church Hill | Wednesday January 17, 2018 | 7:00 am - 9:00 am<br>11:00 am - 2:00 pm<br>3:00 pm - 6:00 pm | 8:00 am - 9:00 am<br>11:30 am - 12:30 pm<br>4:30 pm - 5:30 pm |
| Pelham Street and College Street | Wednesday January 17, 2018 | 7:00 am - 9:00 am<br>11:00 pm - 2:00 pm<br>3:00 pm - 6:00 pm | 8:00 am - 9:00 am<br>11:15 am - 12:15 pm<br>4:30 pm - 5:30 pm |

The Pelham Street and Church Hill intersection was counted for 8 hours for all-way stop and signal warrant purposes. The traffic volumes counted were increased and balanced between intersections, where appropriate, for consistency. The existing weekday AM and PM peak hour traffic volumes are shown in Figure 4.

## 3.5 Pedestrian Crossing Survey

A pedestrian crossing survey at the Pelham Street and Church Hill intersection (for east-west crossings) was conducted on January 18, 2018 for 8 hours in duration. The weather conditions were sunny, with a temperature of approximately -9 degrees C. The purpose was to obtain volumes and classification (i.e. adult, child, seniors and those with accessible needs) of pedestrians crossing, compliance with the PPS and to make observations of pedestrian crossing issues. Pedestrians crossing both upstream and downstream of the PPS (i.e. J-walking) were also recorded. The summary results are shown in Table 2. Detailed results for pedestrian volumes and classifications are provided in Appendix D.

Table 2 – Pedestrian Survey at Pelham Street PPS

| | Number of Pedestrian Crossings at Pelham Street | | | |
|---|---|---|---|---|
| Location | AM Peak Hour | MD Peak Hour | PM Peak Hour | Total 8 Hours |
| North leg of Pelham St | 3 | 11 | 8 | 37 |
| At PPS (during "do not walk" phase") | 5 | 10 | 10 | 27 |
| At PPS when pedestrian signal is activated (during walk phase) | 1 | 2 | 3 | 13 |
| South leg of Pelham St | 2 | 3 | 5 | 14 |
| Total volumes (pedestrians) | 11 | 26 | 26 | 91 |

Due to the comparatively higher number of retail and commercial uses located to the north of the intersection, compared to the south of the intersection, the crossing volumes at or near the north leg are generally higher. For the full 8-hour period, excluding midblock crossings, 27 pedestrians complied with the PPS and 13 pedestrians did not, resulting in a compliance of 67.5 percent. Additionally, the following observations were noted at the crossing, as summarized in Table 3. There were two "near misses" observed involving vehicle-pedestrian conflicts at the PPS during our 8-hour surveys.

Table 3 – Pedestrian Crossing Observations

| Crossing Direction | Time | Description |
|---|---|---|
| NW corner to NE corner | 1:35 pm | Woman crossing the street with infant at the PPS (during walk phase) was almost struck by vehicle exiting from an on-street parking space located within the intersection |
| NW to NE corner of Pelham Street | 4:17 pm | Senior crossing street at the PPS (during walk phase) was almost struck by a southbound vehicle making U-turn within the intersection |

## 3.6 On-street Parking at Intersection

In reference to the Town of Pelham Zoning Parking requirements (except found in Appendix D), a vehicle cannot park within 10m (33ft) of an intersection. Previously referred to Figure 2 shows the on-street parking bay on the east side of Pelham Street within the intersection. As noted in previous studies and from our review of pedestrian crossings, the on-street parking bay conflicts with vehicle and pedestrian movements within the intersection.

Vehicles are also not permitted to park within 3m (10 ft.) or within 1.5m (5 ft.) of a laneway, driveway or a curb-cut. On the east side of Pelham Street, vehicles were observed to block the driveway of the restaurant (Volcanos Pizzeria).

### 3.7 Vehicle Queuing Survey

Table 4 shows our recordings of peak hour vehicle queuing (number of vehicles and estimated queue lengths in metres) when the PPS walk phase was activated.

Table 4 – Vehicle Queuing Study Results

| Pelham Street and Church Hill | Available Storage Length (m) | Maximum Observed Vehicle Queue During Peak Hour (number of vehicles / length [m]) | | |
|---|---|---|---|---|
| Direction | | AM | MD | PM |
| Northbound | 100[1] | 4 veh / 28 m | 3 veh / 21 m | 7 veh / 35 m |
| Southbound | 90[2] | 6 veh / 42 m | 5 veh / 35 m | 9 veh / 63 m |
| Eastbound | n/a | 2 veh / 18 m | 1 veh / 7 m | 3 veh / 21 m |

Notes: (1) Distance from south leg of Pelham Street and Church Hill to the Meridian Credit Union driveway.
(2) Distance from the PPS to Pelham Town Square.

From our observations of vehicle queuing at the intersection, all vehicles tend to clear the intersection after each cycle. No vehicles were observed to experience lengthy delays at Church Hill when making eastbound left and right turns at the intersection.

### 3.8 Vehicle Collision Review

Based on correspondence with the Town, there has only been one collision reported within the past three years at the Pelham Street and Church Hill intersection. Therefore, no further vehicle collision analyses were conducted.

### 3.9 Driver Sight Distance Review

Driver sight distance was reviewed at the Pelham Street and Church Hill intersection for a driver making an eastbound left or right turn from Church Hill. During busier times of the day, vehicles parked near the intersection on the west side of Pelham Street limit sightlines for turning vehicles at the intersection. When the on-street parking bays are empty, the available sight distance from the extension of the curb line at the west leg of the intersection (from Church Hill) is 100 m looking northbound along Pelham Street and 350 m looking southbound. As per the Transportation Association of Canada (TAC) manuals (and the town of Pelham, Municipal Design Engineering Design standards, Section 2.1.1), the required sight distance is 85 to 140 m, which is met by the available sight distance (when vehicles are not parked on-street, on the west side of the intersection). Excerpts of the applicable standards and the detailed driver sight distance review are provided in Appendix D.

## 4. FUTURE TRAFFIC CONDITIONS

Future traffic volumes were determined based on a review of planned development applications received by the Town and estimates of background traffic volume growth in the study area. Detailed information is provided in Appendix E. For analysis purposes of future conditions, a five-year study horizon is assumed.

## 4.1 Background Growth Rate

An annual growth rate of 2.0% per year was applied to existing traffic volumes on Pelham Street to obtain future traffic volumes in the weekday AM and PM peak hours. The existing traffic volumes with the growth rate applied are shown in Figure 5.

## 4.2 Planned Background Developments

Based on discussions with the Town, the only notable development in the study area is 1440 Pelham Street, Fonthill. The development is to contain an additional 12 residential units to add onto the existing commercial floors beneath the residential units to construct four-storey mixed use building. As shown in **Error! Reference source not found.**, trips for the background development were generated by using the Institute of Transportation Engineers (ITE) Trip Generation manuals, 9th Edition, trip rates for the proposed building on Pelham Street. The background development traffic volumes are shown in Figure 6.

Table 5 – Site Trip Generation

| Land Use | | Size | Weekday AM Peak Hour | | | Weekday PM Peak Hour | | |
|---|---|---|---|---|---|---|---|---|
| | | | In | Out | Total | In | Out | Total |
| Residential Condominium | Units: | 12 | | | | | | |
| ITE Code 230 | | Distribution | 17% | 83% | 100% | 67% | 33% | 100% |
| | | Equation | Ln(T)= 0.80Ln(X)+0.26 | | | Ln(T)= 0.82Ln(X)+0.32 | | |
| | | Rate | 0.13 | 0.62 | 0.75 | 0.61 | 0.30 | 0.92 |
| | | Trips | 2 | 7 | 9 | 7 | 4 | 11 |

Source: ITE Trip Generation, 9th Edition, Land Use Code 230 (Residential Condominium/Townhouse)

The background development (at 1440 Pelham Street) is expected to generate a total of 9 two-way trips in the weekday AM peak hour and 11 total trips in the PM peak hour.

Traffic volumes generated by the background development were added to the future background traffic volumes (existing volumes plus estimated traffic growth) to obtain future total traffic volumes for the weekday AM and PM peak hours. The future total traffic volumes for the 2023 horizon year are shown in Figure 7.

## 4.3 Capacity and Vehicle Queuing Analysis

A capacity and vehicle queuing analysis was performed for the study area intersections using Synchro analysis software. The intersection of Pelham Street and Church Hill was modeled as both an unsignalized (all-way stop-controlled) and as a signalized intersection. Capacity and Queue analysis sheets and Level of Service (LOS) definitions are provided in Appendix F and Appendix G, respectively. The capacity analysis and queue results are further summarized in Table 6 and Table 7, respectively.

Table 6 – Capacity Analysis Results, Pelham Street and Church Hill, All-way Stop and Signalized Control

| Intersection Movement | 2023 Total Traffic Conditions | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Unsignalized Condition (Stop Control) | | | | Signalized Condition | | | | | |
| | AM Peak Hour | | PM Peak Hour | | AM Peak Hour | | | PM Peak Hour | | |
| | Delay | LOS | Delay | LOS | V/C | Delay | LOS | V/C | Delay | LOS |
| **Pelham Street and Church Hill** | | | | | 0.38 | 6 | A | 0.48 | 6 | A |
| Eastbound Left | 10 | B | 12 | B | 0.41 | 17 | B | 0.40 | 16 | B |
| Eastbound Right | 15 | B | 22 | C | 0.37 | 4 | A | 0.49 | 5 | A |
| Northbound Left | 10 | B | 28 | D | 0.17 | 3 | A | 0.50 | 5 | A |

For all-way stop controlled intersections, individual movements operating above an LOS of E or above are generally considered critical. Signalized intersections operating at an overall volume-to-capacity (v/c) ratio of 0.90 or above are typically considered critical. The results of our analysis indicate that from a traffic capacity / level-of-service perspective, the intersection could function as either all-way stop controlled or as signalized controlled (with reserve capacity).

Table 7 – Vehicle Queue Analysis Results, Pelham Street and Church Hill, All-way Stop and Signalized Control

| Intersection | Distance to Nearest Upstream Intersection (m) | 95th Percentile Vehicle Queues | | | |
|---|---|---|---|---|---|
| | | Future 2023 Total Conditions (Unsignalized – Stop Control) | | Future 2023 Total Conditions (Signalized) | |
| **Pelham Street and Church Hill Street** | | AM Peak Hour | PM Peak Hour | AM Peak Hour | PM Peak Hour |
| Eastbound Left / Right | 205 | 16 | 13 | 21 | 20 |
| Northbound Left / Through | 101 | 26 | 38 | 56 | 88 |
| Southbound Left / Through | 58 | 19 | 35 | 20 | 33 |

For all-way stop control, the critical intersection vehicle queues in the peak hours are approximately 16m, 26m and 35m for the eastbound, northbound and southbound movements, respectively. Vehicle queues are expected to be fairly minimal and are not likely to block any upstream intersections.

For signalized control, the critical intersection vehicle queues in the peak hours are approximately 21m, 88m and 33m for the eastbound, northbound and southbound movements, respectively. Vehicle queues are not likely to block any upstream intersections. The queues for signalized control (or for a PPS) would likely be longer than for stop control due to the length of time vehicles would be required to wait in queue for the green / walk phase for east-west movements from Church Hill.

## 4.4 All-way Stop Control Warrant Analysis

The warrant for an all-way stop control at the Pelham Street and Church Hill intersection was reviewed based on requirements noted in the OTM guidelines, Book 5. Weekday traffic volumes were obtained from the intersection TMC and conducted by Trans-Plan on Wednesday, January 18, 2018. The critical peak hour reviewed was 5:00pm to 6:00pm, where a total of 904 vehicles were recorded for all approaches (829 vehicles approaching from Pelham Street and 75 vehicles approaching from Church Hill). The warrant results are summarized in Table 8. The supporting data is contained in Appendix H.

Table 8 – All-way Stop Warrant Analysis for a Minor Road Intersection

| All-Way Stop Minimum Volume Warrant for Church Hill | | | |
|---|---|---|---|
| Total Vehicle Volume (peak hour > minimum) | | Volume Split (peak hour < maximum) | |
| Minimum | Peak Hour | Maximum | Peak Hour |
| 350 | 904 | 75/25 | 92/8 |

To warrant an all-way stop, the total vehicle volumes (from all approaches) must exceed 350 vehicles and the directional split (major road / minor road) must exceed 75 / 25. Although the volumes are met (904 vehicles vs. 350 vehicles), the directional split is not met (25 vehicles vs. 8 vehicles). An all-way stop control at the intersection is therefore, not warranted.

We note that stop signs should only be used where warranted since they can cause substantial inconvenience to motorists. As noted from our review of on-line Department of Transportation documents and experience working with municipalities, improper signing and ignoring the warrants create dangerous conditions for both drivers and pedestrians. Engineering studies indicate that the inappropriate installation of extra stop signs (within a road network) may cause additional problems, such as:

- drivers accelerating between intersections to make up for time lost at the stop sign
- increased rear-end collisions
- a redistribution of traffic onto side streets
- noise pollution and wasted fuel (due to deceleration and acceleration)
- non-compliance issues (i.e. drivers ignoring the inappropriately placed stop signs due to a lack of cross-street traffic)

## 4.5 Traffic Signal Warrant Analysis

A signal warrant analysis was completed based on the OTM guidelines, Book 12 – Traffic Signals. Weekday traffic volumes were obtained from Wednesday, January 18, 2018 TMC and conducted by Trans-Plan. The AM peak hour occurred between 11:00 am and 12:00pm and the PM peak hour occurred between 17:00 pm and 18:00 pm. The all-approach volumes and count hours assessed are shown in Table 9 and the signal warrant analysis results are shown in Table 10. The supporting data is contained in Appendix H.

Table 9 – Weekday 8-Hour Volume Counts

| | | | AM Peak | | | | | PM Peak |
|---|---|---|---|---|---|---|---|---|
| Hour Ending: | 8:00 | 9:00 | 12:00 | 13:00 | 14:00 | 16:00 | 17:00 | 18:00 |
| Existing Traffic Volumes | 417 | 750 | 770 | 768 | 647 | 823 | 893 | 922 |
| Percent of Peak Hour | 54% | 97% | 100% | 83% | 70% | 89% | 97% | 100% |

Table 10 – Traffic Signal Warrant Analysis Results, Pelham Street and Church Hill

| Signal Warrant Results | Future 2022 Total Conditions | | |
|---|---|---|---|
| | Required | Satisfied | Warrant Met? |
| 1 – Minimum Vehicular Volume | 100% | 41% | No |
| 2 – Delay to Cross Traffic | 100% | 60% | No |
| Combination Warrant (1 & 2) | 80% | 41% | No |
| Overall Result | | | No |

Our results indicate that a traffic signal at Pelham Street and Church Hill intersection would not be warranted on a weekday under future conditions. The minimum vehicular volume is 41% out of the required 100% under Justification 1, the delay to cross traffic is 60% out of the required 100% under Justification 2, and the combination warrant is 41% out of the required 80% under the Combination Warrant.

As shown in Table 11, the number of pedestrian crossings (for the 8-hour period) was also reviewed to see if warrants would be met for a traffic signal.

Table 11 – Signal Warrant based on Pedestrian Volumes, Pelham Street and Church Hill

| 8 Hour Vehicular Volume $V_8$ | | Net 8 Hour Pedestrian Volume | | | | |
|---|---|---|---|---|---|---|
| | | < 200 | 200 - 275 | 276 - 475 | 476 - 1000 | >1000 |
| Justification 6A | < 1,440 | 78 pedestrians counted: Not Justified | | | | |

The 8-hour pedestrian volume count is 78 pedestrians, which is less than the minimum threshold of 1,440 pedestrians over the count period. A traffic signal is not warranted at the Pelham Street and Church Hill intersection.

# 5. SUMMARY AND RECOMMENDATIONS

This review of the Pedestrian Priority Signal (PPS) at the intersection of Pelham Street at Church Hill in Fonthill is summarized as follows:

## 5.1 Summary

- Trans-Plan reviewed background documentation and conducted current traffic counts and surveys at the study area intersections. The following surveys and results are noted:
  - Pedestrian Crossing Study: 91 pedestrians crossed either at or in the vicinity the PPS during the 8-hour count period. Of the 40 pedestrians that crossed at the PPS, 27 crossed during the “walk” phase, resulting in a fairly low compliance rate of 67.5 percent.
  - Pedestrian Crossing Observations: two vehicle-pedestrian conflicts were observed; the issue for one of the incidents resulted from a vehicle exiting the on-street parking near the PPS.
  - Vehicle Queue Study: there were no issues of vehicle queues at the Pelham Street at Church Hill intersection extending to upstream / downstream intersections. Vehicles tend to clear after each cycle.
  - Collision History Review: there was only one reported collision that occurred at the Pelham Street at Church Hill intersection; based on collisions, the intersection would not be susceptible to correction by adding all-way stop control or signalized control.
  - Driver Sight Distance Review: there is adequate visibility from the approach at Church Hill to see vehicles travelling in the northbound and southbound directions along Pelham Street; however, when vehicles are parked along the west side of Pelham Street, the visibility becomes limited.
- To establish future operating conditions for a five-year study horizon, roadway traffic was increased by 2% per year and traffic for the one notable background development, 1440 Pelham Street, was included in our traffic model.
- Synchro analysis software was used to model the intersection as both all-way stop control and as signalized control. Both methods of intersection control would operate acceptably; however, from our warrant analysis (using OTM guidelines), neither control type is warranted due to low pedestrian crossing volumes and due to comparatively low volumes of traffic entering the intersection from the minor street, Church Hill.

## 5.2 Recommendations

Despite the traffic signal warrant analysis not being met according to the provisions of OTM, there are very rare cases where the engineer's study finds no satisfaction of numerical warrants, but finds other special conditions that result in a conclusion that a signal is the best solution compared to other possible alternatives. According to the conditions of the intersection, the OTM indicates "should not" rather than a "shall not" for the very reasons discussed above. It is important to note that a politically dictated unwarranted signal installation (or all-way stop installation) may not be the best recommended solution.

Installing an all-way stop control for the Pelham Street and Church Hill intersection, when not warranted, may lead to other unintended consequences, such as non-compliance issues.

Another traffic signal warrant analysis could be conducted again over the summer/spring season, as there is a greater chance of higher pedestrian volumes crossing at the PPS due to warmer weather conditions; however, given the 8-hour volumes of 78 pedestrians in the winter and the required volume of 1,440 pedestrians, it is unlikely that the warrant would be met.

We agree with the Town's comment that drivers approaching northbound onto Pelham Street from Church Hill may not see the traffic signals on the north leg of Pelham due to the placement of the PPS; however, (in addition to the existing stop sign for the eastbound approach) we suggest adding enhancements to the crossing location to address this. Our traffic and safety recommendations at the Pelham Street at Church Hill intersection are as follows:

- Remove on-street public parking within a minimum of 10m from the intersection (and within the intersection)
- Introduce a raised crosswalk to enhance the PPS crossing location and improve pedestrian safety. An example is provided in Figure 8.

Respectfully submitted,

Anil Seegobin, P.Eng.
Partner, Engineer

Trans-Plan Transportation Inc.
Transportation Consultants

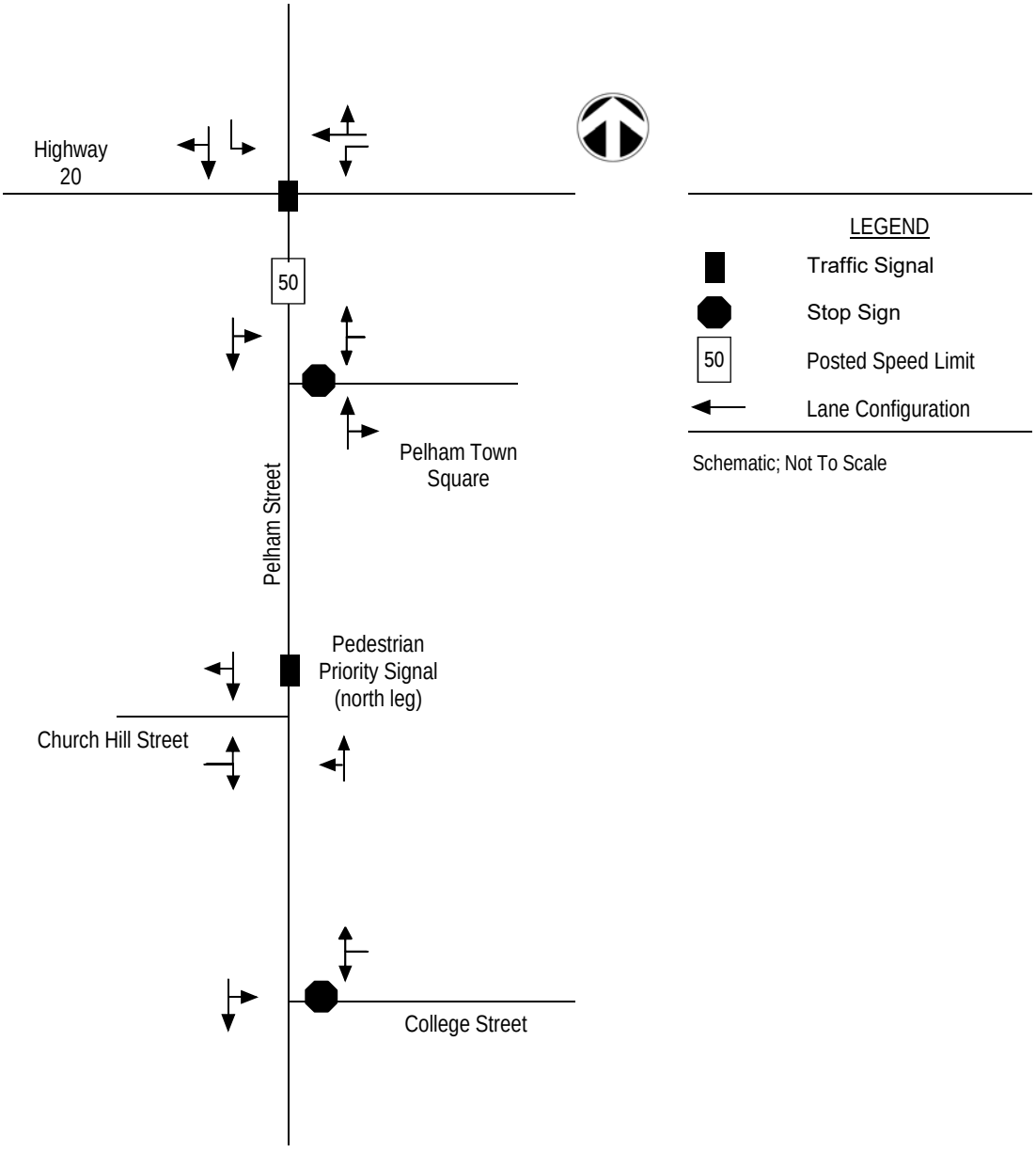
Figure 1 – Study Area Map


Source: Google Maps

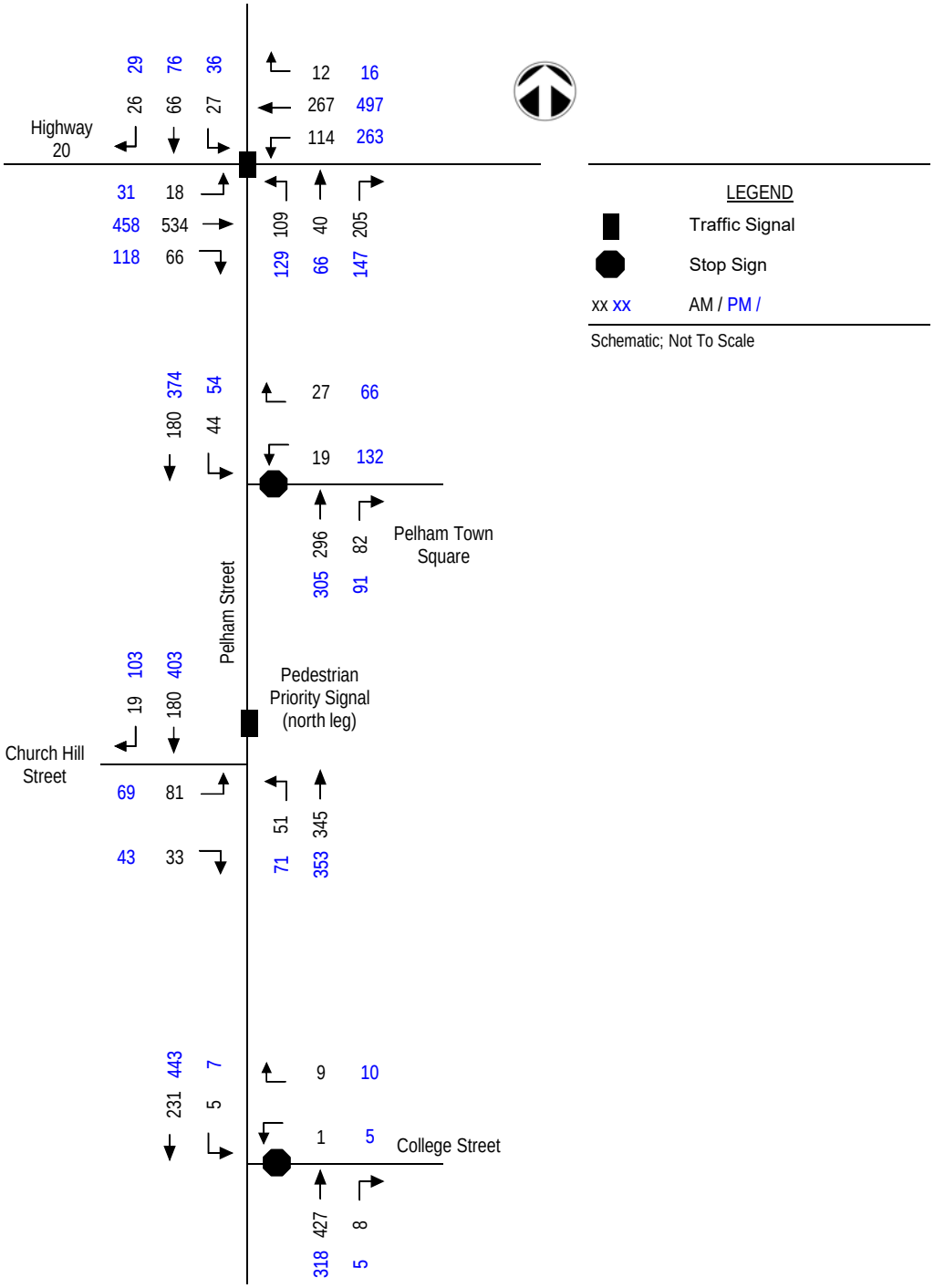
Figure 2 – Looking North along Pelham Street from Southwest corner of Church Hill


Source: Google Maps

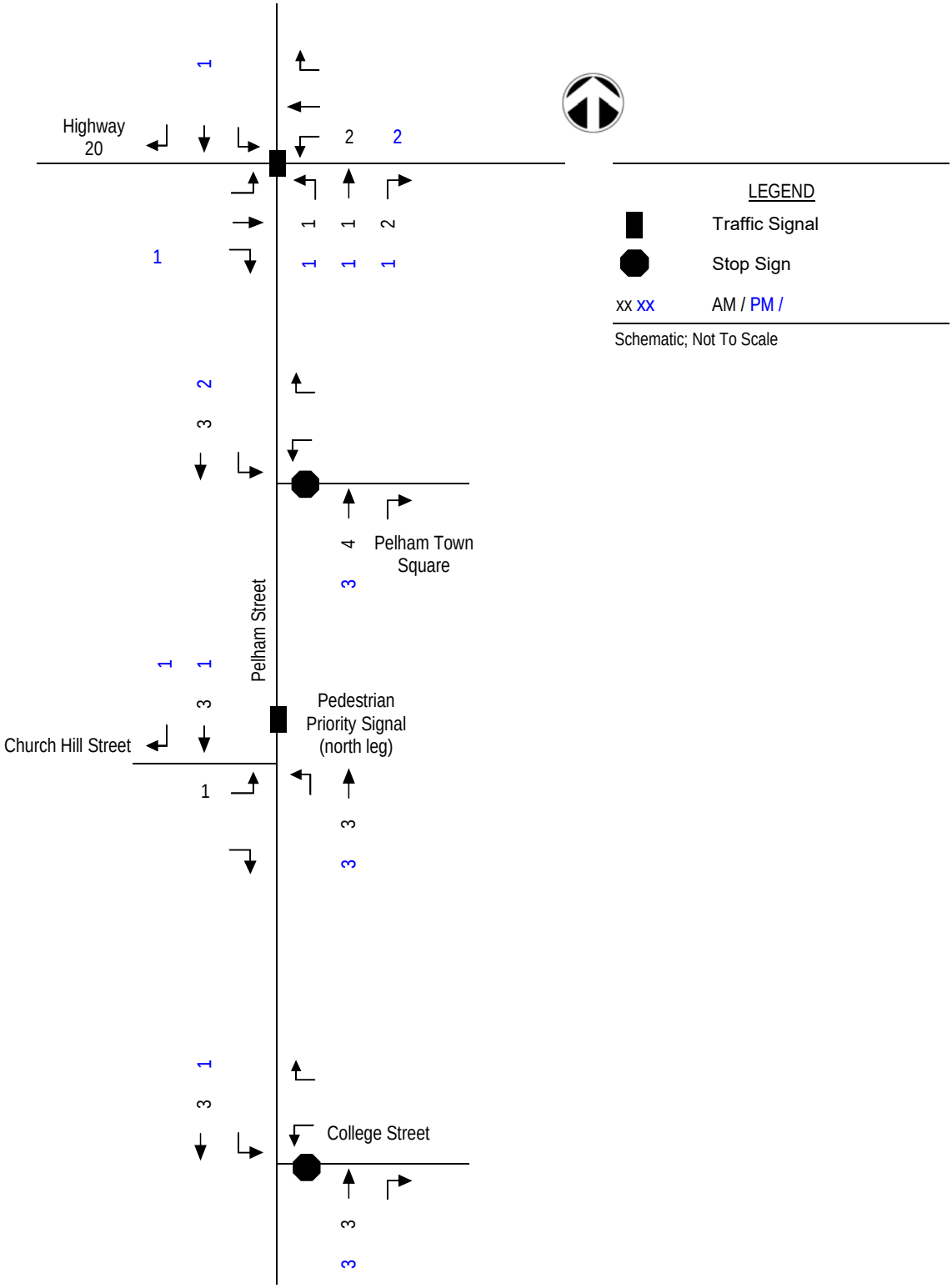
## Figure 3: Study Area Roadway Characteristics



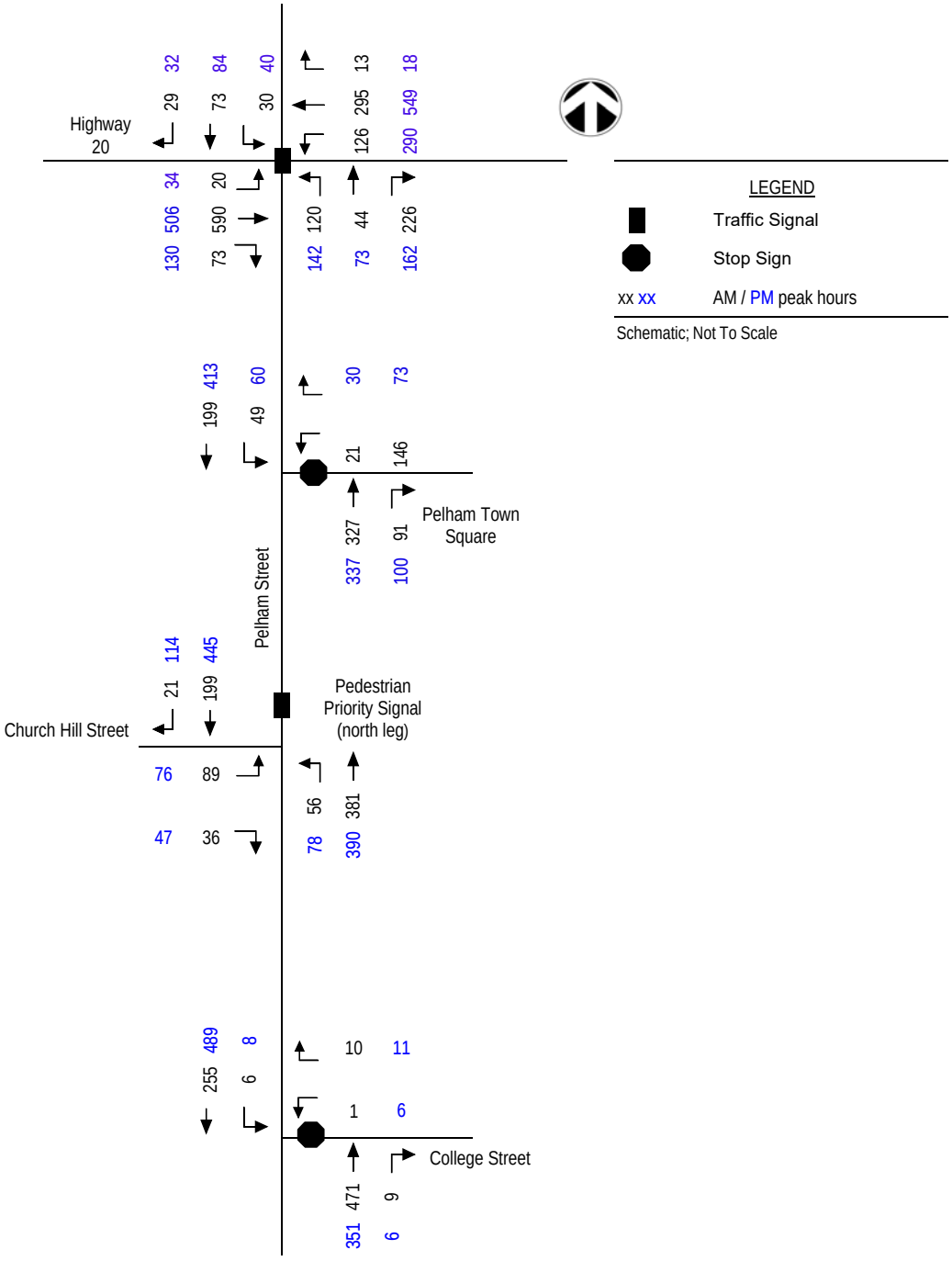
## Figure 4: Existing Traffic Volumes, Weekday AM and PM Peak Hours



## Figure 5: Development Traffic Volumes, Weekday AM and PM



# Figure 6: Growth Traffic Volumes, Weekday AM and PM



## Figure 7: 2023 Total Traffic Volumes Weekday AM and PM

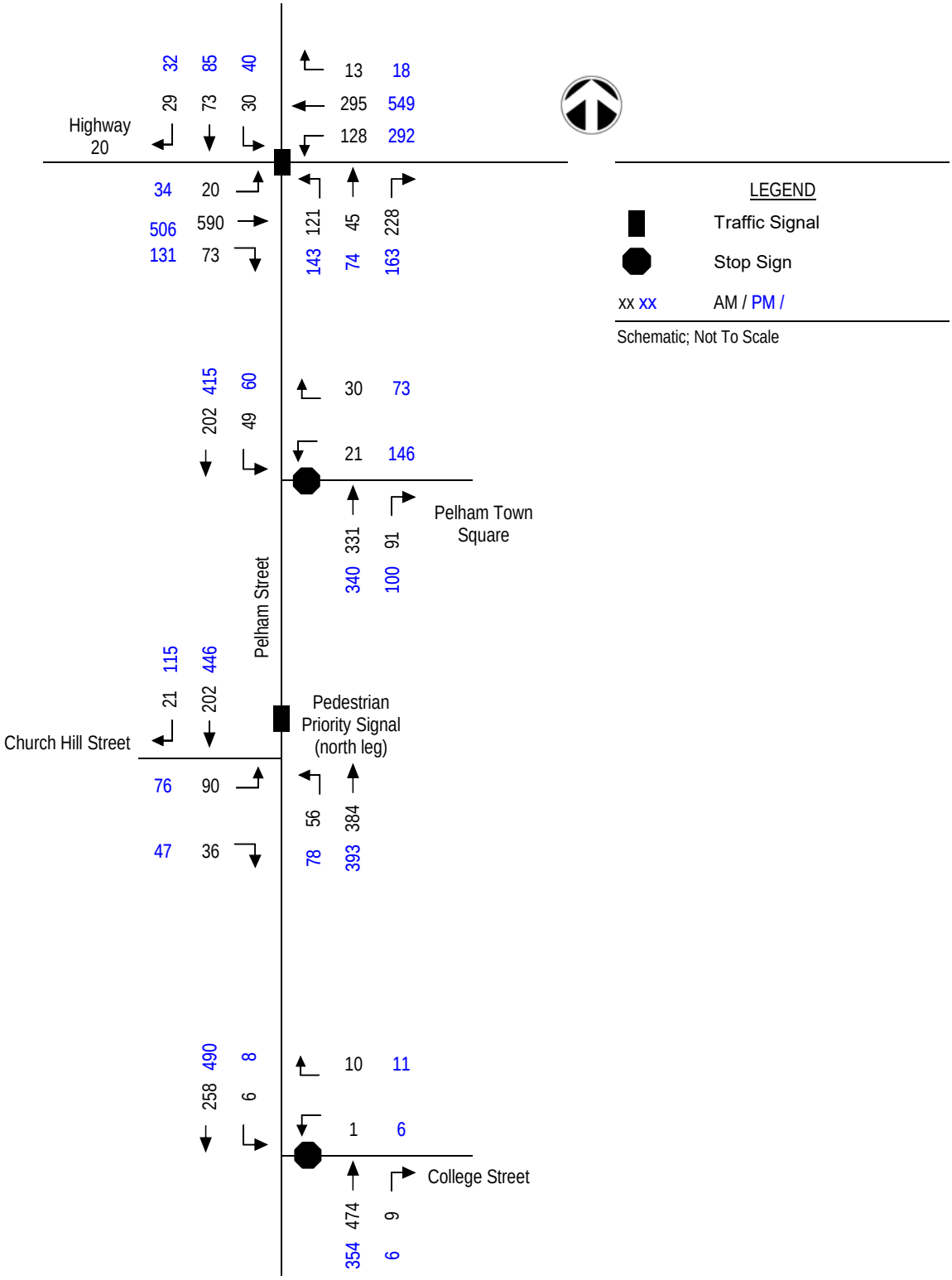


Figure 8 – Example of Raised Asphalt Crosswalk

Source: Google Images

APPENDICES

Appendix A – Background Information

Appendix B – Intersection Drawing of Pedestrian Priority Signal

Appendix C – Turning Movement Counts and Signal Timing

Appendix D – Vehicle Queueing and Pedestrian Crossing Surveys

Appendix E – Driver Sight Distance Review

Appendix F – Capacity and Queue Analysis Sheets

Appendix G – Level of Service Definitions

Appendix H – All Way Stop and Signal Warrant Analysis

# APPENDIX A

Background Information

-

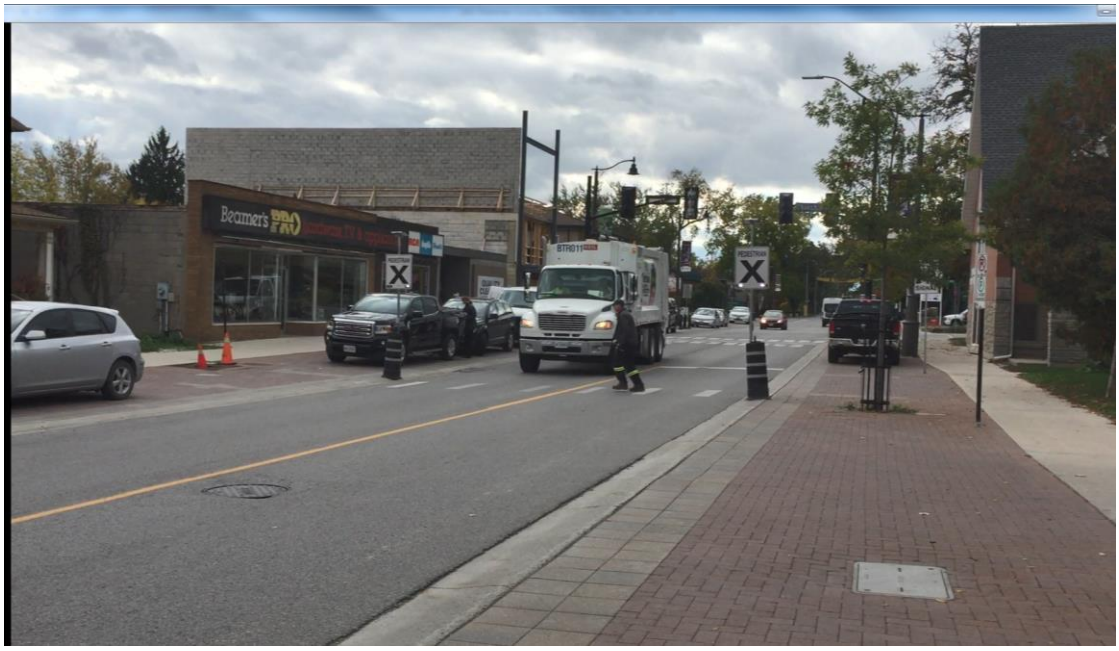



Figure 2 Pilot crossing October 2016

Pilot PXO observations:

- Video, drone footage, photos, staff, public and PATC observations were reviewed, and compared to that from the PPS.
- The PXO stopped most vehicles travelling north/south with the activation of the flashing lights.
- Some of the vehicles stopped if the lights were not activated but a pedestrian stood at the road side.
- A few vehicles stopped if the lights were activated but no pedestrian was there.
- On-street parking made visibility difficult for pedestrians and drivers. Without the pedestrian using 'body language' to indicate an intention to cross, especially when parking spaces were occupied, it was sometimes difficult for the driver to see the pedestrian.
- In addition, the conflict with driveway accesses and Pelham Town Square made moving vehicles a challenge for the pedestrian to stay aware.
- PXOs, with or without flashing lights, require some degree of driver and pedestrian education (eye contact from pedestrian to driver, pedestrian showing intention to cross by standing/waiting/motioning)

- Signage and flashing lights would be recommended to increase visibility of a mid-block PXO. (PXOs can also be built in other formats, depending on the number of lanes, traffic direction and location of crossing).
- The Pelham Active Transportation Committee did not strongly support the mid-block crossing pilot, and did not feel it was a safer option than the fully signalized intersection.
- Stacking/lineup of vehicles stopped for the PXO crossing, when activated, was not observed to be excessive in morning or evening rush hour time, due to its short duration.
- The 2009 Fonthill Traffic Study (by R and R Associates Inc.) does suggest that future modifications to on-street parking on Pelham Street consider the need for proper sight lines at the intersections of Church Hill and of Pelham Town Square (p. 86). No corrections to sight lines were made with the Pelham Street reconstruction project.

PPS observations

- The PPS consistently stops all vehicles travelling north/south with the red light, but does not consistently stop all vehicles turning north onto Pelham from Church Hill.
- The time settings for the activation of the PPS and the crossing time appear to be adequate, and are consistent with those across the Region.
- Stacking/lineup of vehicles stopped for the crossing light, when activated, is not excessive in morning or evening rush hour time. However, the 2009 Fonthill Traffic Study notes that the signal, based on 2009 volumes, does not meet minimum spacing standards for proximity to Highway 20.
- The report suggests a three lane cross section for Pelham between Highway 20 and Church Hill to improve safety, and also suggests calming measures be considered to slow speeds, reduce volumes and reduce pedestrian/traffic conflicts in the downtown core (it notes the collisions recorded to 2009 in this commercial area are directly related to accesses, side streets and parking movements). Sight lines due to on-street parking were also identified as needing correction. To date, a two-way signal was installed, rather than three, and no calming measures or sight line improvements have been made.

- Installation of a new PXO mid-block, with pedestrian-activated side-mounted amber beacon lights (type C) was quoted at approximately $12,000 at a Southern Ontario municipality in 2016. Both of these mid-block options were not considered further at this time, due to the existing conflict with on-street parking, traffic speeds and sight lines.

- A 3-way stop at the intersection could be considered, instead of traffic signals, but stacking of vehicles, especially during rush hours, is anticipated to be considerable, and could affect sightlines for drivers and those using on-street parking to park and exit their vehicles.

  Although the pilot PXO was considered an innovative attempt to overcome crossing challenges, without additional larger-scale calming and sight line correction measures for the downtown core, a mid-block crossing may prove unsuccessful as an improvement.

  **As the creative problem solving process led staff to identify safer pedestrian crossing on Pelham Street as the challenge, the boxed solution is to fully signalize the intersection at Church Hill and Pelham Street. This capital cost can be considered with the 2018 Road Capital Budget request.**

The Challenge:

How might we allow pedestrians to cross Pelham Street safely in the downtown core?

How might we calm the downtown core to allow safer crossing of pedestrians and traffic from accesses and side streets?

Our Recommended Solution:

BE IT RESOLVED that Committee of the Whole receive the Public Works Report 'Safer Pedestrian Crossing on Pelham Street' for information.

Rationale:

Installation of a fully signalized intersection will reduce the risk of pedestrian collision at an existing pedestrian crossing.

Measure of Success:

These include: Fewer near-miss reports by pedestrians, the public, the PATC and staff, at the intersection of Church Hill and Pelham Street, and a safer, calmer downtown core.

# 8. CONCLUSIONS AND RECOMMENDATIONS

## 8.1 Conclusions

The following discussion lists the conclusions drawn from background data, field inventories and subsequent analyses of traffic data and collision history within the Fonthill Traffic Study primary and secondary study areas.

1. Based on field inventories conducted on March 24, and 25, 2009, a review of the available departure sight distance at the STOP controlled (two-way and all-way) intersections concluded that the majority of the two-way STOP controlled intersections currently have differing degrees of restricted sight lines, due in most part, to a variety of obstructions within the sight triangles (i.e. trees, bushes, signs, hydro poles, the presence of parked vehicles and building structures). Notable intersections where restricted sight lines are more problematic include Pelham Street at Pelham Town Square (westbound direction) and Station Street at Hurricane Road (northbound direction). In most cases, the recommended sight lines can be improved by removing obstacles within the sight triangles.

2. Roadways carrying the heaviest two-way 24 hour traffic volumes included Regional Road 20 (17,700 vpd), Pelham Street (10,251 vpd), Rice Road (4,940 vpd), Pelham Town Square (3,967 vpd), Port Robinson Road (3,188 vpd), Church Hill (2,847 vpd), Pancake Lane (2,794 vpd), and Station Street (2,077 vpd).

3. Historical and recent spot speed surveys (conducted on April 2, 2009) indicated that drivers traveling on Town and Region roads generally disregard posted speed limits. The average percentage compliance for all roadways combined, was found to be 38 percent with a median value of 42 percent compliance.

4. The operational performance of the existing intersections (signalized and unsignalized) within the study area indicated that the majority of intersections are operating at acceptable levels of service with reasonable delays with the exception of a number of critical movements at several intersections. Notable delays are experienced within the Regional Road 20 corridor in the eastbound (morning peak hour) and westbound (afternoon peak hour) directions due to the higher volumes of traffic exiting and entering Fonthill during peak times with only one through lane in each direction to accommodate the traffic volumes. Due to the lack of available gaps in through traffic, left turn manoeuvres are problematic for Pelham Town Square westbound (PM peak hour), Port Robinson Road westbound (PM peak hour), Pancake Lane eastbound (AM and PM peak hour), and Hurricane Road south-eastbound (all peak hours). Several driveways accesses also experience poor levels of service and longer delays for left turning traffic; however, traffic queues are accommodated within the private sites in each case.

5. The operational performance of the existing intersections (signalized and unsignalized) within the study area including remedial measures and programmed roadway improvements indicated that through movements within the Regional Road 20 corridor will be improved; however, the eastbound (AM peak hour) and westbound (PM peak hour) through movements at the intersection of Pelham Street and Regional Road 20 will experience lower levels of service and longer delays due to the sheer volume of traffic utilizing only one lane in each direction. The length of the eastbound traffic queues may cause blockages from time to time of the Canboro Road/Regional Road 20 intersection during the morning peak hour. Left turn manoeuvres at the unsignalized intersections will be improved; however, the

unsignalized intersection at Hurricane Road and Regional Road 20 will still experience longer delays during the afternoon peak hour.

6. The potential installation of traffic signal control at the Church Hill/Pelham Street intersection can be accommodated. Although signal spacing between Regional Road 20 and Church Hill does not meet minimum standards, from a traffic operations perspective (based on existing 2009 traffic volumes), a traffic signal at this location will operate effectively. Suggested improvements in conjunction with a new traffic signal at this location include a three lane cross section from Regional Road 20 to south of Church Hill and signal coordination with the existing traffic signals at Regional Road 20.

7. A review of traffic control warrants for Port Robinson Road-Brock Street/Pelham Street (potential for the installation of traffic signals), Pancake Lane-John Street/Pelham Street (potential for the installation of traffic signals), Hurricane Road/Station Street (potential for the installation of an All-way STOP control), and Station Street/Port Robinson Road (review of current All-way STOP control) indicated that, based on the collected traffic data, none of the aforementioned intersections currently meet warrants. In the case of a new traffic signal installation at the Port Robinson Road-Brock Street/Pelham Street intersection, additional factors should be considered as part of the justification process beyond the traffic signal warrant including safety issues, traffic operations, physical, and strategic considerations. From a safety perspective, the installation of traffic signals may help slow traffic (based on a review of the spot speed survey on Pelham Street), reduce the probability and severity of collisions involving right-of-way conflicts, and provide a safe crossing for pedestrians and school children. From a traffic operations perspective, new traffic signals would improve traffic operations without exhibiting any detrimental affects to either the intersection or transportation network as a whole.

8. There are a number of Context Sensitive Solutions and traffic calming principles and practices that could be applied to the revitalization of the downtown core encompassing elements associated with roadside design, the traveled way, and intersections. Traffic calming, focused on measures that could be considered to slow traffic speeds, reduce traffic volumes, and reduce pedestrian/traffic conflicts within the downtown core could also be applied where warranted.

9. Based on a review of reported collision data, 135 collisions occurred in the study area of which about 21% occurred at the intersections and about 18% were intersection related. The remaining collisions were either non-intersection related or occurred at a private driveway, parking lot, or other location. There were no fatal collisions reported. Four percent were non-reportable, 14% were non-fatal injuries, and 82% were property damage only collisions. From a statistical significance point of view, only the section of Regional Road 20 from Pelham Street to Station Street was determined to be of concern. The majority of collisions that occurred within the Regional Road 20 corridor were single motor vehicle and rear end collisions (52%) with the remainder being made up of sideswipe, turning movement, or overtaking type collisions. In most cases, the collision experience at each of the intersections and roadway segments was similar to or less than that of the Ontario average collision experience. The two main safety issues are likely to be managing speed along Regional Road 20 and Pelham Street, as motorists transition from rural to urban conditions, and managing access and parking in the commercial part of the study area. On Pelham Street, south of Regional Road 20, the collisions recorded in the commercial area are directly related to accesses, side streets, and parking movements.

a. Provision of a new north-south pedestrian sidewalk along the west side of Pelham Street from Elizabeth Drive to Brock Street, as a minimum, to tie into the future signalized intersection configuration at the intersection of Pelham Street and Brock Street/Port Robinson Road;

b. Provision of a new east-west sidewalk facility with the reconstruction of Brock Street and Elizabeth Drive to ensure pedestrians have safer access to local residential neighbourhoods;

c. Upgrading of existing sidewalk facilities (east side of road) and provide additional sidewalk on the west side of Station Street with the future upgrading of the roadway. A future sidewalk on the west side of Station Street could be tied into future upgrades to the Steve Bauer Trail in this location;

d. Cycling on Town roads and on existing trail facilities is currently permitted and should be further encouraged through the provision of wider pavements and/or on- and off-street cycling facilities where practical; and

e. Formalize and provide connectivity for the Steve Bauer Trail from Regional Road 20 to Port Robinson Road.

6. The installation of a new traffic signal at the Port Robinson Road-Brock Street/Pelham Street intersection would need to be justified based on other factors, beyond a strictly technical justification (i.e. traffic signal warrant), including safety issues, traffic operations, physical, and strategic considerations.

7. The future installation of a new traffic signal at the Church Hill/Pelham Street intersection could be accommodated from a traffic operations perspective and would provide a safe crossing location for pedestrians within the downtown area. It is recommended that, as part of a future traffic signal installation at this location, the roadway cross section elements on Pelham Street between Regional Road 20 and Church Hill be reviewed along with the need to coordinate the existing traffic signal timings at Regional Road 20 with the future traffic signal timings at Church Hill.

The built urban environment along Pelham Street is highly supportive to pedestrian travel. The complete street design allows the Town to increase its capacity to hold special events and festivals while maximizing on-street parking during non peak periods. January 2017 count data indicates low pedestrian volumes; could be the result of the winter season.

Street furniture located along both sides of Pelham Street in proximity to the site driveway connections and the municipal roadway, Pelham Town Square, intersections have the potential to limit the available sightlines for motorists.

The Town is currently reviewing pedestrian safety at the pedestrian actuated traffic control signal at the Church Hill intersection with Pelham Street. The Town will consider the recommendations from the safety review for possible implementation.

To support multi-modal transportation within the Town of Pelham and through the Town from a Regional perspective, the provision of identifiable cycling infrastructure could be considered by the Town.

## Recommendations

Based on the forgoing the following is recommended:

- On-street parking within 30 metres of the pedestrian signal at Church Hill be removed.
- The Town consider the need for stop control on the site driveway approach to Pelham Street. The requirement for stop sign control on private driveways should be applied consistently throughout the Town.
- Both site driveway connections be signed with Do Not Enter signage to support the one-way operation.
- Signage be provided on the driveway approaches near the building corners to warn drivers of potential pedestrian activity
- No improvements to the existing form of two-way stop control is recommended at the Pelham Street intersections with Pelham Town Square and Church Hill.
- The Town should implement the recommendations from the safety review of the pedestrian actuated traffic control signal.
- The Town consider utilizing an alternative colour of paving stones to identify driveway connections to Pelham Street.
- The two on-street parking spaces across the site's frontage be removed.
- The Town consider designating Pelham Street as a signed bicycle route. Pavement markings and signage should confirm to the OTM.

Based on the findings of this study, no other roadway or traffic control improvements are required or recommended to accommodate the future traffic within the study area.

RUSIT
&
ASSOCIATES LTD.

25 Meadowvale Dr.
Unit #6, Fonthill, ON,
L0S 1E4

ierfinofrank@gmail.com
289 607 0018

July 31 2017

Town of Pelham
20 Pelham Square
P.O. Box 400
Fonthill, Ontario
L0S 1E0

**Re: Stacking of Southbound Vehicles on Pelham Street (Between Church Hill and Highway 20)**
**Pelham Street**
**Town of Pelham**

**Attention: Derek Young, C. Tech.**
**Supervisor of Engineering**

Dear Mr. Young

We have reviewed the stacking of vehicles driving southbound on Pelham Street and Traffic report provided below for Fonthill Traffic.

| No. | Description | Issued | Received |
|---|---|---|---|
| 1. | Fonthill Traffic Study Final Report by R & R Associates Inc. | September, 2009 | July 20, 2017 |

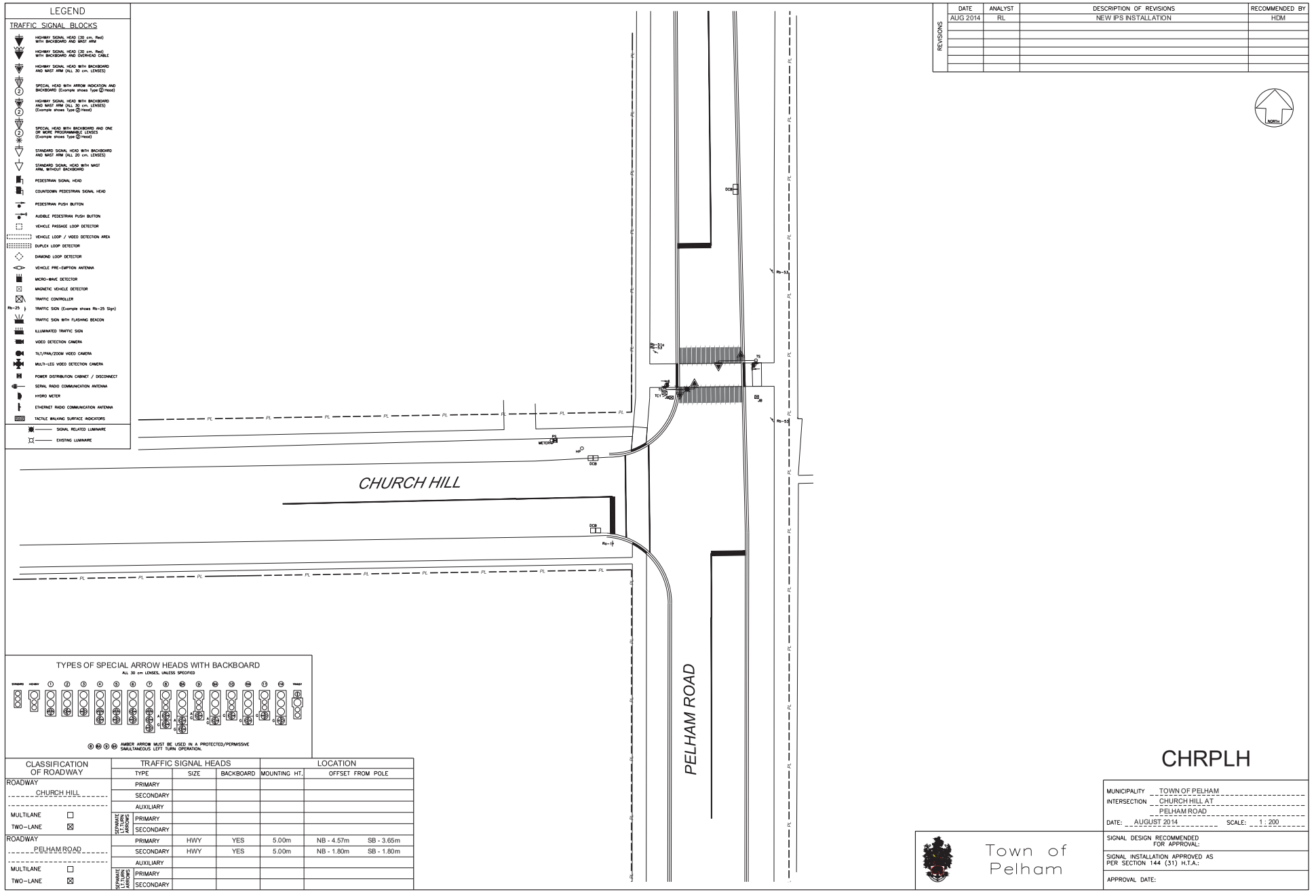
From our review of the Fonthill Traffic Report I have the following comments.

1) The OTM 13 recommends a minimum distance between signalized intersections of 215 metres for roads posted 60km/hr. The distance between Highway 20 and Church Hill is 179m, which does not meet this minimum spacing of 215m between signalized intersections.
2) The installation of new traffic lights at Church Hill and South Pelham Road will slightly improve the traffic operations of left turn movements from Pelham Town Square to South Pelham Road for PM peak hour conditions from LOS F to LOS E.
3) The review of Traffic Queues for PM peak hour for the southbound 95$^{th}$ percentile on South Pelham Road at Church Hill intersection for the through movement was estimated to be 48 metres. Based on my field observations the queuing reaches Highway 20 on South Pelham Road (estimated queuing of 150 metres) on South Pelham Road at the Church Hill intersection during the PM peak hour conditions. See attach photos for queuing on South Pelham Road.

# APPENDIX B

Intersection Drawing of Pedestrian Priority Signal

CHRPLH




| REVISIONS | DATE | ANALYST | DESCRIPTION OF REVISIONS | RECOMMENDED BY |
|---|---|---|---|---|
| | AUG 2014 | RL | NEW IPS INSTALLATION | HDM |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

NORTH

TYPES OF SPECIAL ARROW HEADS WITH BACKBOARD

ALL 30 cm LENSES, UNLESS SPECIFIED

STANDARD HIGHWAY ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑧A ⑨ ⑨A ⑩ ⑩A ⑪ ⑪A TRANSIT

⑧ ⑧A ⑨ ⑨A AMBER ARROW MUST BE USED IN A PROTECTED/PERMISSIVE SIMULTANEOUS LEFT TURN OPERATION.

| CLASSIFICATION OF ROADWAY | | TRAFFIC SIGNAL HEADS TYPE | SIZE | BACKBOARD | LOCATION MOUNTING HT. | OFFSET FROM POLE |
|---|---|---|---|---|---|---|
| ROADWAY CHURCH HILL | | PRIMARY | | | | |
| | | SECONDARY | | | | |
| | | AUXILIARY | | | | |
| MULTILANE ☐ | SEPARATE LEFT-TURN ARROWS | PRIMARY | | | | |
| TWO-LANE ☒ | | SECONDARY | | | | |
| ROADWAY PELHAM ROAD | | PRIMARY | HWY | YES | 5.00m | NB - 4.57m SB - 3.65m |
| | | SECONDARY | HWY | YES | 5.00m | NB - 1.80m SB - 1.80m |
| | | AUXILIARY | | | | |
| MULTILANE ☐ | SEPARATE LEFT-TURN ARROWS | PRIMARY | | | | |
| TWO-LANE ☒ | | SECONDARY | | | | |

# CHRPLH

MUNICIPALITY TOWN OF PELHAM

INTERSECTION CHURCH HILL AT PELHAM ROAD

DATE: AUGUST 2014 SCALE: 1 : 200

Town of Pelham

SIGNAL DESIGN RECOMMENDED FOR APPROVAL:

SIGNAL INSTALLATION APPROVED AS PER SECTION 144 (31) H.T.A.:

APPROVAL DATE:

DRAWING FILE: P:\PW_SIGNALS\Municipal\Pelham\cad\CHRPLH\drawings sent\2014 12 11_Legal_to Al Monnet\CHRPLH_LEGAL.dwg PLOTTED: Dec 11, 2014 - 10:48am PLOTTED BY: chatzis

# APPENDIX C

Turning Movement Counts and Signal Timing Plans

# Turning Movement Count - Details Report (15 min)

**Location.....** Highway 20 @ Pelham Street

**Municipality.....** PELHAM

**Count Date.....** Thursday, June 08, 2017

| | | Pelham Street | | | | | | | | | | Highway 20 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North Approach | | | | | South Approach | | | | | East Approach | | | | | West Approach | | | | |
| Time Period | | LT | TH | RT | U-Turn | TOT | LT | TH | RT | U-Turn | TOT | LT | TH | RT | U-Turn | TOT | LT | TH | RT | U-Turn | TOT |
| 07:00 | 07:15 | 2 | 9 | 3 | 0 | 14 | 16 | 1 | 37 | 0 | 54 | 12 | 41 | 2 | 0 | 55 | 2 | 74 | 6 | 0 | 82 |
| 07:15 | 07:30 | 5 | 6 | 2 | 0 | 13 | 18 | 3 | 39 | 0 | 60 | 15 | 46 | 2 | 0 | 63 | 2 | 95 | 11 | 0 | 108 |
| 07:30 | 07:45 | 6 | 14 | 12 | 0 | 32 | 18 | 7 | 38 | 0 | 63 | 19 | 54 | 0 | 0 | 73 | 3 | 133 | 14 | 0 | 150 |
| 07:45 | 08:00 | 7 | 11 | 10 | 0 | 28 | 31 | 7 | 49 | 0 | 87 | 23 | 60 | 5 | 0 | 88 | 6 | 120 | 15 | 0 | 141 |
| Hourly Total | | 20 | 40 | 27 | 0 | 87 | 83 | 18 | 163 | 0 | 264 | 69 | 201 | 9 | 0 | 279 | 13 | 422 | 46 | 0 | 481 |
| 08:00 | 08:15 | 7 | 14 | 4 | 0 | 25 | 20 | 5 | 50 | 0 | 75 | 22 | 56 | 3 | 0 | 81 | 6 | 123 | 13 | 0 | 142 |
| 08:15 | 08:30 | 3 | 13 | 5 | 0 | 21 | 31 | 9 | 51 | 0 | 91 | 19 | 55 | 4 | 0 | 78 | 6 | 145 | 22 | 0 | 173 |
| 08:30 | 08:45 | 9 | 19 | 12 | 0 | 40 | 22 | 7 | 47 | 0 | 76 | 35 | 79 | 1 | 0 | 115 | 4 | 134 | 21 | 0 | 159 |
| 08:45 | 09:00 | 8 | 20 | 5 | 0 | 33 | 36 | 19 | 57 | 0 | 112 | 38 | 77 | 4 | 0 | 119 | 2 | 132 | 10 | 0 | 144 |
| Hourly Total | | 27 | 66 | 26 | 0 | 119 | 109 | 40 | 205 | 0 | 354 | 114 | 267 | 12 | 0 | 393 | 18 | 534 | 66 | 0 | 618 |
| 11:00 | 11:15 | 12 | 12 | 5 | 0 | 29 | 36 | 16 | 38 | 0 | 90 | 35 | 84 | 7 | 0 | 126 | 5 | 94 | 18 | 0 | 117 |
| 11:15 | 11:30 | 8 | 14 | 4 | 0 | 26 | 32 | 9 | 35 | 0 | 76 | 46 | 92 | 2 | 0 | 140 | 6 | 101 | 19 | 0 | 126 |
| 11:30 | 11:45 | 11 | 11 | 6 | 0 | 28 | 29 | 20 | 35 | 0 | 84 | 37 | 104 | 6 | 0 | 147 | 4 | 91 | 16 | 0 | 111 |
| 11:45 | 12:00 | 6 | 25 | 7 | 0 | 38 | 24 | 16 | 22 | 0 | 62 | 45 | 102 | 5 | 0 | 152 | 8 | 115 | 19 | 0 | 142 |
| Hourly Total | | 37 | 62 | 22 | 0 | 121 | 121 | 61 | 130 | 0 | 312 | 163 | 382 | 20 | 0 | 565 | 23 | 401 | 72 | 0 | 496 |
| 12:00 | 12:15 | 12 | 20 | 5 | 0 | 37 | 27 | 11 | 45 | 0 | 83 | 40 | 80 | 7 | 0 | 127 | 5 | 105 | 16 | 0 | 126 |
| 12:15 | 12:30 | 9 | 13 | 3 | 0 | 25 | 31 | 13 | 40 | 0 | 84 | 37 | 72 | 9 | 0 | 118 | 7 | 104 | 19 | 0 | 130 |
| 12:30 | 12:45 | 13 | 11 | 6 | 0 | 30 | 21 | 6 | 35 | 0 | 62 | 36 | 82 | 8 | 0 | 126 | 6 | 94 | 18 | 0 | 118 |
| 12:45 | 13:00 | 7 | 15 | 8 | 0 | 30 | 31 | 12 | 31 | 0 | 74 | 38 | 97 | 7 | 0 | 142 | 6 | 102 | 26 | 0 | 134 |
| Hourly Total | | 41 | 59 | 22 | 0 | 122 | 110 | 42 | 151 | 0 | 303 | 151 | 331 | 31 | 0 | 513 | 24 | 405 | 79 | 0 | 508 |
| 13:00 | 13:15 | 9 | 18 | 2 | 0 | 29 | 29 | 15 | 43 | 0 | 87 | 41 | 81 | 7 | 0 | 129 | 5 | 96 | 23 | 0 | 124 |
| 13:15 | 13:30 | 7 | 9 | 6 | 0 | 22 | 23 | 11 | 23 | 0 | 57 | 49 | 72 | 6 | 0 | 127 | 1 | 123 | 25 | 0 | 149 |
| 13:30 | 13:45 | 12 | 12 | 3 | 0 | 27 | 37 | 12 | 36 | 0 | 85 | 45 | 100 | 7 | 0 | 152 | 6 | 91 | 20 | 0 | 117 |
| 13:45 | 14:00 | 11 | 13 | 10 | 0 | 34 | 24 | 9 | 43 | 0 | 76 | 48 | 85 | 7 | 0 | 140 | 2 | 92 | 12 | 0 | 106 |
| Hourly Total | | 39 | 52 | 21 | 0 | 112 | 113 | 47 | 145 | 0 | 305 | 183 | 338 | 27 | 0 | 548 | 14 | 402 | 80 | 0 | 496 |
| 15:00 | 15:15 | 6 | 18 | 1 | 0 | 25 | 31 | 13 | 37 | 0 | 81 | 57 | 72 | 5 | 0 | 134 | 5 | 102 | 12 | 0 | 119 |
| 15:15 | 15:30 | 7 | 12 | 6 | 0 | 25 | 38 | 19 | 36 | 0 | 93 | 58 | 118 | 5 | 0 | 181 | 5 | 112 | 25 | 0 | 142 |
| 15:30 | 15:45 | 10 | 17 | 3 | 0 | 30 | 35 | 21 | 40 | 0 | 96 | 54 | 107 | 5 | 0 | 166 | 9 | 119 | 20 | 0 | 148 |
| 15:45 | 16:00 | 6 | 24 | 8 | 0 | 38 | 30 | 12 | 20 | 0 | 62 | 41 | 116 | 5 | 0 | 162 | 12 | 126 | 32 | 0 | 170 |
| Hourly Total | | 29 | 71 | 18 | 0 | 118 | 134 | 65 | 133 | 0 | 332 | 210 | 413 | 20 | 0 | 643 | 31 | 459 | 89 | 0 | 579 |

| | | Pelham Street | | | | | | | | | | Highway 20 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North Approach | | | | | South Approach | | | | | East Approach | | | | | West Approach | | | | |
| Time Period | | LT | TH | RT | U-Turn | TOT | LT | TH | RT | U-Turn | TOT | LT | TH | RT | U-Turn | TOT | LT | TH | RT | U-Turn | TOT |
| 16:00 | 16:15 | 7 | 15 | 10 | 0 | 32 | 26 | 12 | 34 | 0 | 72 | 53 | 113 | 8 | 0 | 174 | 9 | 123 | 26 | 0 | 158 |
| 16:15 | 16:30 | 8 | 18 | 4 | 0 | 30 | 33 | 18 | 42 | 0 | 93 | 66 | 125 | 5 | 0 | 196 | 5 | 119 | 25 | 0 | 149 |
| 16:30 | 16:45 | 6 | 20 | 7 | 0 | 33 | 31 | 23 | 46 | 0 | 100 | 62 | 116 | 2 | 0 | 180 | 8 | 114 | 30 | 0 | 152 |
| 16:45 | 17:00 | 9 | 16 | 8 | 0 | 33 | 48 | 16 | 43 | 0 | 107 | 54 | 114 | 6 | 0 | 174 | 10 | 104 | 23 | 0 | 137 |
| Hourly Total | | 30 | 69 | 29 | 0 | 128 | 138 | 69 | 165 | 0 | 372 | 235 | 468 | 21 | 0 | 724 | 32 | 460 | 104 | 0 | 596 |
| 17:00 | 17:15 | 13 | 26 | 6 | 0 | 45 | 23 | 13 | 27 | 0 | 63 | 76 | 131 | 3 | 0 | 210 | 8 | 128 | 26 | 0 | 162 |
| 17:15 | 17:30 | 8 | 14 | 8 | 0 | 30 | 27 | 14 | 31 | 0 | 72 | 71 | 136 | 5 | 0 | 212 | 5 | 112 | 39 | 0 | 156 |
| 17:30 | 17:45 | 5 | 20 | 8 | 0 | 33 | 31 | 14 | 27 | 0 | 72 | 68 | 116 | 6 | 0 | 190 | 6 | 89 | 36 | 0 | 131 |
| 17:45 | 18:00 | 3 | 18 | 6 | 0 | 27 | 40 | 18 | 34 | 0 | 92 | 57 | 134 | 2 | 0 | 193 | 7 | 107 | 18 | 0 | 132 |
| Hourly Total | | 29 | 78 | 28 | 0 | 135 | 121 | 59 | 119 | 0 | 299 | 272 | 517 | 16 | 0 | 805 | 26 | 436 | 119 | 0 | 581 |
| Grand Total | | 252 | 497 | 193 | 0 | 942 | 929 | 401 | 1211 | 0 | 2541 | 1397 | 2917 | 156 | 0 | 4470 | 181 | 3519 | 655 | 0 | 4355 |
| Truck % | | 3% | 4% | 5% | 0% | 4% | 2% | 3% | 3% | 0% | 3% | 4% | 6% | 1% | 0% | 5% | 2% | 5% | 4% | 0% | 5% |

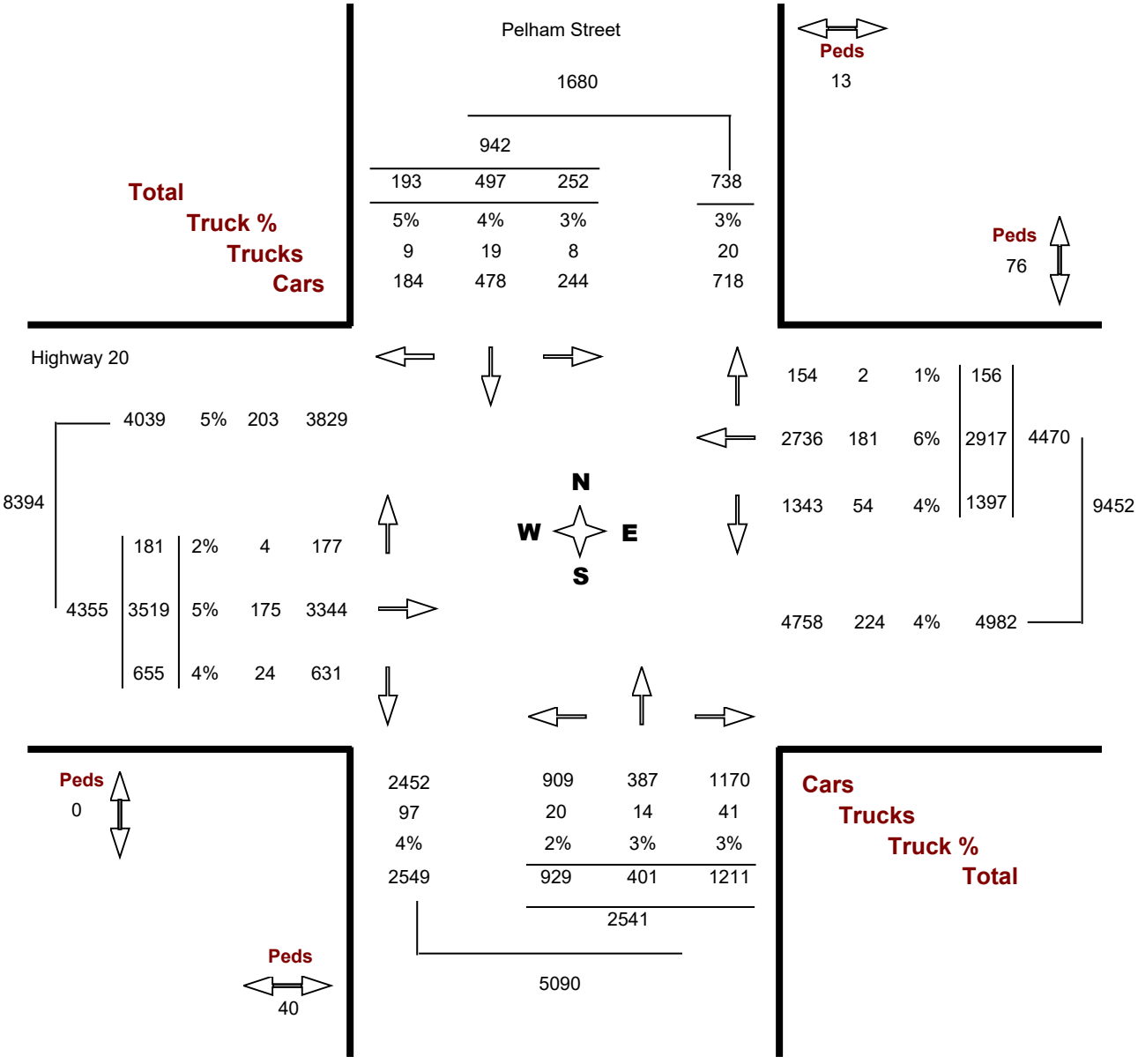
# Turning Movement Count Report
## Full Study

**Location.....** Highway 20 @ Pelham Street

**Municipality.....** PELHAM

**GeoID.....** 00504

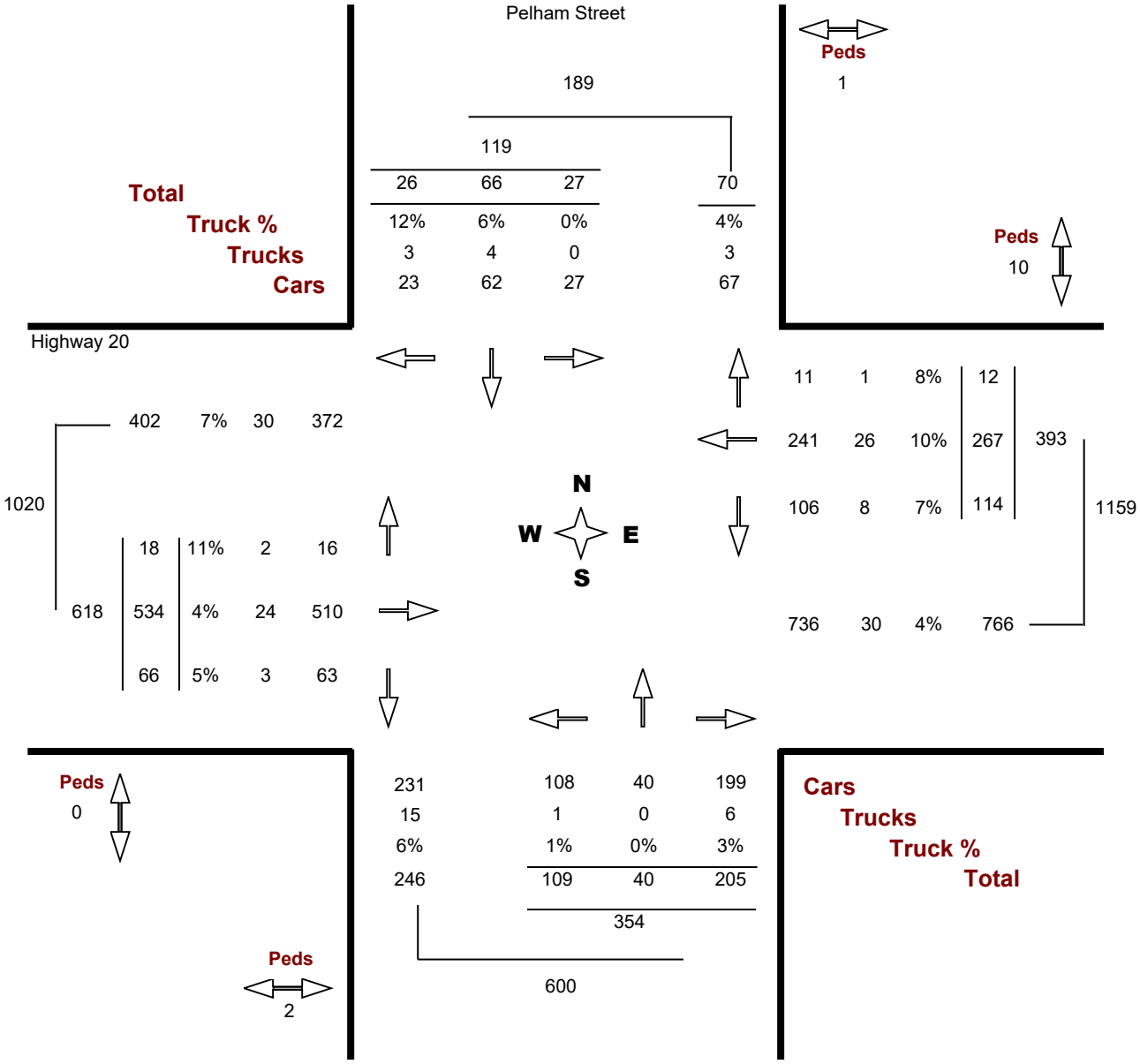
**Count Date.....** Thursday, 08 June, 2017



# Turning Movements Report - AM Period

**Location.....** Highway 20 @ Pelham Street
**Municipality.** PELHAM
**Traffic Cont.** Traffic signal
**Major Dir.....** East west

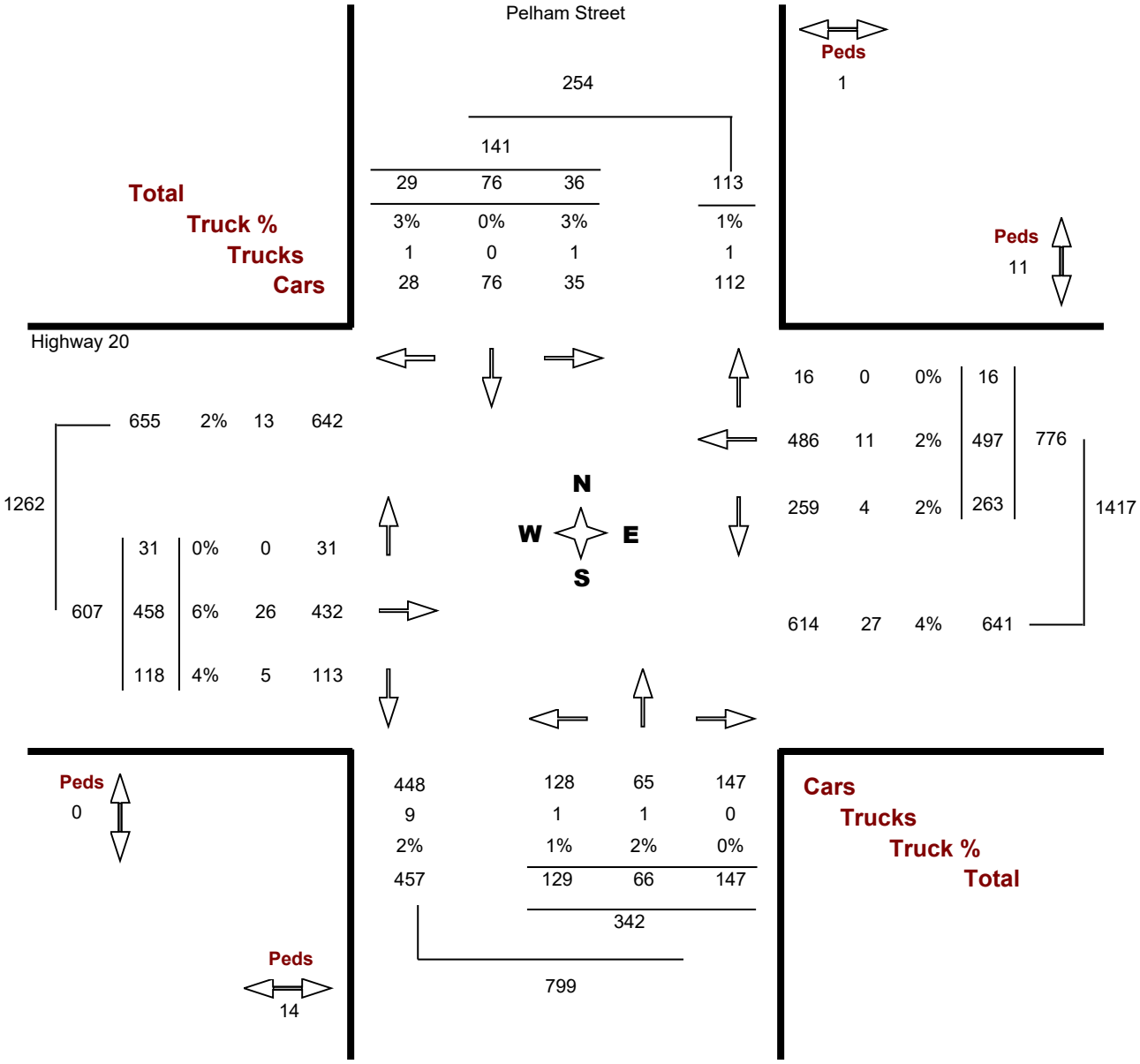
**GeoID.....** 00504
**Count Date.** Thursday, 08 June, 2017
**Count Time.** 07:00 AM — 09:00 AM
**Peak Hour..** 08:00 AM — 09:00 AM



# Turning Movements Report - PM Period

**Location.....** Highway 20 @ Pelham Street
**Municipality.** PELHAM
**Traffic Cont.** Traffic signal
**Major Dir.....** East west

**GeoID.....** 00504
**Count Date.** Thursday, 08 June, 2017
**Count Time.** 03:00 PM — 06:00 PM
**Peak Hour..** 04:30 PM — 05:30 PM



NTS

paradigm TRANSPORTATION SOLUTIONS LIMITED

# Existing Traffic Volumes

1440 Pelham Street
J000012

Figure 3

TRANS-PLAN
transportation engineering

# Turning Movement Count Diagram

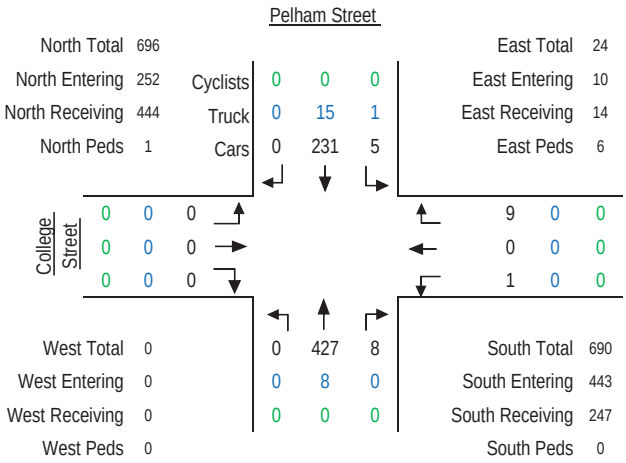
Intersection: Pelham St. and College St.

Intersection ID:

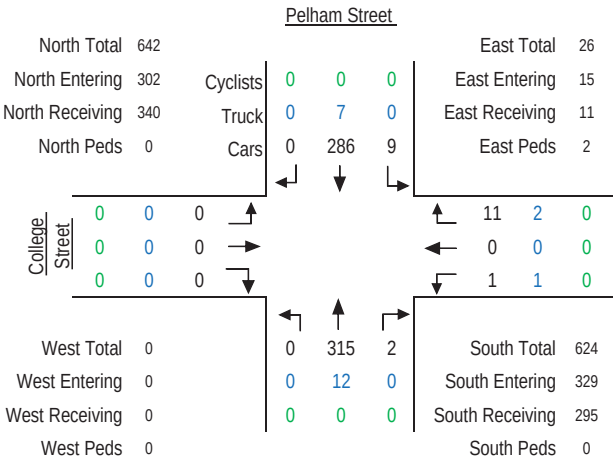
Municipality: Fonthill, Ontario

Date: Thursday January 18, 2018

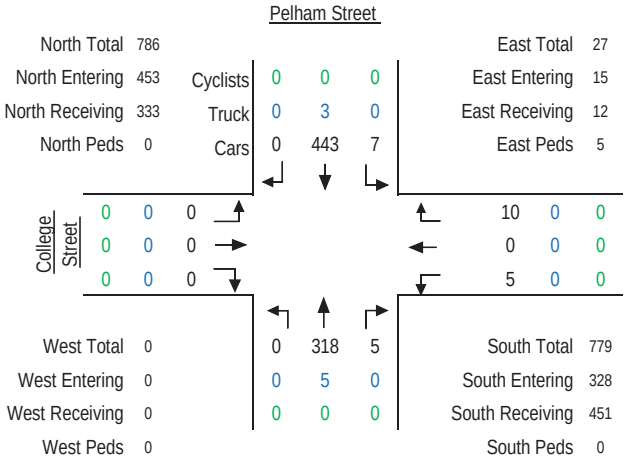
## AM Peak Hour: 8:00 to 9:00



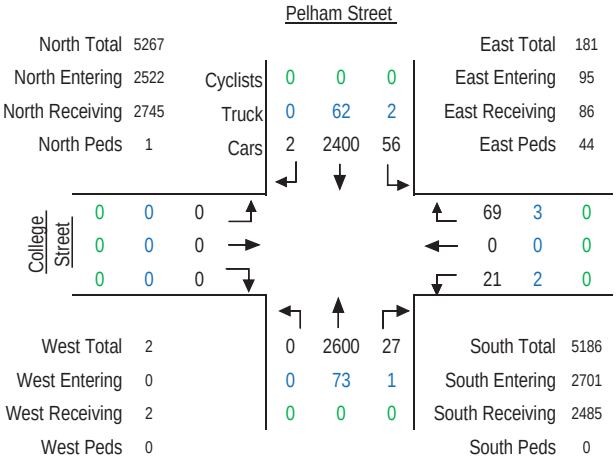

## MD Peak Hour: 11:15 to 12:15




## PM Peak Hour: 16:45 to 17:45




## Total 8-Hour Count



TRANS-PLAN
transportation engineering

## Turning Movement Count Diagram

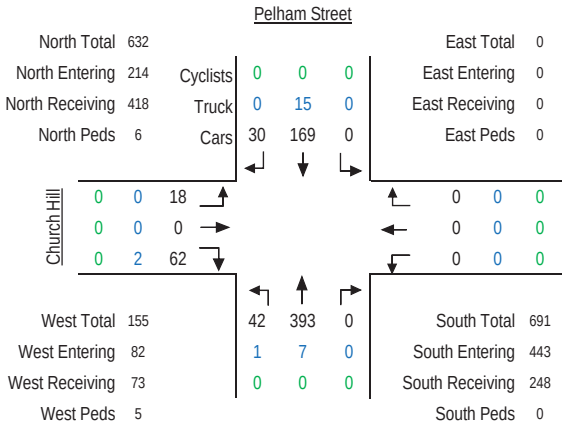
Intersection: Pelham St. and Church Hill

Intersection ID:

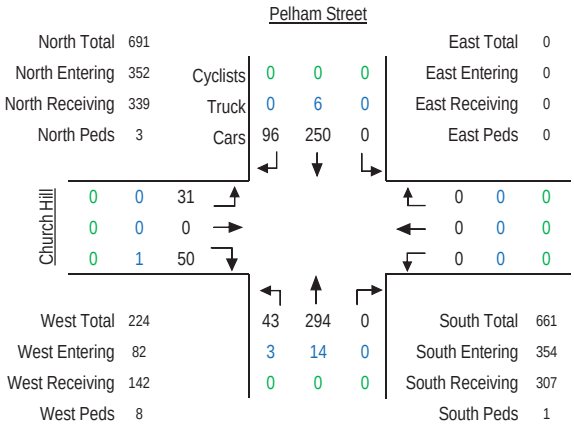
Municipality: Fonthill, Ontario

Date: Thursday January 18, 2018

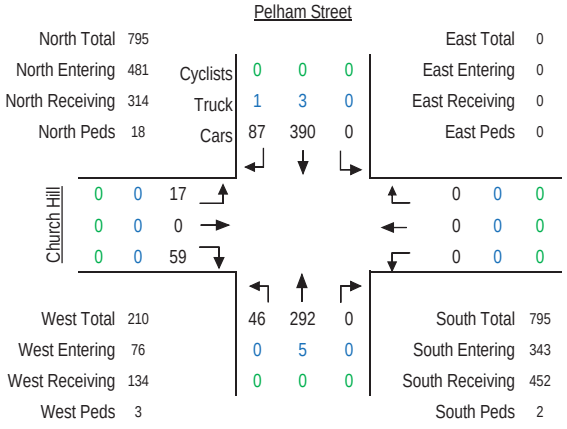
### AM Peak Hour: 8:00 to 9:00



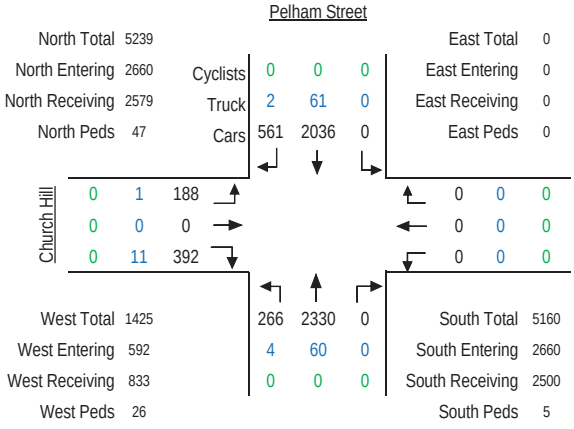

### MD Peak Hour: 11:30 to 12:30




### PM Peak Hour: 16:30 to 17:30




### Total 8-Hour Count



| Signal Code: CHRPLH | | | | | | |
|---|---|---|---|---|---|---|
| Intersection: CHURCH HILL & PELHAM RD (IPS) | | | | | | |
| Municipality: pelham | | | | | | |
| Owner: city | | | | | | |
| Last Modified: 11/11/2013 1:59:49 PM | | | | | | |
| Timing Parameters | NBD & SBD THRU PELHAM RD. | PED PHASE | n/a | n/a | n/a | n/a |
| Min Green | 35 | 17 | 0 | 0 | 0 | 0 |
| Walk | 30 | 7 | 0 | 0 | 0 | 0 |
| Ped Clearance | 5 | 10 | 0 | 0 | 0 | 0 |
| Vehicle Ext. | 0 | 0 | 0 | 0 | 0 | 0 |
| Max Green | 35 | 17 | 0 | 0 | 0 | 0 |
| Yellow | 4.1 | 3 | 0 | 0 | 0 | 0 |
| All Red | 3.2 | 2 | 0 | 0 | 0 | 0 |

| | | Offset |
|---|---|---|
| Minimum Cycle | 64.3 | 0 |
| Pedestrian Cycle | 64.3 | |
| Maximum Cycle | 64.3 | 0 |
| Operation | SA | |

**Installed On:**
--/--/----
**Count Date:**
--/--/----

FA = Fully Actuated SA = Semi Actuated FT = Fixed Time

*Note: you need to change the paper orientation from Portriat to Landscape

| | | | | | | |
|---|---|---|---|---|---|---|
| Signal Code: 020PLH | | | | | | |
| Intersection: RR20 (HIGHWAY 20) & PELHAM RD. | | | | | | |
| Municipality: pelham | | | | | | |
| Owner: region | | | | | | |
| Last Modified: 1/5/2018 8:53:59 AM | | | | | | |
| Timing Parameters | WBD ADVANCE HIGHWAY 20 | EBD & WBD THRU HIGHWAY 20 | NBD & SBD THRU PELHAM RD. | n/a | n/a | n/a |
| Min Green | 6 | 10 | 8 | 0 | 0 | 0 |
| Walk | 0 | 8 | 13 | 0 | 0 | 0 |
| Ped Clearance | 0 | 14 | 19 | 0 | 0 | 0 |
| Vehicle Ext. | 2.5 | 2.2 | 2.2 | 0 | 0 | 0 |
| Max Green | 30 | 40 | 30 | 0 | 0 | 0 |
| Yellow | 3 | 4.1 | 4.1 | 0 | 0 | 0 |
| All Red | 0 | 2.8 | 2.4 | 0 | 0 | 0 |

| | | Offset |
|---|---|---|
| Minimum Cycle | 31.4 | 0 |
| Pedestrian Cycle | 67.4 | |
| Maximum Cycle | 116.4 | 0 |
| Operation | FA | |

**Installed On:**
**8/1/2017**
**Count Date:**
**11/12/2014**

FA = Fully Actuated SA = Semi Actuated FT = Fixed Time

*Note: you need to change the paper orientation from Portriat to Landscape

# APPENDIX D

Vehicle Queueing and Pedestrian Crossing Surveys

# Vehicle Queue Study at PPS

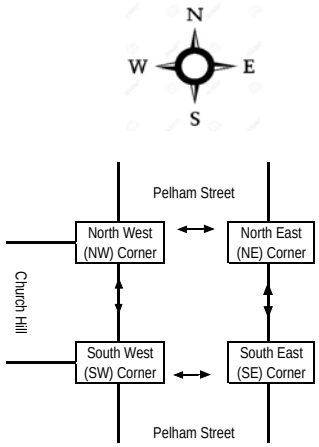
Date: 17-Jan-18
Location: Pelham Street and Church Hill
Weather: Sunny, Clear -9
Surveyor: D. Selcuk, Trans-Plan

| Peak | Time (when PPS was activated) | Northbound | Southbound | Eastbound |
|---|---|---|---|---|
| | 7:25 AM | 1 | 2 | 0 |
| | 7:55 AM | 2 | 1 | 1 |
| | 8:25 AM | 2 | 3 | 0 |
| AM Peak | 8:45 AM | 4 | 6 | 2 |
| | 9:35 AM | 3 | 3 | 0 |
| MD Peak | 11:35 AM | 3 | 5 | 1 |
| | 12:40 AM | 1 | 4 | 1 |
| | 1:10 PM | 1 | 2 | 0 |
| | 1:20 PM | 2 | 2 | 2 |
| | 2:30 PM | 3 | 1 | 0 |
| | 2:40 PM | 1 | 0 | 0 |
| | 3:10 PM | 2 | 4 | 1 |
| | 3:45 PM | 5 | 3 | 2 |
| PM Peak | 4:55 PM | 7 | 9 | 3 |
| | 5:15 PM | 4 | 2 | 0 |
| | 5:50 PM | 4 | 5 | 1 |
| | 6:45 PM | 2 | 1 | 0 |

Pedestrian Study around PPS

Date: 17-Jan-18
Location: Pelham Street and Church Hill
Weather: Sunny, Clear -9
Surveyor: D. Selcuk, Trans-Plan

| Time | Age | Origin | Destination | Crossing Delay | | | | Comments |
|---|---|---|---|---|---|---|---|---|
| 7:15 | A | SE | NE | 4sec | | | | |
| 7:30 | S | SE | NE | | 7 sec | | | |
| 7:45 | A | SW | NW | | 8 sec | | | |
| | A | NW | NE | 4sec | | | | |
| 8:00 | A | NW | NE | | | | | J walk north of Church Hill |
| | A | NE | NW | | | | | J walk north of Church Hill |
| 8:05 | A | NE | NW | 5 sec | | | | |
| 8:10 | A | SW | NW | | 8 sec | | | |
| 8:13 | A | NW | NE | | 8 sec | | | crossed while light green |
| 8:20 | T | NW | SW | 5 sec | | | | |
| 8:25 | A | NE | SE | | | 12 sec | | |
| | T | NW | NE | | 9 sec | | | |
| | 2 T | SW | NW | <5 | | | | |
| | 2T | NW | NE | <5 | 8 sec | | | |
| 8:38 | T | NE | SE | | 7 sec | | | |
| 8:40 | A | NW | NE | | 7 sec | | | J walk north of Church Hill |
| 8:43 | T | SW | SE | <5 | | | | J walk south of Church Hill |
| 8:46 | T | NW | NE | | | 12 sec | | |
| 8:47 | T | SW | NW | | | 11 | | |
| 8:53 | A | NE | SE | 4 sec | | | | |
| 8:55 | A | NE | SE | | 7 sec | | | |
| 8:58 | A | NE | SE | | 8 sec | | | |
| 9:00 | 2A | SE | SW | <5 | | | | J walk south of Church Hill |
| 11:00 | A | NW | NE | | 7 sec | | | crossed while green light |
| 11:12 | 2A | NW | NE | | 8 sec | | | crossed while green light |
| 11:16 | A | NW | NE | | 10 | | | crossed while green light |
| 11:23 | A | NW | NE | | 9 | | | crossed while green light |
| 11:30 | A | NW | NE | | 9 | | | crossed while green light |
| 11:36 | 2S | NW | SW | | | 18 | | |
| 11:43 | A | NW | NE | <5 | | | | J walk north of Church Hill |
| 11:47 | A | NE | NW | 3 | | | | J walk north of Church Hill |
| 11:50 | A | NE | NW | 4 | | | | J walk north of Church Hill |
| 11:56 | S | NE | NW | 5 | | | | crossed while green light |
| 12:01 | A | NW | NE | | 6 | | | J walk north of Church Hill |
| 12:03 | A | NE | NW | 5 | | | | crossed while green light |
| 12:18 | A | SW | SE | | 7 | | | J walked south of church Hill |
| 12:21 | S | NW | NE | | | 11 | | crossed while green light |
| 12:22 | A | NE | NW | | 10 | | | crossed while green light |
| 12:23 | A | SW | SE | | | 15 | | J walked south of church Hill |
| 12:28 | S | SE | NW | | | 17 | | J walked south of church Hill inter |
| 12:30 | S | SW | NW | | 8 | | | |
| 12:34 | A | NE | NW | | 9 | | | J walked north of Church Hill |
| 12:40 | S | NE | NW | | | | 24 | |
| 12:41 | A | NE | NW | | 8 | | | J walked north of Church Hill |
| 12:42 | S | NW | NE | | | 13 | | J walked north of Church Hill |
| 12:44 | 2S | SW | NW | | 10 | | | |
| 12:48 | A | NE | NW | <5 | | | | J walked north of Church Hill |
| 12:55 | S | NE | NW | 5 | | | | J walked north of Church Hill |
| 1:01 | S | NW | NE | | 10 | | | J walked north of Church Hill |
| 1:04 | S | NW | NE | | | 12 | | J walked north of Church Hill |
| 1:08 | A + C | NW | NE | | | 15 | | |
| 1:10 | A | NE | NW | | | | 30 | |
| 1:12 | A | NE | NW | | | | 27 | |
| 1:12 | T | SW | NW | | | 12 | | |
| 1:16 | T | NW | NE | | | 11 | | crossed while green light |
| 1:17 | S | NW | NE | | | 12 | | crossed while green light |
| 1:20 | A | NE | NW | | | | | crossed while green light |
| 1:25 | A | NE | NW | | 10 | | | crossed while green light |
| 1:30 | A | NW | NE | | 8 | | | crossed while green light |
| 1:36 | 2S | SW | NW | | | 14 | | |
| 1:37 | 2A | SE | SW | | | 11 | | J walked south of Church Hill |
| 1:45 | S | NE | NW | | 6 | | | crossed while green light |
| 1:46 | A | NW | NE | 4 | | | | crossed while green light |
| 1:47 | S | NE | NW | | 7 | | | J walked north of Church Hill |
| 1:50 | A | NW | NE | 5 | | | | crossed while green light |
| 1:52 | A | NE | NW | 3 | | | | J walked north of Church Hill |
| 1:55 | A | SW | SE | 3 | | | | J walked south of Church Hill |
| 1:56 | A | NW | NE | 4 | | | | crossed while green light |
| 1:57 | A | NW | NE | | 6 | | | crossed while green light |
| 1:58 | S | NW | NE | | 8 | | | J walked north of Church Hill |
| | | | | | | | | |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3:00 | A | NE | NW | | 6 | | | J walked north of Church Hill |
| 3:03 | A | NE | NW | | 7 | | | J walked north of Church Hill |
| 3:05 | A | NE | NW | | 7 | | | J walked north of Church Hill |
| 3:08 | S | NW | NE | | 6 | | | J walked north of Church Hill |
| 3:15 | S | NE | NW | 5 | | | | J walked north of Church Hill |
| 3:20 | S | SE | SW | 4 | | | | J walked south of Church Hill |
| 3:21 | S | SE | NE | | 8 | | | |
| 3:25 | A | NW | SW | | | 11 | | |
| 3:25 | A | SW | SE | | | 12 | | J walked south of Church Hill |
| 3:30 | S | NE | NW | | | 14 | | J walked south of Church Hill |
| 3:33 | T | NE | NW | | | | 23 | |
| 3:38 | A | NE | NW | | 10 | | | J walked north of Church Hill |
| 3:38 | A | NE | NW | 3 | | | | J walked north of Church Hill |
| 3:44 | 2 T | NE | NW | | | | 20 | |
| 3:44 | 2 T | NW | SW | | 7 | | | |
| 3:45 | A | SW | SE | | | | 21 | J walked south of Church Hill |
| 3:46 | A | SE | SW | | | | 30 | J walked south of Church Hill |
| 3:56 | A | NW | NE | | 10 | | | crossed while green light |
| 3:58 | A | SW | NW | | | 11 | | |
| 4:58 | A | NW | NE | | | 19 | | |
| 4:04 | S | SW | SE | | 8 | | | J walked south of Church Hill |
| 4:20 | S | NE | NW | | | | 25 | |
| 4:30 | S | SW | NW | | | 10 | | |
| 4:32 | S | NE | NW | | | 10 | | |
| 4:32 | S | SW | SE | | | 10 | | |
| 4:32 | A | NE | NW | 4 | | | | J walked north of Church Hill |
| 4:37 | 2C | SW | NW | | 7 | | | |
| 4:38 | 2C | NW | NE | 5 | | | | J walked north of Church Hill |
| 4:43 | A | SW | SE | | | 18 | | J walked south of Church Hill |
| 4:45 | S | NE | NW | | 9 | | | crossed while green light |
| 4:47 | A | NW | NE | | 7 | | | J walked north of Church Hill |
| 4:48 | A | NE | NW | | 6 | | | J walked north of Church Hill |
| 4:48 | S | NW | SW | | 7 | | | |
| 4:50 | S | NE | NW | | | | 21 | |
| 4:52 | A | NW | NE | 4 | | | | J walked north of Church Hill |
| 4:55 | S | NE | NW | | 6 | | | J walked north of Church Hill |
| 4:56 | S | NE | SW | | | 12 | | J walked south of Church Hill |
| 5:00 | S | NE | NW | | | 12 | | walked while green light |
| 5:03 | A | NW | NE | | | 10 | | J walked north of Church Hill |
| 5:15 | A | NE | NW | 4 | | | | walked while green light |
| 5:16 | T | NE | NW | | | | 32 | |
| 5:17 | T | NE | NW | | | 20 | | |
| 5:19 | 2S | NW | NE | | | | 33 | |
| 5:22 | T | NE | NW | 3 | | | | J walked north of Church Hill |
| 5:25 | T | SE | SW | | 9 | | | walked while green light |
| 5:25 | 2A | NW | NE | | | 12 | | walked while green light |
| 5:25 | A | NW | NE | | | 18 | | |
| 5:26 | S | NW | NE | | 8 | | | J walked north of Church Hill |
| 5:27 | A | NE | NW | | 10 | | | J walked north of Church Hill |
| 5:27 | A | NW | NE | | 9 | | | J walked north of Church Hill |
| 5:28 | A | NW | NE | | | 12 | | J walked north of Church Hill |
| 5:27 | A | NE | NW | | | 15 | | J walked north of Church Hill |
| 5:40 | A | NW | NE | 5 | | | | walked while green light |
| 5:42 | A | NW | NE | 5 | | | | walked while green light |
| 5:50 | A | NW | NE | | | | 31 | |
| 6:45 | A | NE | NW | | | | 25 | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

# APPENDIX E

Driver Sight Distance Review

Location: Church Hill and Pelham Street
Date: Wednesday, January 18, 2017
Time: 12:00pm
Weather: Clear ~-10C
Surveyors D.,Selcuk

Number of Lanes 2
Posted Speed Limit: 50 km/h
Design Speed: 50 km/h

**Sight Distance Study**

| Looking South from Church Hill | | | | |
|---|---|---|---|---|
| Looking south from curb | | | | |
| Available Sight Distance | Reason | Criteria | Required Sight Distance | Requirement Met? (Y / N) |
| 355 | Vertical Curve | 2.1.1 | 85-140 | Y |
| | | TAC | 160 | Y |


Looking South from Curb

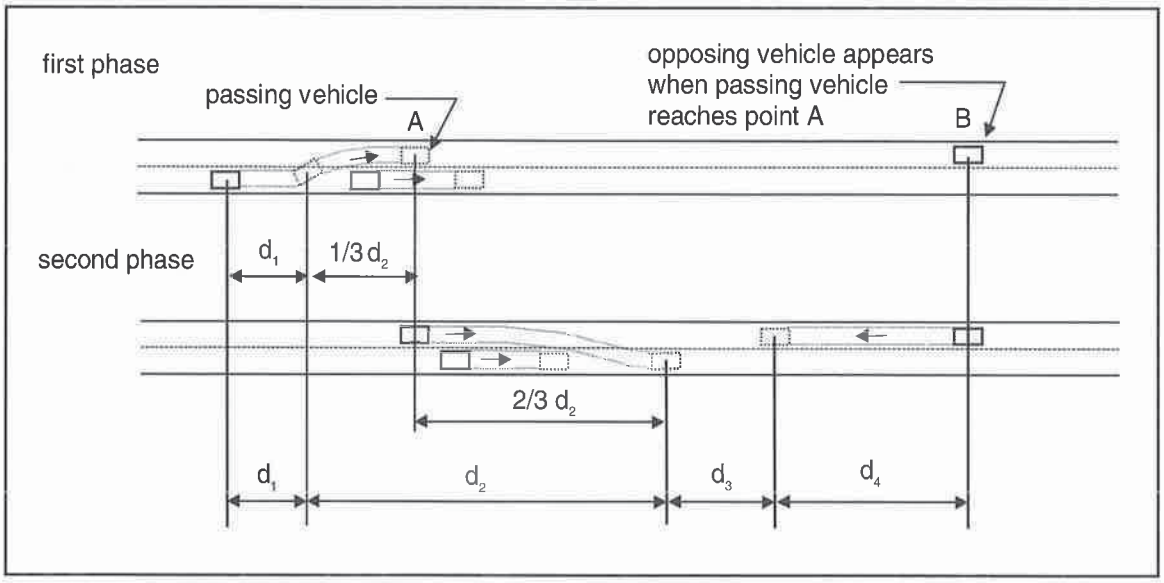
| Looking South from Church Hill | | | | |
|---|---|---|---|---|
| Looking south from stop line | | | | |
| Available Sight Distance (m) | Reason | Criteria | Required Sight Distance (m) | Requirement Met? (Y / N) |
| 325 | Vertical Curve | 2.1.1 | 85-140 | Y |
| | | TAC | 160 | Y |


Looking South from Stop Line

| Looking nouth from Church Hill | | | | |
|---|---|---|---|---|
| Looking north from stop line | | | | |
| Available Sight Distance (m) | Reason | Criteria | Required Sight Distance (m) | Requirement Met? Y / N) |
| 60 | Vertical Curve | 2.1.1 | 85-140 | N |
| | | TAC | 160 | N |

| Looking north from Church Hill | | | | |
|---|---|---|---|---|
| looking north from curb | | | | |
| Available Sight Distance (m) | Reason | Criteria | Required Sight Distance (m) | Requirement Met? (Y / N) |
| 100 | Vertical Curve | 2.1.1 | 85-140 | Y |
| | | TAC | 160 | Y |

**Figure 1.2.5.1 Elements of Passing Sight Distance[21]**




Minimum passing sight distance equals the addition of $d_1$ through $d_4$. Table 1.2.5.5 shows the minimum passing sight distances for various design speeds.

**Table 1.2.5.5 Minimum Passing Sight Distance[21]**

| Design Speed (km/h) | Assumed Speeds (km/h) | | Minimum Passing Sight Distance (m) (rounded) |
|---|---|---|---|
| | Passed Vehicle | Passing Vehicle | |
| 30 | 29 | 44 | 220 |
| 40 | 36 | 51 | 290 |
| 50 | 44 | 59 | 350 |
| 60 | 51 | 66 | 410 |
| 70 | 59 | 74 | 490 |
| 80 | 65 | 80 | 550 |
| 90 | 73 | 88 | 610 |
| 100 | 79 | 94 | 680 |
| 110 | 85 | 100 | 730 |
| 120 | 91 | 106 | 800 |
| 130 | 97 | 112 | 860 |

These "minimum" passing sight distances were derived from field studies carried out between 1938 and 1941[21]. Subsequent studies[4] have shown these values to be generally conservative for modern drivers and vehicles, but the "minimum" passing sight distances have not been reduced by AASHTO.

It has been suggested[5] that required passing sight distance is successively longer for a passenger car passing a passenger car, a passenger car passing a truck, a truck passing a passenger car and a truck passing a truck, but that all of these required distances are less than those given as "minimums" by AASHTO (Table 1.2.5.5). A comparison of these requirements is shown on Figure 1.2.5.2, which reproduces results of modelling research[5]. In presenting these results, the authors commented that:

> "neither (their) models nor the current AASHTO.... models have any direct demonstrated relationship to the safety of passing manoeuvres on two-lane road. Such demonstrated safety relationships are needed before any change in passing..... criteria can be reasonably contemplated".

### *2.1.1 Design Criteria*

| | Laneway | Local Road | Collector Road | Arterial |
|---|---|---|---|---|
| Minimum Grade<br>With Curbs<br>Without Curbs | <br>0.4%<br>0.6% | <br>0.4%<br>0.6% | <br>0.5%<br>0.6% | <br>0.5%<br>0.6% |
| Maximum Grade | 8.0% | 8.0% | 6.0% | 5% |
| Maximum Grade for Through Roads at Intersection | 3.5% | 3.5% | 3.0% | 3.0% |
| Maximum Grade for Stop Roads at Intersection | 2.5% | 2.5% | 1.5% | 1.5% |
| Minimum Curb Radius at Intersection with Arterial Road | 9m | 9m | 13m | 15m |
| Minimum Curb Radius at Intersection with Collector Road | 9m | 9m | 13m | 15m |
| Minimum Curb Grade | 0.40% | 0.40% | 0.50% | 0.50% |
| Minimum Curb Grade at Radius of Intersections | 0.80% | 0.80% | 0.80% | 0.80% |
| Cul-de-Sac Minimum Outside Curb Radius | N/A | 15m | N/A | N/A |
| R.O.W. (minimum) | 7.5m | 20m | 20m * | 30m |
| Pavement Width (measured curb face to curb face) | 6.0m | 8.5m<br>14.0m | 10.40m<br>12.60m<br>14.80m | |
| Minimum Centreline Radius | 60m ** | 60m ** | 85m | |
| Design Speed | 15 kph | 50 kph | 50 to 60 kph | 60 to 80 kph |
| Vertical Curve<br>Minimum sight stopping distance<br>LVC=KA (MTC Manual)<br>K. for Sag<br>K. for Crest | <br>65m<br><br>12<br>8 | <br>65m<br><br>12<br>8 | <br>85m<br><br>20<br>15 | <br>85 to 140<br><br>9 or 16<br>13 or 36 |
| Superelevation | None | None | None | None |
| Intersection Angle | 70-110° at local, 80-100° at collector and arterial *** | 70-110° at local, 80-100° at collector and arterial *** | 80-100°*** | 90° |
| Minimum Intersection Spacing | 34m | 80m | 120m | 250m |
| Minimum Stopping Sight Distance | - | 65m | 85m | - |

* Town may request 22.0 m R.O.W.

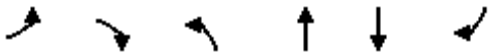
** Except at 90° corners for crescents and courts.

*** All streets are to intersect at 90° unless existing road alignments or property restrictions required otherwise.

# APPENDIX F

Capacity and Queue Analysis Sheets

# Stop Control Intersection



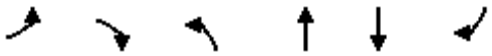
| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | | Stop | Stop | |
| Volume (vph) | 76 | 47 | 78 | 393 | 446 | 115 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 83 | 51 | 85 | 427 | 485 | 125 |

| Direction, Lane # | EB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total (vph) | 134 | 512 | 610 |
| Volume Left (vph) | 83 | 85 | 0 |
| Volume Right (vph) | 51 | 0 | 125 |
| Hadj (s) | -0.07 | 0.07 | -0.09 |
| Departure Headway (s) | 6.5 | 5.2 | 5.0 |
| Degree Utilization, x | 0.24 | 0.74 | 0.84 |
| Capacity (veh/h) | 516 | 673 | 709 |
| Control Delay (s) | 11.5 | 21.6 | 28.4 |
| Approach Delay (s) | 11.5 | 21.6 | 28.4 |
| Approach LOS | B | C | D |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 23.8 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 72.5% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

## Intersection: 3: Church Hill Street & Pelham Street

| Movement | EB | NB | SB |
|---|---|---|---|
| Directions Served | LR | LT | TR |
| Maximum Queue (m) | 20.2 | 29.6 | 27.3 |
| Average Queue (m) | 10.4 | 15.6 | 11.6 |
| 95th Queue (m) | 16.3 | 26.0 | 19.2 |
| Link Distance (m) | 205.1 | 100.9 | 57.8 |
| Upstream Blk Time (%) | | | |
| Queuing Penalty (veh) | | | |
| Storage Bay Dist (m) | | | |
| Storage Blk Time (%) | | | |
| Queuing Penalty (veh) | | | |



| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | | Stop | Stop | |
| Volume (vph) | 76 | 47 | 78 | 393 | 446 | 115 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 83 | 51 | 85 | 427 | 485 | 125 |

| Direction, Lane # | EB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total (vph) | 134 | 512 | 610 |
| Volume Left (vph) | 83 | 85 | 0 |
| Volume Right (vph) | 51 | 0 | 125 |
| Hadj (s) | -0.07 | 0.07 | -0.09 |
| Departure Headway (s) | 6.5 | 5.2 | 5.0 |
| Degree Utilization, x | 0.24 | 0.74 | 0.84 |
| Capacity (veh/h) | 516 | 673 | 709 |
| Control Delay (s) | 11.5 | 21.6 | 28.4 |
| Approach Delay (s) | 11.5 | 21.6 | 28.4 |
| Approach LOS | B | C | D |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 23.8 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 72.5% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

## Intersection: 3: Church Hill Street & Pelham Street

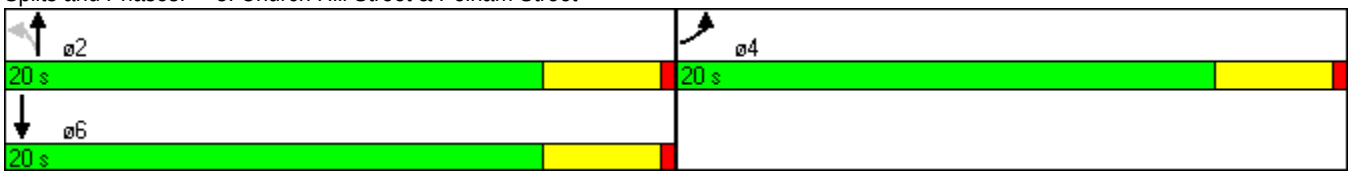
| Movement | EB | NB | SB |
|---|---|---|---|
| Directions Served | LR | LT | TR |
| Maximum Queue (m) | 16.0 | 45.6 | 41.3 |
| Average Queue (m) | 9.7 | 24.0 | 21.0 |
| 95th Queue (m) | 12.7 | 38.2 | 35.1 |
| Link Distance (m) | 205.1 | 100.9 | 57.8 |
| Upstream Blk Time (%) | | | |
| Queuing Penalty (veh) | | | |
| Storage Bay Dist (m) | | | |
| Storage Blk Time (%) | | | |
| Queuing Penalty (veh) | | | |

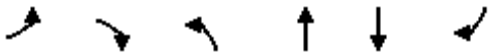
# Signalized Intersection

| Lane Group | EBL | NBL | NBT | SBT |
|---|---|---|---|---|
| Lane Configurations | | | | |
| Volume (vph) | 81 | 51 | 345 | 180 |
| Turn Type | | Perm | | |
| Protected Phases | 4 | | 2 | 6 |
| Permitted Phases | | 2 | | |
| Detector Phase | 4 | 2 | 2 | 6 |
| Switch Phase | | | | |
| Minimum Initial (s) | 4.0 | 4.0 | 4.0 | 4.0 |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 20.0 | 20.0 | 20.0 | 20.0 |
| Total Split (%) | 50.0% | 50.0% | 50.0% | 50.0% |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.0 | 4.0 | 4.0 | 4.0 |
| Lead/Lag | | | | |
| Lead-Lag Optimize? | | | | |
| Recall Mode | None | Max | Max | Max |
| Act Effct Green (s) | 7.4 | | 27.0 | 27.0 |
| Actuated g/C Ratio | 0.20 | | 0.74 | 0.74 |
| v/c Ratio | 0.33 | | 0.33 | 0.16 |
| Control Delay | 11.4 | | 5.0 | 3.9 |
| Queue Delay | 0.0 | | 0.0 | 0.0 |
| Total Delay | 11.4 | | 5.0 | 3.9 |
| LOS | B | | A | A |
| Approach Delay | 11.4 | | 5.0 | 3.9 |
| Approach LOS | B | | A | A |

| Intersection Summary | |
|---|---|
| Cycle Length: 40 | |
| Actuated Cycle Length: 36.7 | |
| Natural Cycle: 40 | |
| Control Type: Semi Act-Uncoord | |
| Maximum v/c Ratio: 0.33 | |
| Intersection Signal Delay: 5.7 | Intersection LOS: A |
| Intersection Capacity Utilization 48.1% | ICU Level of Service A |
| Analysis Period (min) 15 | |

Splits and Phases: 3: Church Hill Street & Pelham Street





| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 81 | 33 | 51 | 345 | 180 | 19 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | | | 1.00 | 1.00 | |
| Frt | 0.96 | | | 1.00 | 0.99 | |
| Flt Protected | 0.97 | | | 0.99 | 1.00 | |
| Satd. Flow (prot) | 1728 | | | 1851 | 1838 | |
| Flt Permitted | 0.97 | | | 0.95 | 1.00 | |
| Satd. Flow (perm) | 1728 | | | 1765 | 1838 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 88 | 36 | 55 | 375 | 196 | 21 |
| RTOR Reduction (vph) | 31 | 0 | 0 | 0 | 5 | 0 |
| Lane Group Flow (vph) | 93 | 0 | 0 | 430 | 212 | 0 |
| Turn Type | | | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | | 2 | | | |
| Actuated Green, G (s) | 5.0 | | | 25.3 | 25.3 | |
| Effective Green, g (s) | 5.0 | | | 25.3 | 25.3 | |
| Actuated g/C Ratio | 0.13 | | | 0.66 | 0.66 | |
| Clearance Time (s) | 4.0 | | | 4.0 | 4.0 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 226 | | | 1166 | 1214 | |
| v/s Ratio Prot | c0.05 | | | | 0.12 | |
| v/s Ratio Perm | | | | c0.24 | | |
| v/c Ratio | 0.41 | | | 0.37 | 0.17 | |
| Uniform Delay, d1 | 15.3 | | | 2.9 | 2.5 | |
| Progression Factor | 1.00 | | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 1.2 | | | 0.9 | 0.3 | |
| Delay (s) | 16.5 | | | 3.8 | 2.8 | |
| Level of Service | B | | | A | A | |
| Approach Delay (s) | 16.5 | | | 3.8 | 2.8 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 5.6 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.38 | | |
| Actuated Cycle Length (s) | 38.3 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 48.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

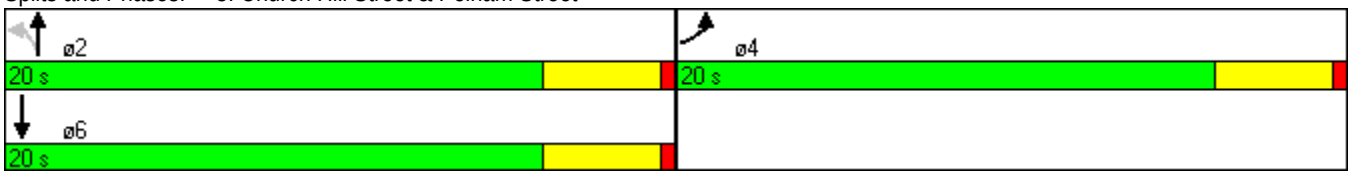
## Intersection: 3: Church Hill Street & Pelham Street

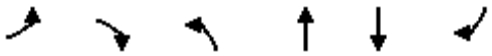
| Movement | EB | NB | SB |
|---|---|---|---|
| Directions Served | LR | LT | TR |
| Maximum Queue (m) | 22.2 | 79.1 | 27.3 |
| Average Queue (m) | 12.8 | 25.9 | 7.3 |
| 95th Queue (m) | 20.6 | 56.2 | 19.8 |
| Link Distance (m) | 205.1 | 100.9 | 57.8 |
| Upstream Blk Time (%) | | | |
| Queuing Penalty (veh) | | | |
| Storage Bay Dist (m) | | | |
| Storage Blk Time (%) | | | |
| Queuing Penalty (veh) | | | |

| Lane Group | EBL | NBL | NBT | SBT |
|---|---|---|---|---|
| Lane Configurations | | | | |
| Volume (vph) | 76 | 78 | 393 | 446 |
| Turn Type | | Perm | | |
| Protected Phases | 4 | | 2 | 6 |
| Permitted Phases | | 2 | | |
| Detector Phase | 4 | 2 | 2 | 6 |
| Switch Phase | | | | |
| Minimum Initial (s) | 4.0 | 4.0 | 4.0 | 4.0 |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 20.0 | 20.0 | 20.0 | 20.0 |
| Total Split (%) | 50.0% | 50.0% | 50.0% | 50.0% |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.0 | 4.0 | 4.0 | 4.0 |
| Lead/Lag | | | | |
| Lead-Lag Optimize? | | | | |
| Recall Mode | None | Max | Max | Max |
| Act Effct Green (s) | 7.4 | | 26.3 | 26.3 |
| Actuated g/C Ratio | 0.20 | | 0.73 | 0.73 |
| v/c Ratio | 0.34 | | 0.44 | 0.46 |
| Control Delay | 10.3 | | 6.8 | 6.3 |
| Queue Delay | 0.0 | | 0.0 | 0.0 |
| Total Delay | 10.3 | | 6.8 | 6.3 |
| LOS | B | | A | A |
| Approach Delay | 10.3 | | 6.8 | 6.3 |
| Approach LOS | B | | A | A |

| Intersection Summary | |
|---|---|
| Cycle Length: 40 | |
| Actuated Cycle Length: 36.1 | |
| Natural Cycle: 50 | |
| Control Type: Semi Act-Uncoord | |
| Maximum v/c Ratio: 0.46 | |
| Intersection Signal Delay: 6.9 | Intersection LOS: A |
| Intersection Capacity Utilization 72.5% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 3: Church Hill Street & Pelham Street





| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 76 | 47 | 78 | 393 | 446 | 115 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | | | 1.00 | 1.00 | |
| Frt | 0.95 | | | 1.00 | 0.97 | |
| Flt Protected | 0.97 | | | 0.99 | 1.00 | |
| Satd. Flow (prot) | 1714 | | | 1847 | 1811 | |
| Flt Permitted | 0.97 | | | 0.85 | 1.00 | |
| Satd. Flow (perm) | 1714 | | | 1590 | 1811 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 83 | 51 | 85 | 427 | 485 | 125 |
| RTOR Reduction (vph) | 44 | 0 | 0 | 0 | 13 | 0 |
| Lane Group Flow (vph) | 90 | 0 | 0 | 512 | 597 | 0 |
| Turn Type | | | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | | 2 | | | |
| Actuated Green, G (s) | 5.0 | | | 24.7 | 24.7 | |
| Effective Green, g (s) | 5.0 | | | 24.7 | 24.7 | |
| Actuated g/C Ratio | 0.13 | | | 0.66 | 0.66 | |
| Clearance Time (s) | 4.0 | | | 4.0 | 4.0 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 227 | | | 1042 | 1187 | |
| v/s Ratio Prot | c0.05 | | | | c0.33 | |
| v/s Ratio Perm | | | | 0.32 | | |
| v/c Ratio | 0.40 | | | 0.49 | 0.50 | |
| Uniform Delay, d1 | 15.0 | | | 3.3 | 3.3 | |
| Progression Factor | 1.00 | | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 1.1 | | | 1.7 | 1.5 | |
| Delay (s) | 16.1 | | | 5.0 | 4.9 | |
| Level of Service | B | | | A | A | |
| Approach Delay (s) | 16.1 | | | 5.0 | 4.9 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 6.1 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.48 | | |
| Actuated Cycle Length (s) | 37.7 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 72.5% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

## Intersection: 3: Church Hill Street & Pelham Street

| Movement | EB | NB | SB |
|---|---|---|---|
| Directions Served | LR | LT | TR |
| Maximum Queue (m) | 22.5 | 99.8 | 35.2 |
| Average Queue (m) | 11.8 | 42.4 | 20.7 |
| 95th Queue (m) | 20.2 | 87.7 | 33.4 |
| Link Distance (m) | 205.1 | 100.9 | 57.8 |
| Upstream Blk Time (%) | | 1 | |
| Queuing Penalty (veh) | | 3 | |
| Storage Bay Dist (m) | | | |
| Storage Blk Time (%) | | | |
| Queuing Penalty (veh) | | | |

# APPENDIX G

Level of Service Definitions

## LEVEL OF SERVICE ANALYSIS AT SIGNALIZED INTERSECTIONS

To assist in clarifying the arithmetic analysis associated with traffic engineering, it is often useful to refer to "Level of Service". The term Level of Service implies a qualitative measure of traffic flow at an intersection. It is dependent upon vehicle delay and vehicle queue lengths at the approaches. Specifically, Level of Service criteria are stated in terms of the average stopped delay per vehicle for a 15-minute analysis period. The following table describes the characteristics of each level:

| Level of Service | Features | Stopped Delay per Vehicle (sec) |
|---|---|---|
| A | At this level of service, almost no signal phase is fully utilized by traffic. Very seldom does a vehicle wait longer than one red indication. The approach appears open, turning movements are easily made and drivers have freedom of operation. | $\leq 5.0$ |
| B | At this level, an occasional signal phase is fully utilized and many phases approach full use. Many drivers begin to feel somewhat restricted within platoons of vehicles approaching the intersection. | $> 5.0$ and $\leq 15.0$ |
| C | At this level, the operation is stable though with more frequent fully utilized signal phases. Drivers feel more restricted and occasionally may have to wait more than one red signal indication, and queues may develop behind turning vehicles. This level is normally employed in urban intersection design. | $> 15.0$ and $\leq 25.0$ |
| D | At this level, the motorist experiences increasing restriction and instability of flow. There are substantial delays to approaching vehicles during short peaks within the peak period, but there are enough cycles with lower demand to permit occasional clearance of developing queues and prevent excessive backups. | $> 25.0$ and $\leq 40.0$ |
| E | At this level, capacity is reached. There are long queues of vehicles waiting upstream of the intersection and delays to vehicles may extend to several signal cycles. | $> 40.0$ and $\leq 60.0$ |
| F | At this level, saturation occurs, with vehicle demand exceeding the available capacity. | $> 60.0$ |

# APPENDIX H

All-way Stop and Signal  Warrant Analysis

# Input Data Sheet

Analysis Sheet | Results Sheet | Proposed Collision

GO TO Justification:

What are the intersecting roadways? Pelham Street and Church Hill

What is the direction of the Main Road street? North-South

When was the data collected? refer OTM PG.70

## Justification 1 - 4: Volume Warrants

a.- Number of lanes on the Main Road? 2 or more

b.- Number of lanes on the Minor Road? 2 or more

c.- How many approaches? 3

d.- What is the operating environment? Rural  Population < 10,000  AND  Speed >= 70 km/hr

e.- What is the eight hour vehicle volume at the intersection? (Please fill in table below)

| Hour Ending | Main Northbound Approach | | | Minor Eastbound Approach | | | Main Southbound Approach | | | Minor Westbound Approach | | | Pedestrians Crossing Main Road |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LT | TH | RT | LT | TH | RT | LT | TH | RT | LT | TH | RT | |
| 8:00 | 13 | 253 | 0 | 0 | 0 | 0 | 0 | 93 | 15 | 7 | 0 | 31 | 2 |
| 9:00 | 43 | 400 | 0 | 0 | 0 | 0 | 0 | 184 | 30 | 18 | 0 | 64 | 6 |
| 12:00 | 37 | 308 | 0 | 0 | 0 | 0 | 0 | 253 | 93 | 30 | 0 | 44 | 0 |
| 13:00 | 42 | 294 | 0 | 0 | 0 | 0 | 0 | 242 | 91 | 37 | 0 | 51 | 6 |
| 14:00 | 23 | 224 | 0 | 0 | 0 | 0 | 0 | 243 | 90 | 28 | 0 | 37 | 1 |
| 4:00 | 39 | 307 | 0 | 0 | 0 | 0 | 0 | 307 | 69 | 26 | 0 | 66 | 5 |
| 5:00 | 30 | 315 | 0 | 0 | 0 | 0 | 0 | 364 | 89 | 22 | 0 | 56 | 14 |
| 6:00 | 43 | 289 | 0 | 0 | 0 | 0 | 0 | 411 | 86 | 21 | 0 | 54 | 18 |
| **Total** | **270** | **2,390** | **0** | **0** | **0** | **0** | **0** | **2,097** | **563** | **189** | **0** | **403** | **52** |

## Justification 5: Collision Experience

| Preceding Months | Number of Collisions* |
|---|---|
| 1-12 | 0 |
| 13-24 | 0 |
| 25-36 | 0 |

* Include only collisions that are susceptable to correction through the installation of traffic signal control

## Justification 6: Pedestrian Volume

a.- Please fill in table below summarizing total pedestrians crossing major roadway at the intersection or in proximity to the intersection (zones). Please reference Section 4.8 of the Manual for further explanation and graphical representation.

| | Zone 1 | | Zone 2 | | Zone 3 (if needed) | | Zone 4 (if needed) | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Assisted | Unassisted | Assisted | Unassisted | Assisted | Unassisted | Assisted | Unassisted | |
| **Total 8 hour pedestrian volume** | 4 | 47 | | 25 | 2 | 0 | 0 | 2 | |
| **Factored 8 hour pedestrian volume** | 55 | | 25 | | 4 | | 2 | | |
| **% Assigned to crossing rate** | | | | | | | | | |
| **Net 8 Hour Pedestrian Volume at Crossing** | | | | | | | | | 0 |
| **Net 8 Hour Vehicular Volume on Street Being Crossed** | | | | | | | | | |

b.- Please fill in table below summarizing delay to pedestrians crossing major roadway at the intersection or in proximity to the intersection (zones). Please reference Section 4.8 of the Manual for further explanation and graphical representation.

| | Zone 1 | | Zone 2 | | Zone 3 (if needed) | | Zone 4 (if needed) | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Assisted | Unassisted | Assisted | Unassisted | Assisted | Unassisted | Assisted | Unassisted | |
| **Total 8 hour pedestrian volume** | 4 | 47 | 0 | 25 | 2 | 0 | 0 | 2 | |
| **Total 8 hour pedestrians delayed greater than 10 seconds** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| **Factored volume of total pedestrians** | 55 | | 25 | | 4 | | 2 | | |
| **Factored volume of delayed pedestrians** | 0 | | 0 | | 0 | | 0 | | |
| **% Assigned to Crossing Rate** | 0% | | 0% | | 0% | | 0% | | |
| **Net 8 Hour Volume of Total Pedestrians** | | | | | | | | | 0 |
| **Net 8 Hour Volume of Delayed Pedestrians** | | | | | | | | | 0 |

Analysis Sheet | Results Sheet | Proposed Collision

# Results Sheet

Input Sheet | Analysis Sheet | Proposed Collision

GO TO Justification:

Intersection: Pelham Street and Church Hill

Count Date: refer OTM PG.70

## Summary Results

| Justification | | | Compliance | | Signal Justified? YES | Signal Justified? NO |
|---|---|---|---|---|---|---|
| 1. Minimum Vehicular Volume | A | Total Volume | 96 | % | ☐ | ☑ |
| | B | Crossing Volume | 41 | % | | |
| 2. Delay to Cross Traffic | A | Main Road | 95 | % | ☐ | ☑ |
| | B | Crossing Road | 60 | % | | |
| 3. Combination | A | Justificaton 1 | 41 | % | ☐ | ☑ |
| | B | Justification 2 | 60 | % | | |
| 4. 4-Hr Volume | | | 27 | % | ☐ | ☑ |
| 5. Collision Experience | | | 0 | % | ☐ | ☑ |
| 6. Pedestrians | A | Volume | Justification not met | | ☐ | ☑ |
| | B | Delay | Justification not met | | | |

- At the intersection of a County or Regional road with a King's Highway in a rural area.

The use of STOP signs should be considered:

- At the intersection of a County or Regional road with a King's Highway in a built-up area;
- At the intersection of a city street or township road with a King's Highway;
- At the intersection of a minor street or road with a through street or highway;
- At unsignalized intersections in a signalized area, except where they would interfere with traffic signal progression;
- At intersections where the application of the normal right hand rule or yield control would be unduly hazardous; and
- At intersections which have experienced a record of collisions of the type which are susceptible to correction by STOP control (see stop collision warrant below).

*Stop Collision Warrant*

STOP sign control may be warranted where three or more right angle or turning collisions per year have occurred over a period of three years and methods of reducing the collision experience, such as sight line improvements, street lighting, parking prohibitions, enforcement, geometric revisions, or YIELD sign controls, have been tried or considered, and found to be inadequate.

*All-way Stop Controls*

In some circumstances, it may be appropriate to install STOP signs on all approaches to an intersection. This results in an all-way stop condition. All-way STOP sign controls disrupt the flow of traffic and introduce delays to all drivers within the intersection and should only be considered at the intersection of two relatively equal roadways having similar traffic volume demand and operating characteristics (see minimum volume warrants below). The approaches should be directly opposing (i.e., not offset), should preferably approach at right angles (i.e., no skewed approaches) and have an equal number of lanes.

All-way stop controls should be considered only under the following situations:

- As an interim measure, where traffic control signals are warranted but cannot be implemented immediately. For information on traffic signal control, refer to Book 12 (Traffic Signals);
- At locations having a high collision frequency where less restrictive measures have been tried and found inadequate (see all-way stop collision warrant below); or
- As a means of providing a transition period to accustom drivers to a change in intersection right-of-way control from one direction to another. Installation under this warrant must be in conformance with the Amendment of Intersection Control, discussed under Special Considerations at the end of Section 2.

*All-way Stop Minimum Volume Warrant (Arterial and Major Roads)*

All-way stop control may be considered on major roads where the following conditions are met:

- The total vehicle volume on all intersection approaches exceeds 500 vehicles per hour for each of any eight hours of the day;

- The combined vehicular and pedestrian volume on the minor street exceeds 200 units per hour (all vehicles plus pedestrians wishing to enter the intersection) for each of the same eight hours, with an average delay to traffic on the minor street (either vehicles or pedestrians wishing to enter the intersection) of greater than 30 seconds; and

- The volume split does not exceed 70/30. Volume on the major street is defined as vehicles only. Volume on the minor street includes all vehicles plus any pedestrians wishing to cross the major roadway.

*All-way Stop Minimum Volume Warrant (Minor Roads)*

All-way stop control may be considered on minor roads where the following conditions are met:

- Total vehicle volume on all intersection approaches exceeds 350 for the highest hour recorded; and

- Volume split does not exceed 75/25 for three-way control or 65/35 for four-way control. Volume is defined as vehicles only.

*All-way Stop Collision Warrant*

For the purposes of this warrant, a high accident frequency is an average of four collisions per year over a three-year period. Only those accidents susceptible to relief through multi-way stop control must be considered (i.e., right angle and turning type collisions).

Included in this warrant are those locations where visibility problems exist which limit the safe approach speed to less than 15 km/h, thereby creating an unreasonable accident potential. Special advance warning or overhead flashing lights may be necessary to augment the control if vertical or horizontal alignment is a factor.

*Inappropriate Use of All-way Stop Control*

All-way stop controls should *not* be used under the following conditions:

- Where the protection of pedestrians, school children in particular, is a prime concern. This concern can usually be addressed by other means;

- As a speed control device;

- On roads where progressive signal timing exists;

- On roads within urban areas having a posted speed limit in excess of 60 km/h;

- At intersections that are not roundabouts having less than three, or more than four, approaches;

- At intersections that are offset, poorly defined or geometrically substandard;

- On truck or bus routes, except in an industrial area or where two such routes cross;

- On multi-lane approaches where a parked or stopped vehicle on the right will obscure the STOP sign;

- Where traffic would be required to stop on grades;

- As a means of deterring the movement of through traffic in a residential area;