THE REGIONAL MUNICIPALITY OF DURHAM

DESIGN SPECIFICATIONS FOR TRAFFIC CONTROL DEVICES, PAVEMENT MARKINGS, SIGNAGE AND ROADSIDE PROTECTION

WORKS DEPARTMENT

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1. General

It is the Region of Durham’s intention that the following design requirements shall be used as a supplement to the Ontario Traffic Manual (OTM), Institute of Transportation Engineers (ITE) and Ministry of Transportation of Ontario (MTO) standards and specifications to meet the needs of the Region of Durham. All information is based on, but not necessarily limited to, the aforementioned manuals. As a general guide, all signal devices, pavement markings and signage installations shall be designed in accordance with the latest books of the OTM. As a general guide, all roadside protection shall be designed in accordance with the latest MTO Roadside Design Manual (RDM).

The following design guidelines and specifications shall be used for the preparation of all traffic control device engineering and legal drawings for Region of Durham approval. It is difficult to completely standardize the design of traffic control devices; however, it is intended that uniformity be ensured wherever possible. Refer to the Engineering Submission section for additional required drawing information.

2. Signal Design Methodology

The design of new traffic control devices or modifications to existing traffic control devices may be influenced considerably by various factors. This may include property restrictions, location of services, cost of service relocation, inherent restrictions of existing/future road geometry and existing/conceptual traffic conditions.

Data collection is an essential element of the design process that may establish the type or character of an intersection treatment and traffic control device design. The following data information shall be considered, if applicable, in the design stage for traffic signal devices, associated pavement markings and signage:

1. Speed studies.
2. Vehicle turning movement count data including pedestrian activity.
3. Historical collision statistics, of the past three consecutive years; segregated into annual collisions and frequency of collisions by type and pattern.
4. Durham Safety Improvement Program (DSIP) Information.
5. Available studies (safety audits, intersection reviews, traffic impact studies).
6. Review of existing signal timing plans.
7. Existing/future amenities that will impact subject intersection(s).
8. Aerial photographs.
9. Scope of future road works.

3. Traffic Signal Controller Assembly

The Region of Durham shall supply and install all traffic signal controller assemblies. Controller assemblies may include, but not necessarily limited to, the following:

1. Controller Cabinet.
2. Controller Unit (timer) with 170 Controller phase designations.
3. Malfunction Management Unit (MMU).
4. Remote communication equipment.
5. Bus Interface Units (BIU).
6. Signal Pre-emption Equipment (fire, rail, transit signal priority).
7. Vehicle detection equipment, video monitoring equipment.
8. Pedestrian Button Central Control Unit.
9. Power supply.

4. Traffic Drawing Requirements

4.1 Legal Drawing Approval

In accordance with the Highway Traffic Act, section 144 (31), revised 1997, the final legal drawing (also known as PHM-125) shall be approved by the Regional Municipality of Durham Approval Designee (Manager of Traffic Engineering and Operations).

Where a traffic control signal is located on a road or intersection that falls under the jurisdiction of the Local Municipalities, a municipal official may endorse the legal drawing in addition to the aforementioned approval.

Where a traffic signal is located on a road or intersection that falls under the jurisdiction of the MTO, an MTO approval designee shall solely approve the legal drawing. The legal drawing shall be generated using the Ministry's latest PHM format.

4.2 Legal Drawing Detail

Traffic legal drawings shall be generated using the latest Traffic Engineering and Operations drawing format. Refer to Engineering Submissions section for general drawing requirements.

The legal drawings shall show the intersection details on all approaches for a distance from the intersection that directly affects the traffic control device operation. Legal drawing detail should be identified to scale to include, but not necessarily limited to, the following items:

1. Intersection geometry.
2. Edge of roadway, pavement, shoulders, curb and gutter, sidewalks and raised islands.
3. Regulatory signs that directly affect the traffic control device operation.
4. Pavement markings including lane width, storage and parallel lane length and taper length dimensions.
5. Location, orientation, and type of traffic signal head including mounting heights.
6. Location of pedestrian signal heads and pushbuttons if any.
7. Emergency optical pre-emption equipment.
8. Roadway lighting.
9. Communication equipment used for traffic equipment (pedestals and termination points).
10. Vehicle detection equipment and detection areas, if applicable.
11. Blank-out signs and active or continuous flashing advance warning signs and other types of equipment operated by the signal controller.
12. Location and orientation of the controller cabinet.
13. Pole footings, electrical conduit and appurtenances, chambers, maintenance holes, hand holes, junction boxes, traffic signal power supply location and grounding rods.
14. Utility poles.
15. Property access/egress locations (i.e., driveways, curb depressions, ramps).

16. Property lines (Right-of-way and easements).

17. Parking meters and parking control.

18. Bus bays, bus stop locations;

4.3 Legal Drawing Scale

1. Traffic Signal Layout view: metric scale shall be 1:250.

2. Roadway Geometric Layout view: metric scale shall be 1:500.

4.4 Construction Drawing Scale

Metric scale shall be 1:250 or 1:500, whichever is appropriate.

5. Traffic Signal Layout

5.1 Application Heuristics

1. Signal design to include a minimal number of poles.

2. Single member mast arm lengths shall be kept to a minimum.

3. Existing utilities poles shall be utilized for traffic signal equipment and required signage installation, wherever feasible.

4. Design of permanent traffic control signals shall include underground electrical conduit unless otherwise advised by the Region of Durham.

5. Pedestrian crossing distances shall be minimal and incorporated into the signal design. Accessibility to pedestrian equipment for mobility impaired shall be addressed, if applicable.

6. Intersection illumination shall be considered in the signal design.

5.2 Temporary Signal Installation

A temporary signal legal drawing is required for all temporary signal applications. Refer to Section 4 for required drawing detail and approvals.

A minimum of two signal heads shall be installed per approach and shall be appropriately positioned. Provide a sufficient length of coiled traffic cable to allow signal head movement to accommodate road reconstruction widening and/or traffic-staging scenarios.

Signal head height, measured from the bottom of backboard, over traveled portion of roadway shall be 5.8 metres.

Temporary signal poles shall be located so as to cause minimal construction interference.

5.3 Signal Heads

For traffic control signals under the jurisdiction of the Region of Durham and Local Area Municipalities, the following shall apply:

1. Traffic signal heads for new and reconstructed signals shall be Region of Durham approved, 3- section or 4-section, 300 millimetre diameter light emitting diode (LED) lenses with reflective backboards.

2. Bicycle signal heads for new and reconstructed signals shall be Region of Durham approved, 3- section, 300 millimetre diameter LED lenses with no backboard.

3. Pedestrian signal heads for new and reconstructed signals shall be LED.

5.4 Signal Head Spacing

Maximum horizontal signal head spacing between primary and secondary signal heads per approach shall be 15.0 metres.

Minimum horizontal signal head spacing between primary and secondary signal heads per approach shall be six metres.

Maximum longitudinal signal head spacing between primary and secondary signal heads per approach shall be five metres.

5.5 Signal Head Distance from Approach Stop Line

Maximum longitudinal distance from the primary signal head to the approach stop line shall be 50.0 metres.

Minimum longitudinal distance from the primary signal head to the approach stop line shall be 20.0 metres.

5.6 Pedestrian Push Buttons

Pedestrian push buttons for new and reconstructed signals shall be accessible buttons as per the Accessibility for Ontarians with Disabilities Act (AODA) and in accordance with applicable TAC and OTM guidelines.

5.7 Controller Cabinet Footing and Location

New traffic controller cabinet footing shall be:

1. Installed as per Region Standards unless otherwise advised by the Region.
2. Installed adjacent to existing/proposed sidewalk where applicable or on reasonably level ground and is accessible to maintenance personnel/ vehicles.
3. Located on the approach side of the roadway nearest to power supply source.
4. Located a minimum distance of 11.0 metres from the power supply source and a minimum distance of 5.5 metres from the nearest grounding plate/ rod.
5. Located outside existing or proposed visibility triangle.
6. Orientated with the back of the controller facing the intersection in such a manner where at least 50 per cent of the traffic signal displays are visible.

5.8 Power Supply Control Cabinet

Power supply shall be obtained from existing overhead power sources, nearest to proposed/existing traffic controller footing. Should an overhead power supply feed not be feasible, a concrete footing for an underground power supply assembly shall be installed. Hydro meters to be installed where required by hydro authority. Liaison with hydro authority will be required for approval to connection to existing hydro plant.

5.9 Power Supply Grounding Equipment

Service grounding shall be a minimum distance of 5.5 metres from hydro service pole used. A minimum of 2 ground plates or 4 ground rods, spaced at three metres in any pattern, shall be installed at the power supply control cabinet location as per Region Standards.

5.10 Signal Head Minimum Height

Signal head height, measured from the bottom of backboard, over traveled portion of roadway shall be five metres. Top elevation of secondary signal head, in centre median island, shall match top elevation of primary signal head.

5.11 Mast Arms

Proposed single member mast arm lengths shall be kept to a minimum. Mast arms shall be single member spun aluminum. The following arm lengths shall be used:

Single Member Mast Arm Nominal Lengths

Metres	**Feet**
1.8	6
2.4	8
3.0	10
3.7	12
4.6	15
5.5	18
6.1	20
6.7	22
7.6*	25*

* Not recommended for use unless absolutely necessary

5.12 Primary Mast Arm Minimum Length

Minimum length of signal member mast arm used for a primary signal head shall be three metres.

5.13 Maximum Mast Arm Length for Wood Pole

Maximum length of single member mast arm mounted to a wood utility pole shall be 4.6 metres. The structural integrity of a proposed joint use utility pole shall be evaluated for joint usage feasibility and approval shall be provided in writing from respective utility owner and/or operator.

5.14 Traffic Pole Spatial Separation

All new traffic poles shall have a minimum spatial separation of seven metres.

All new traffic poles shall be installed with a minimum spatial distance of two metres measured from the back edge of curb or edge of traveled pavement to the edge of traffic pole footing, except when pole is being used to mount accessible pedestrian buttons.

5.15 Pole Footings

Pole footings shall be installed as per Region Standards.

Refer to the following chart for concrete pole footing applications:

Concrete Footing	**Specification Drawing**	**Base Type**
Signal pole with mast arm and signal head	S-400.010	Type III
Signal Pole in centre median island *	S-400.010	Type III /Type II*
Pedestrian Pole (no mast arm)	S-400.010	Type I
Pedestrian Push Button Pole	OPSD 2200.041	
Lighting Pole	S-400.010	Type III

*Note: Type II concrete footing should not be used unless absolutely necessary and shall be used in retrofit applications where space constraints exist.

6. Electrical Conduit

6.1 General

Electrical conduit installation will be necessary where no conduit exists or where existing conduits are deemed by the Region of Durham to be substandard or deficient. Minimum required utility clearances must be satisfied in the proposed conduit layout design.

Installation of electrical conduit will be required for future signalized intersections necessitated by land development, unless otherwise advised by the Region, and shall be laid in a ring around the intersection, if required. All necessary Electrical Safety

Authority (ESA) inspections shall be conducted, and approval certificates shall be forwarded to the Region of Durham’s Traffic Engineering and Operations Division.

6.2 Intersection Conduit Location

Conduit shall generally run parallel or perpendicular to the roadway and routed to run in a direct line between poles and handholes. A maximum of 2 - 90-degree sweep bends shall be allowed in a single conduit run where absolutely required. Conduit run redirection angle shall not exceed 90 degrees.

Proposed horizontal location of conduit shall accommodate future road works, if applicable.

6.3 Conduit Material

Conduit material shall be polyvinyl chloride (PVC) for open cut trench or high-density polyethylene (HDPE) for trenchless installation or approved equivalent (refer to Approved Manufactures’ Product List).

6.4 Conduit Installation Method

All new conduits shall be installed using the open cut method. Where conduit is proposed to cross an undisturbed paved road or surface (i.e., without proposed road works), it shall be installed using the directional bore method.

6.5 Conduit Sizing

Traffic signal electrical conduit shall be minimum 75 millimetres in diameter for the following applications:

1. Crossing all signalized intersection legs
2. From pole footing to handhole.

Interconnect shall be a minimum of two - 75 millimetres diameter conduit.

6.6 Conduit to Controller Cabinet Footing

Two - 75 millimetre and one- 50 millimetre conduit shall be placed from the surface mount controller footing or pole mount controller footing to nearest handhole where conduit branches outward to cross road legs.

6.7 Inductive Loop Lead-in Conduit

Conduit shall be 25 millimetre in diameter where two or less inductive loop lead cables are proposed for same lead in conduit.

Conduit shall be 32 millimetre or two 25 millimetre in diameter where three or more inductive loop lead- in cables are proposed for the same lead in conduit.

6.8 Conduit Cover

Conduit cover crossing a roadway shall be minimum 1200 millimetre and minimum 760 millimetres in all other areas.

6.9 Interconnect Conduit Horizontal Location

1. Urban Installation
   - Under normal urban conditions (urban cross section), interconnect conduit shall be located as per Region Standards.
2. Rural Installation
   - Under normal rural conditions (rural cross section), the interconnect conduit shall be located two metres from the edge of pavement. Final handhole rim elevation shall be

installed 50 millimetres below final gravel shoulder grade. For future locating an equipment marker shall be placed at the property line perpendicular to the handhole.

Proposed location of conduit shall accommodate future road works, if applicable.

7. Electrical Handholes

7.1 Handholes Locations

Electrical handhole assemblies shall be installed as per specification. A minimum of 1 handhole shall be installed at:

1. All intersection quadrants.
2. Within raised median islands as per Region Standards.

New handholes shall not be installed within paved boulevard areas including sidewalks, unless absolutely necessary.

One handhole on each intersection quadrant shall be grounded as per specification. Proposed location of handholes shall accommodate future road works, if required.

7.2 Handhole Spacing

Proposed handholes shall be located a minimum distance of two metres from proposed or existing pole footings, measured from the center of the handholes and/or pole footings.

Handhole spacing for interconnect conduit shall not exceed 150 metres between 450 millimetre diameter handholes and shall not exceed 400 metres between rectangular handholes.

8. Vehicle Presence Detection

8.1 General

Vehicle presence detection should be as shown on the supplied drawings unless otherwise advised by the Region of Durham. Non-intrusive detection will be the preferred method for vehicle and bicycle detection. In situations where inductive loops are requested, all loops shall be a simple loop configuration and installed in base asphalt prior to top or final lift installation, if possible.

Under normal applications all detection zones shall be centered within the traveled lane. Detection zone or loop locations must be as per OTM, Book 12.

8.2 Loop Material and Sealants

Inductive loop cable must meet International Municipal Signal Association (IMSA) specifications.

8.3 Left Turn Advance Detection Location

Left turn advance detection zone must be setback 15.0 metres from nearest edge of stop bar and centered within the lane. Left turn advance setback detection zone should be installed, regardless of warrant values or justification, in new signal installations or reconstructions.

8.4 Detection zone or inductive Loop Sizing

Left turn lane stop bar	1.8 metres by 15.0 metres
Left turn lane setback (advance)	1.8 metres by nine metres
Shared through & right turn lane stop bar	1.8 metres by 15.0 metres
Right turn lane setback	1.8 metres by nine metres
Through lane stop bar	1.8 metres by 15.0 metres
Long Distance (extension)	1.8 metres by 1.8 metres
Central System / Permanent Count Station (PCS) (diamond configuration)	1.8 metres by 1.8 metres

8.5 Permanent Count Station (PCS)

Permanent count station installation and location must be confirmed by the Region of Durham. In locations where non-intrusive detection is used, detection should be installed where the detector is least likely to be obstructed. Inductive loops should be located where there is minimal or no potential of queuing of vehicles.

8.6 Long Distance/Dilemma Detection (Extension Loops)

Long distance detection operating parameters as shown on the supplied drawings unless otherwise advised by the Region of Durham.

8.7 Emergency Vehicle Pre-Emption

Emergency vehicle pre-emption (EVP) at signalized intersections in the Region of Durham is achieved by using stroboscopic light emitting device technology for emergency fire vehicles.

The Region of Durham shall supply all necessary EVP equipment and determine installation requirements including vehicle detection ranges and traffic signal phase sequencing.

8.8 Transit Signal Priority (TSP)

Transit Signal Priority in the Region of Durham is achieved by the use of a variety of systems and signal timing strategies to reduce transit vehicles delays at traffic control signals where a priority transit route is identified.

9. Signal Timing, Operation and Capacity Analysis

9.1 General

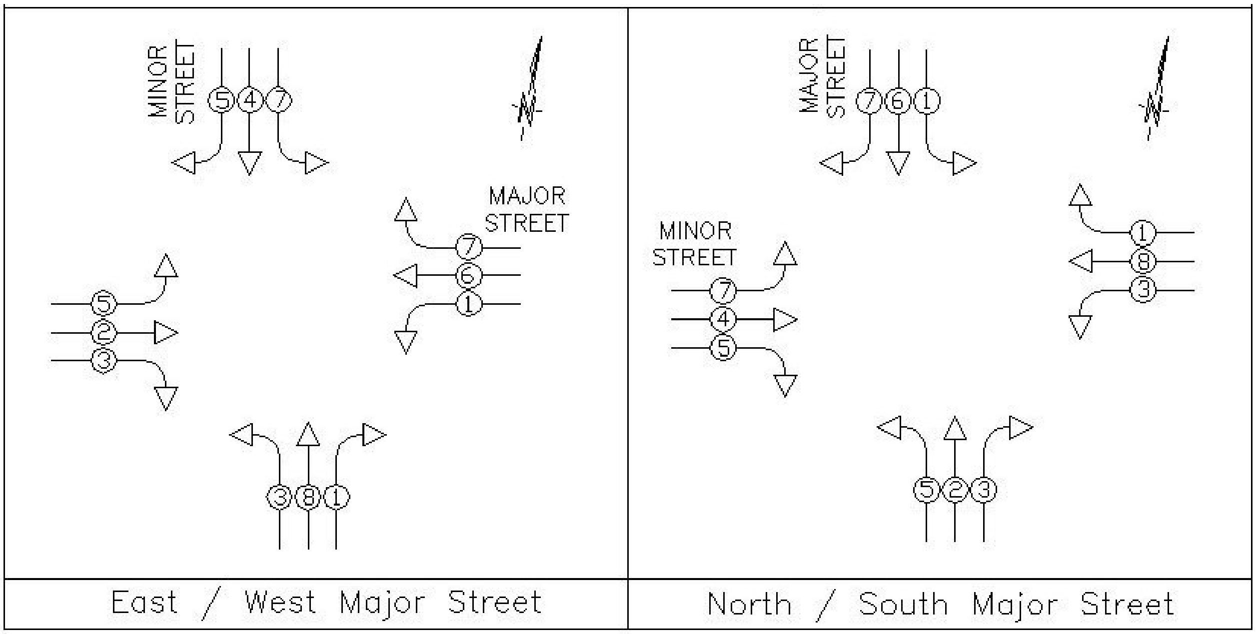
The Region of Durham's traffic control signal timing and operation guidelines should be used as a supplement to the standards and specifications provided in the following manuals to meet the needs of the Region of Durham:

1. Highway Capacity Manual (HCM)
2. Ontario Traffic Manual (OTM) - Ministry of Transportation Ontario (MTO)
3. Institute of Transportation Engineers (ITE)
4. Canadian Capacity Guide (CCG)

All information contained herein is based on, but not necessarily limited to, the above mentioned manuals. Timing and operational methodologies/principles should be in accordance with the latest revisions of these manuals. The guidelines should be used to ensure uniformity wherever possible. The Works Department will review and approve all signal timing, operational and capacity reviews for existing and new/proposed traffic control devices within the Region of Durham.

Existing and proposed traffic control devices should use Controller timer phasing configurations as shown in Figure 1.

Figure 1 – Controller Phase Configuration



9.2 Traffic Analysis

Intersection capacity and signal analysis must be generated using Synchro version 10 or otherwise approved by the Region. Analysis must include modeling of signal coordination and progression where applicable.

The modeling of existing conditions may require variances of some of the following guidelines to provide an actual representation of existing conditions. Digital copies of the Synchro models used for analysis must be provided for review by the Region of Durham's Traffic Engineering and Operations Division (TEO).

Any proposed parameter variances must be approved by the Region of Durham's TEO.

Traffic signal analysis not conforming to these guidelines will be disregarded unless the Region grants prior approval.

9.3 Analysis Reports

Numerous reports can be created through Synchro and Sim Traffic to provide Measure of Effectiveness (MOE). The MOE's values normally required by the Region include volume/capacity ratio, approach delay/LOS, intersection delay, queue length.

Analysis must include the following reports where applicable and/or requested by the Region of Durham:

1. Intersection: Lanes, Volumes, Timings
2. Intersection: Queues
3. HCM 2000: Signalized
4. HCM 2000: Unsignalized
5. Measures of Effectiveness: Summary

9.4 Turning Lane Minimum Requirement

Traffic signals must have sufficient storage lengths to accommodate for a 10 to 15-year projected vehicle growth volume unless otherwise advised by the Region of Durham. An ultimate level of service ‘D’ (60 per cent) should be achieved unless otherwise advised by the Region.

9.5 Signal Timing Practices and Methodologies

Current signal timing operations and strategies are derived from sound engineering practices and extensive traffic operation experience.

A traffic subsystem consists of a minimum of two traffic control signals, strategically coordinated by time of day to achieve efficient network progression and minimize delay.

The intention is to provide main street traffic with optimized green bands to suit the desired coordination pattern or progression flow.

A review or analysis of an existing signal network including the addition of a new traffic signal within the network must adhere to established rationale and guidelines as approved by the Region of Durham’s TEO. Any recommended cycle lengths must be conducive to the Region’s established sub-system progression, level of service and delay optimization, where applicable.

It is required that prior to any traffic signal optimization, there be initial consultation with the Region of Durham’s TEO.

9.6 Minimum Timing Intervals

The following minimum timing intervals must be used for the timing of new traffic control signals:

Regional Timing Minimums

Interval	**Minimum (seconds)**
Circular green for roads posted at less than 70 km/h (urban)	20.0 (Main Road) 8.0 (Minor Road)
Circular green for roads posted 70 km/h or more (rural)	20.0 (Main Road) 12.0 (Minor Road)
Circular green extension unit (at stop bar)	3.0
Advanced green (arrow)	5.0
Advanced green extension unit (arrow)	3.0
Flashing advanced green clearance	3.0
Circular amber	3.0
All red	1.0
Pedestrian walk	7.0
Pedestrian clearance	5.0

9.7 Amber Clearance

Amber clearance interval is based on ITE Canada's Canadian Capacity Guide for Signalized Intersections. It is a function of approach speed and grade, variable perception- reaction time, deceleration/acceleration rate constant primarily due to gravity.

$$A = t+v/(2a+70.6g)$$

Where:

A = amber interval clearance time represented in seconds.

t = variable perception and reaction time represented in seconds.

1.8 seconds for operating speeds of 70 kilometres per hour or greater (rural areas only).

One second for operating speeds of less than 70 kilometres.

v = operating speed (85^{th} percentile or 10 kilometres per hour above posted) of vehicle represented in kilometres per hour.

a = average deceleration rate (11 kilometres per hour per second).

70.6 = factor of two times the acceleration of gravity represented in kilometres per hour per second.

g = average approach road grade (per cent grade divided by 100). Measured within 50 metres of the stop line. Downhill grade is negative.

9.8 All-Red Clearance

All-red clearance interval is a function of the width of the intersection with or without crosswalks, length of vehicle, and approach speed.

The formula will be expressed as follows for intersections without crosswalks:

$$R = 3.6(w+L)/v_{veh}$$

The formula will be expressed as follows for intersections with crosswalks:

$$R= 3.6(P+L)/v_{veh}$$

Where:

R = length of the all-red clearance interval to the nearest 0.1 second.

3.6 = factor to convert kilometres per hour to metres per second.

w = width of the intersection represented in metres, measured from the near side stop line to the farthest edge of conflicting traffic lane.

P= width of the intersection represented in metres, measured from the near side stop line to the farthest edge of conflicting pedestrian crosswalk line.

L= length of vehicle, use six metres.

V_{veh} = operating speed (85th percentile) of sampled vehicles represented in kilometres per hour, through the intersection. For signals installed at a tee intersection, the left turn operating speed shall be the same as the approach posted speed.

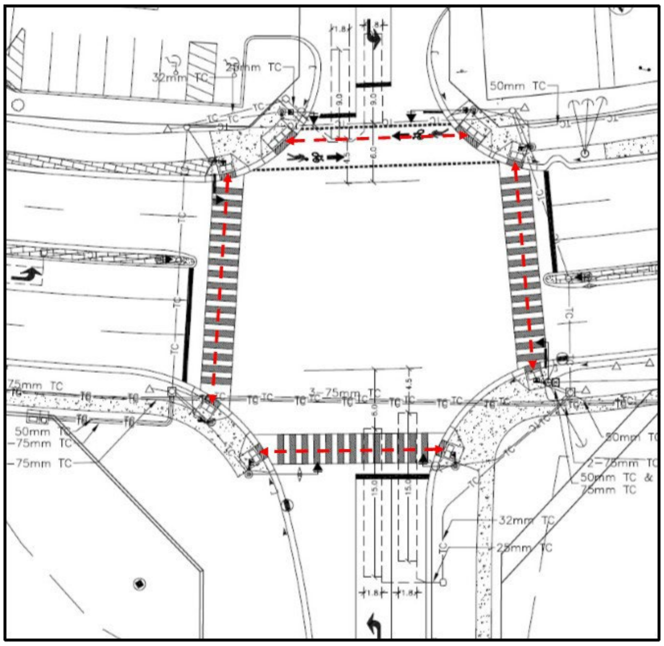
9.9 Pedestrian Walking Speed

The pedestrian walking speed used to calculate pedestrian walk and clearance intervals is one metre per second.

9.10 Pedestrian Crossing Distance

Pedestrian crossing distance is measured from back of curb to back of curb. The distance is measured at the centre of the crosswalk lines on all sides of the intersections. For measurements in the same direction, the greater of distances must be used in calculations.

Figure 2 – Method to measure pedestrian crossing distances



9.11 Pedestrian Crossing Time - 'Walk' Interval

The pedestrian walk interval must be determined using a modified version of the Canadian Capacity Guide (CCG). A 'Walk' interval of seven seconds shall be applied to all signalized intersection with pedestrian facilities. A 'Walk' interval of 10.0 seconds may be applied in specific situation as approved by the Region of Durham's TEO.

9.12 Pedestrian Crossing Time – Clearance Interval (Flashing Hand + Solid Hand)

The CCG recommends providing a reasonable amount of pedestrian clearance interval so that a pedestrian who has just stepped off into the crosswalk, even during the last moment of the walk indication, will have enough time to complete their crossing. The pedestrian clearance interval generally consists of the Flashing Hand plus solid hand indications. Although the Ontario Traffic Manual states that the 'Flashing Hand' time and countdown indicator may include the amber and all-red intervals, it is not a requirement. Instead, the Region uses the non-displayed countdown time during the amber and all- red intervals as an extra buffer at the end of the Flashing Hand.

The Region has chosen to calculate the 'Flashing Hand' time using the following formula, always rounding up:

Flashing Hand indication = $(d_w / v_{ped1.0})$ – amber – all-red where:

d_w is the pedestrian crossing distance (in metres) v_{ped} is the pedestrian walking speed of one metre per second

Sample Calculation:
d_w = 32.0 m $v_{ped\ 1.0}$ = 1.0 m/s amber = 4.1 seconds all red= 2.5 seconds

$= d_w / v_{p1.0}$ – amber – all red

= (32.0 / 1.0) – 4.1 – 2.5

= 25.4 seconds

Therefore, total flashing hand time = 26 seconds

Sample Calculation (including Walk and Flashing Hand):
d_w = 27.0 m $v_{ped\ 1.0}$ = 1.0 m/s amber = 3.7 seconds all-red = 2.2 seconds

$= d_w / v_{p1.0}$ – amber – all red

= 7 + (27.0 / 1.0) – 3.7 – 2.2

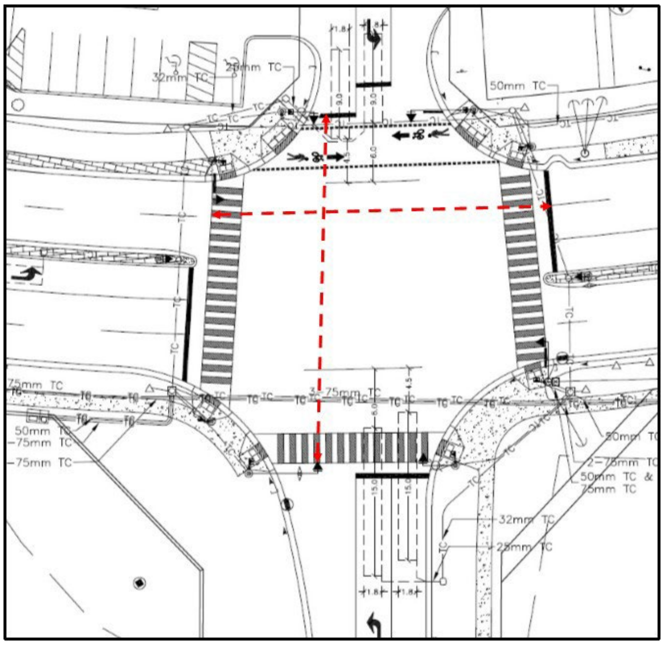
= 28.1 seconds

Therefore, the total crossing time (Walk and Flashing Hand) = 29 seconds

9.13 <u>Vehicle Crossing Distances</u>

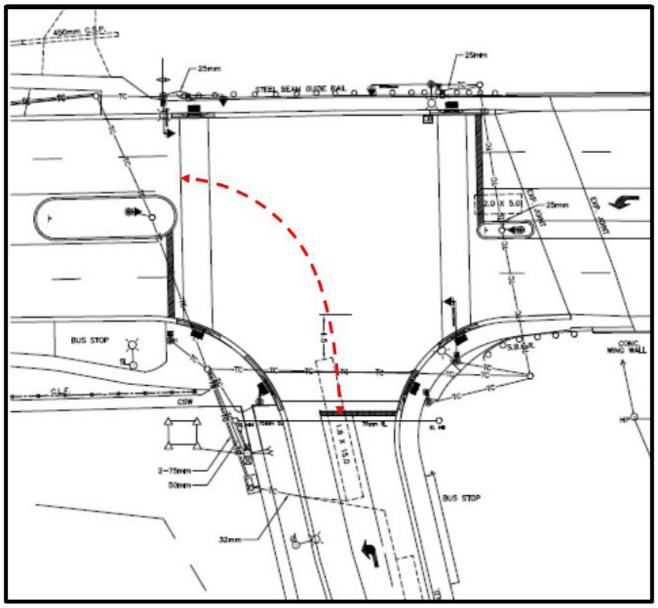
Vehicle crossing distance is measured from the stop bar to the furthest crosswalk line at the receiving side of the intersection for a four-leg intersection.

Figure 3 – Method to measure vehicle crossing distances
(a four leg intersection with crosswalks)



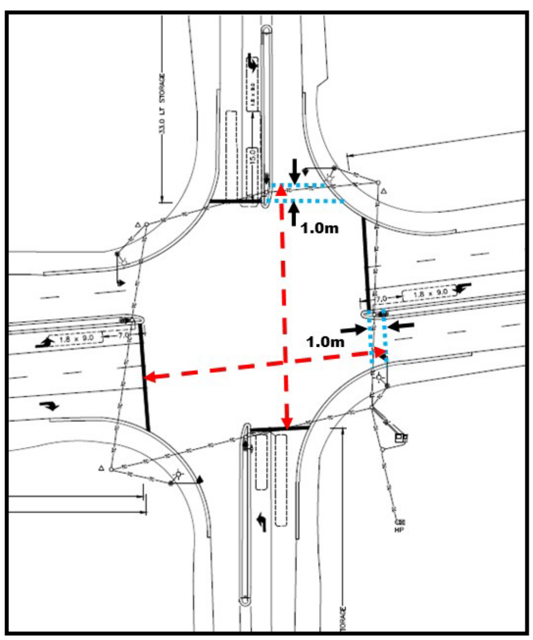
A T-intersection is measured by the driving path from the left turn stop bar to the furthest crosswalk line at the receiving side of the intersection.

Figure 4 – Method to measure vehicle crossing distances
(T- intersection)



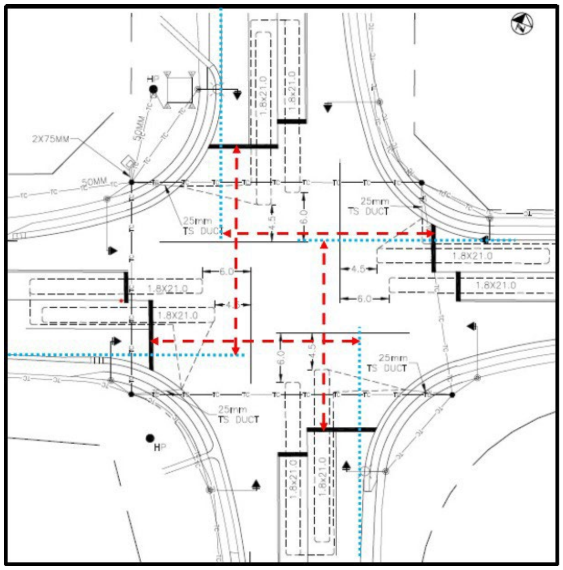
A rural intersection with pedestrian heads and no crosswalk lines is measured from the stop bar to one metre back of the opposing stop bar (where the crosswalk would be located).

Figure 5 - Method to measure the vehicle crossing distance at an intersection with pedestrian heads and no crosswalk lines.



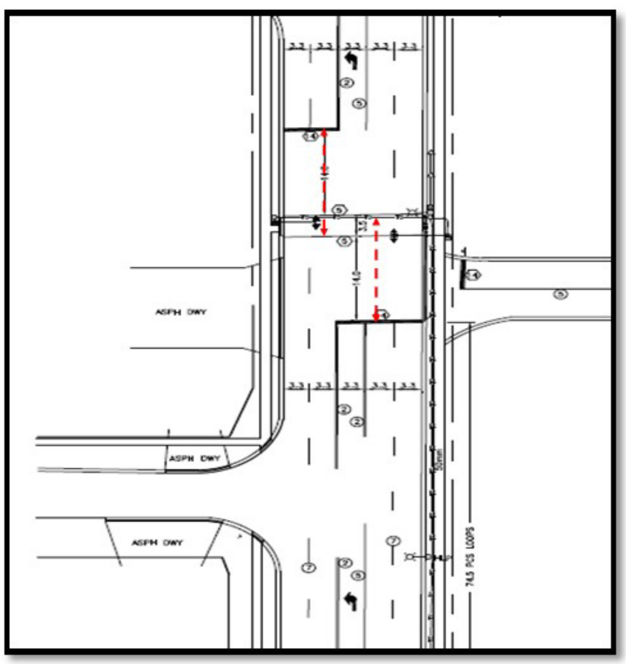
A rural intersection with no pedestrian crossings and no crosswalk lines is measured from stop bar to the furthest conflicting edge of the roadway.

Figure 6 – Method to measure the vehicle crossing distances (full intersection without crosswalks)



Intersection Pedestrian Signals (IPS) and Midblock Pedestrian Signals (MPS) is measured from the stop bar to the far side of the crosswalk line.

Figure 7 – Method to measure the vehicle crossing distances at an IPS or MPS



9.14 Countdown Pedestrian Signals (CPS)

CPS are used to improve the positive guidance of pedestrians and to better convey the international crossing symbols of the walk person and flashing upright hand. CPS will countdown in descending fashion for the total duration of the flashing hand indication. Countdown pedestrian signals are installed in all directions at signalized intersection locations.

9.15 Cycle Length Determination

In most cases, the cycle time for a signal is pre-determined by the requirements of the signals within a network sub-system. The most critical intersection(s) in the sub-system usually govern and its cycle time is applied to all other intersections within the sub- system.

In all cases, the Region of Durham's TEO will review and approve all signal timing, operational and capacity reviews for existing and new/proposed traffic control devices.

As a guide, cycle lengths within a Central Business District (CBD) (see list below for what characterizes a CBD) must not exceed 80 seconds. Cycle length must not exceed 120 seconds in all other areas unless otherwise approved by the Region of Durham's TEO.

9.16 Area Type

Central Business District (CBD) characteristics are:

1. Narrow rights-of-way.
2. Frequent on street parking.
3. Vehicle blockages.
4. Abundant taxi or bus activity or both.
5. Small curb radii.
6. Limited use of exclusive turn lanes.
7. High pedestrian activity.
8. Dense population (high rise apartments, condominiums, or offices).
9. Mid block curb cuts.
10. Closely spaced intersections (less than 215 metres).
11. One-way streets.

All these characteristics may not necessarily be present for an intersection to be deemed as a CBD. It is expected that the Traffic Engineering and Operations Division will be consulted in uncertain situations.

9.17 Signal Spacing and Access Management

Access Management of private driveways and the spacing of signalized intersections depend greatly upon the cycle length and projected speed and flow of traffic for a particular corridor. An emphasis should be made at the planning stages in determining the proper spacing of signals.

Reference should be made to the ‘Arterial Corridor Guidelines’ (February 2007), section 3.2 Frequency of Intersections for signal spacing of the approved and to the current version of the Durham Region’s Official Plan Amendment.

10. Intersection Modelling Guidelines

10.1 Ideal Saturation Flow Rate in Synchro

Use the default ideal saturation flow of 1900 passenger car per hour of green per lane (pcphgpl) for HCM related analysis. This saturation flow should also be used for Synchro analysis.

In the absence of field measured saturation flows, a number of adjustment factors must be considered and, if applicable, used to adjust the Ideal Saturated Flow values on each approach lane of the intersection. These adjustment factors are shown in the “Lane” and “Volume” Windows in Synchro.

The following conditions are applicable for field measured saturation flows:

1. A saturation flow (SF) based on a one-day SF flow study would not be accepted unless it is factored down by five per cent.
2. The “factoring down” would be waived if the consultant undertook at least three studies for the same movement on different days of the same week or over three consecutive weekends for weekend studies.
3. In case of doubt, the Region could request details of the saturation flow study from the consultant.

The above values are not recommended for use in planning or operational design.

Traffic patterns and characteristics may change over time so typical or conservative values should be used to account for this possible variability.

10.2 Lane Widths in Synchro

Actual lane width should always be noted however in the absence of actual measurements use standard lane widths of:

1. 3.5 metres for through lanes
2. 3.25 metres for exclusive left and right turn lanes
3. Lane width greater than 4.8 metres should be entered as two lanes

10.3 Approach Road Grade

Approach grades should be used in analysis. Use a negative grade for downhill conditions.

10.4 Lost Time Adjust in Synchro

Use zero seconds for all movements unless otherwise approved by the Region of Durham's TEO.

10.5 Right Turn on Red in Synchro

Right turns on red (RTOR) are added to the capacity of the lane as determined using the saturation flow rate and the effective green time. The number of right turns (in pcus) is a function of the conflicting vehicular and/or pedestrian flows and the presence of a right-turn lane. Field observations have shown that RTOR tends to be zero or near zero where there are heavy conflicting pedestrian movements.

For operational analysis, the default value should indicate the use of RTOR unless otherwise substantiated by field studies

For planning analysis, include RTOR volume by especially if a separate right- turn lane (not a bus bay) is provided since future pedestrian volumes cannot be accurately predicted.

Right turns on red in exclusive right turn lanes should not be included if:

1. The queue of through traffic normally extends beyond the start of the exclusive right turn lane effectively hindering vehicles from turning right.
2. The right turn lane is less than 15.0 metres long (exclusive of taper), is being used as a loading bay by buses and the total expected dwell time is more than five per cent of the total green time in an hour.

10.6 Lane Utilization Factor

Synchro applies lane utilization factors based on HCM 2000 Exhibit 10-23 Default Lane Utilization Adjustment Factors. These are to be used unless recent field studies support changing them. If adjustments are made the supporting field studies are to be provide in the appendix of the analysis report and approved by the Region of Durham's TEO.

10.7 Traffic Volume

Total vehicle (car and heavy) volume for the peak hour for the corresponding movement.

Existing Volumes
Total vehicle volume for the corresponding movement as per the turning movement count for the peak hour being modelled.

Existing traffic volumes must be current volumes (no more than two years old). If current counts cannot be obtained from the Region, new counts are to be conducted and submitted in the appendix of the analysis report. Unless otherwise specified, the volumes supplied by the Region are intersection volumes that have been counted at the stop lines.

Future Volumes
Growth factor can be applied (see Growth Factor) to existing volumes or proposed future volumes used with a growth factor of one. All justification for proposed growth rate and future volumes to be provide in report.

10.8 Conflicting Pedestrians

Pedestrian volumes are shown on the counts provided by the Region.

10.9 Peak Hour Factor (PHF)

Consideration for peak flow rates is important in capacity analysis.

1. AM, PM, and Weekend peak periods, use PHF = 0.92.
2. Noon/Weekend off peak periods for through movements, use PHF = 0.90.
3. If a large factory or sports arena releases all of its vehicles at once, the traffic may have a large spike and a lower PHF should be used.

10.10 Growth Factor (GF)

For operational analysis of current conditions, a GF of one shall be used.

For planning analysis, current volumes can be adjusted to show future volumes by applying an appropriate Growth Factor.

To calculate a growth factor based on a growth rate over several years, use the following formula:

$$\text{Growth Factor (GF)} = (1+r)^Y$$

Where:

$r=$ growth rate (per cent converted to decimal)

$Y=$ number of years (typically 10 and not exceeding 15 years)

For example, the growth factor for three per cent growth over 10 years is:

$GF = (1 + 0.03)^{10} = 1.34$

10.11 Heavy Vehicles

Input as the percentage of the total volume which as classified as truck/heavy vehicles on the turning movement count.

Heavy vehicles are defined as those with more than four tires touching the pavement. The number of heavy vehicles for each movement is shown on the turning movement counts provided by the Region.

10.12 Existing Signal Timings

Existing signal timings and mode of control must be current data and obtained from the Region. The information used in capacity analysis should not be more than six months old.

10.13 Mode of Control

The mode of control for existing signals in the Region of Durham must remain the same during intersection analysis. The mode of control should be identified as follows:

1. “Pre-timed” for fixed timed intersections.

   Example of Recalls:

   - ‘Max’ for all phases

2. “Actuated-Coordinated” for semi-actuated intersections

   Example of Recalls:

   - ‘C-Max’ for main street (phase 2 and 6)
   - ‘None’ for side street (phase 4 and 8)

3. “Actuated-Coordinated” for fixed timed intersections with callable left turnphases.

   Example of Recalls:

   - ‘C-Max’ for main street (phase 2 and 6)
   - ‘Max’ for side street (phase 4 and 8)
   - ‘None’ for advance phases (1, 3, 5, 7)

4. “Actuated-Uncoordinated” for fully-actuated intersections

   Example of Recalls:

   - ‘None for main street (phase 2 and 6)
   - ‘None’ for side street (phase 4 and 8)

10.14 Synchro Sim Traffic

Sim Traffic is the animation portion of Synchro that simulates the data inputted into Synchro. Generally, the simulations provide a good representation of existing and future impacts but could yield results that are contradictory to reports created in Synchro.

Network animation attempts to provide realistic macroscopic scenarios for the entire network. Individual intersection simulation results may be different from that shown in Synchro due to network constraints.

The Region recommends setting the following parameters under “Options”, “Intervals and Volumes” and “Intervals”:

1. The “Recording” start time should be the start of the period being simulated.

2. For the “Seeding” duration time, use the time it takes for a vehicle to travel from one end of the network to another. If the travel time is typically 10 minutes during the study period, the “Seeding” duration should be 10 minutes.

3. The “Seeding” start time should be the “Recording” start time less the “Seeding” duration (i.e., the “Seeding” start time should be 7:50 a.m. if a “Recording” start time is 8:00 a.m., and the “Seeding” duration is 10 minutes.).

4. The “Recording” duration should be a minimum of 60 minutes; this duration should allow sufficient time for any queuing problems to build up and so appear in the simulation.

11. Pavement Markings and Signage

11.1 General

As a general rule, all pavement, hazard and delineation marking designs shall conform to the Ontario Traffic Manual, Book 11, and applicable Ontario Provincial Standard Specifications for material, application and reflectorization and shall be approved by the Region of Durham Traffic Engineering and Operations Division.

Legal and engineering drawings shall denote markings as per Region of Durham standard.

Federal seasonal use restrictions must be followed when applying alkyd/ solvent-based paint.

Pavement marking materials for:

1. Transverse markings and symbols must be durable in the form of thermoplastic, cold screed extruded or spray plastic (Methyl Methacrylate).

2. Longitudinal marking materials may be durable in the form of thermoplastic, cold screed extruded or spray plastic (Methyl Methacrylate) or waterborne paint.

Signage:
All proposed signage shall conform to their respective Ontario Traffic Manuals, unless otherwise specified. The Region of Durham may supply signage, unless otherwise advised. Existing utility poles are acceptable for mounting, if feasible, and within driver’s range of vision.

11.2 Stop Bar

As a general rule, main street stop bar(s) shall be perpendicular to the main street roadway. Minor street stop bar(s) shall be parallel to main street roadway.

Stop bars shall be 45 centimetres in width.

As a general rule, stop bar locations at signalized intersections shall be set back from centreline of the cross street a minimum distance of 17.0 metres where cross sections of the intersecting roadway are less than five lanes and 20.0 metres where cross sections are greater than or equal to five lanes. Applicable vehicle turning templates shall determine the appropriate location of left turn lane stop bars. Where centre median islands are required, the setback distance is then measured to the median island bullnose and the stop bar relocated one metre back of the bullnose.

For non-signalized intersections, the location of the stop bar on the minor street will be determined using applicable vehicle turning templates and as noted in Unsignalized intersection markings.

11.3 Pedestrian Crosswalk

Crosswalks shall be three metres wide and shall be set back from traveled edge of roadway

3.5 metres, if feasible with an absolute minimum offset of 0.6 metres as per OTM. The offset from the crosswalk line to the stop bar shall be one metre. Crosswalk lines shall be 10 centimetres in width. The location of the pedestrian crossings shall determine the location of pedestrian crossing ramps. Consider implementing ladder crosswalk markings at high pedestrian traffic areas, where approved by the Region. With ladder bar crossings, crosswalk lines shall be 20 centimetres in width with 60 centimetres ladder bar spaced at 60 centimetres. Anti- slip material must be used. (i.e., aluminum oxide/ corundum).

At crosswalks, two tactile walking surface indicator plates (760 millimetres x 610 millimetres) shall be used with a minimum curb drop of 1.6 metres. At crossrides and locations where crossrides intersect with the adjacent crosswalk (sidewalk ramp locations with more than two tactile plates), radial tactile walking surface indicator plates shall be used to follow the curb radius with a curb drop. Curb drops shall match the full width of the crossride.

11.4 Unsignalized intersection markings

Maximum distance between stop bar and traveled edge of pavement (no pedestrian crosswalk)	Three metres
Minimum distance between stop bar and traveled edge of pavement (with pedestrian crosswalk)	4.1 metres
Minimum separation between stop bar and crosswalk	One metre
Minimum stop bar width	45 centimetres
Minimum crosswalk width if Region three metres standard is not feasible	2.5 metres
Minimum crosswalk set back distance from traveled edge of pavement	0.6 metres
Minimum length of centre line tail (local road)	30 metres
Minimum length of centre line tail (arterial road)	60 metres
Typical centre line placement (no turning lanes)	One half of road width
Typical crosswalk placement on center	One half of sidewalk/ road depression width

11.5 Lane Widths

Lane width dimensions shall be shown at all longitudinal marking deviations. For standard lane width refer to Roads and Entranceways Design Specifications.

11.6 Vehicle Turning Radius Template

Appropriate vehicle turning template shall be used to verify vehicle clearance paths.

11.7 Mast Arm Signs

Mast arm mounted street name signs shall be supplied by the Region of Durham and shall be installed as per Regional Standards. Mast arm mounted signs are not required at intersection pedestrian signal (IPS) locations and commercial entrances.

11.8 Tourism and Private Establishment Signing

Tourism and private establishment signing proposed to be installed on a regional road right-of-way shall meet the criteria outlined in the Region of Durham Tourism and Private Establishment Signing Policy.

12. Intersection Lighting

The scope of the lighting design shall be determined on a site-specific basis. Refer to the Design Specifications for Roadway Lighting section for illumination requirements. As a general rule, illumination shall be provided at the pedestrian crossing areas and/or the entry points of the intersection departure lanes. Liaison with local municipalities and/or hydro authorities may be required for approvals and coordination of works.

13. Roadside Protection

All new and remedial roadside protection works shall primarily be based on the Ministry of Transportation Ontario (MTO) Roadside Design Manual (RDM) issued in 2017, Municipal Ontario Provincial Standard Specifications (OPSS), and Ontario Provincial Standard Drawings (OPSD). Supplemental guidance may be provided by the Roadside Safety Policy Update: Guidelines, Standard Drawings, and Specifications, the Guide Rail and End Treatment. Selection Guidelines adopted by the Regional Municipality of Durham, and the Transportation Association Canada (TAC) Geometric Design Guide for Canadian Roads (GDG), 2017.

13.1 Roadside Protection Justification

Where applicable, the following roadside mitigation treatment should be considered using collision data & engineering judgement when determining an appropriate cost- beneficial treatment to reduce the probability and/or severity of collisions with a roadside obstacle or area of concern:

1. Remove the obstacle.
2. Relocate the obstacle to a location to reduce the probability of it being impacted.
3. Redesign the obstacle so that it can be safety traversed.
4. Reduce the impact severity of the obstacle buy using an appropriate breakaway design.
5. Shield the obstacle with a barrier or crash cushion.
6. Delineate the obstacle.
7. Reduce the posted speed.

These alternatives can be achieved through:

1. Flattening of slopes through the use of fill.
2. Relocation of utilities (utility poles, utility pedestals, etc.).
3. Improvements to drainage.
4. Increases in shoulder widths and edge of rounding to improve clear zones.
5. Redesigning signs to be breakaway.

13.2 Design of Roadside Protection Systems

All new roadside protection systems shall be MASH Compliant. Acceptable roadside safety systems for installation are:

1. OPSD 911.132: Tall Wall Concrete Barrier.
2. OPSD 912.102 Steel Beam Guide Rail with Channel (Optional).
3. OPSD 912.185: Type M20 Steel-Beam Guide Rail.
4. OPSD 912.188: Type M30 Steel-Beam Guide Rail Adjacent to Concrete Curb.
5. OPSD 912.189: Type M30 Steel-Beam Guide Rail Adjacent to Sidewalk.
6. OPSD 912.430 (structure connection) in conjunction with OPSD 912.315 (transition rail) and OPSD 912.130 (SBGR with channel) for concrete barrier and parapet walls.
7. MTOD 912.450 (structure connection) for three-and four-tube railings only.

The appropriate length of need, width of the clear zone and runout length shall be determined using the MTO RDM as guidance. Shy line offsets and flare rates should be designed with reference to the TAC GDG.

Steel-beam guide rail with channel can be used as a structure connection as per OPSD912.430. Channels should only be introduced as a structure, as they provide less cushioning to occupants on impact. Transitions from steel-beam guide rail with channel to Type M steel-beam guide rail shall adhere to OPSD 912.315.

Three Cable Guide Rail should not be used on any new installation. Existing three- cable systems can remain in place until they are forecasted to be upgraded or removed as part of the Capital Roadside Protection Program based on their Net Risk Score.

However, it is preferred that these systems be re-evaluated and modernized to Type M steel-beam guide rail with any adjacent project.

In urban areas, roadside furniture (such as benches, trash cans, and bicycle racks) can present roadside hazards. Ideally these items should be located as far away from the travel lane as possible, as it is not always feasible to install guide rail due to space limitations.

13.3 Materials

The material specification for steel-beam guide rails shall follow OPSS.MUNI 1504. Refer to OPSS.MUNI 1505 for the material specification for steel-beam guide rails with channel.

13.4 Construction

The construction of roadside protection systems shall adhere to the following OPSS construction specifications:

1. OPSS.MUNI 721: Steel-Beam Guide Rail
2. OPSS.MUNI 723: Energy Attenuators
3. OPSS.MUNI 732: Steel-Beam Energy Attenuating Terminal
4. OPSS 740: Concrete Barriers
5. OPSS 741: Temporary Concrete Barriers

Before beginning any construction for the installation of guide rails, contractors shall call Ontario One Call to determine the location of any underground infrastructure or utilize the contractor’s vacuum truck.

13.5 Temporary Construction Zones

Temporary barrier systems should prevent a vehicle from penetrating, vaulting over, or wedging under the installation. Acceptable temporary barrier systems include:

1. Temporary Concrete Barrier (TCB)
2. Quickchange Moveable Barrier (QMB)
3. Temporary Steel Barrier (TSB)
4. Temporary Type M SBGR

When Temporary Concrete Barrier (TCB) is used, a temporary restraint system shall be added at locations of open excavation and/or drop behind it. In particular at bridge rehabilitation or replacement projects where the TCB is along the entire deck length and there is open excavation behind TCB (desk replacement, conversion to semi-integral, removal of approach slab etc.) The TCB should be connected to the bridge deck by pinned or bolted connection per OPSD 911.162 to 911.168

Approach ends of all temporary barrier system installations require appropriate end

terminals in accordance with Section 5.2 of the MTO RDM. To provide a positive connection between an existing concrete barrier system and a temporary concrete barrier installation, refer to Section 5.3 of the MTO RDM.

13.6 Approach and Departure End Treatments

Durham Region accepts the following MASH compliant end treatments:

1. OPSD 922.150: MASH Slotted Rail Terminal System
2. OPSD 922.165: MASH SoftStop Terminal System Installation
3. MTOD 922.171: MASH MAX-Tension Terminal System
4. OPSD 922.186: MASH Sequential Kinking Terminal System
5. OPSD 912.255: Type M Leaving End Treatment

Existing crash cushions can remain in place until the end of their service lives, or until they are forecasted to be removed as part of the Capital Roadside Protection Program based on their Net Risk Score.

13.7 Structure Connections

1. OPSD 912.314 Transition from Type M to Existing Steel Beam Guide Rail
2. OPSD 912.315 Transition from Type M to Steel Beam Guide Rail with Channel
3. OPSD 912.430 Steel Beam Structure Connection
4. MTOD 912.450 Steel Beam Structure Connection – Tube Railing

13.8 Delineation

Object and snowplow markers shall be installed for delineation with reference to the following OPSDs:

1. OPSD 984.201: Approach End Delineation
2. OPSD 984.202: Leaving End Delineation
3. OPSD 984.203: Temporary Delineation for Energy Attenuators
4. OPSD 984.204: Permanent Delineation for Energy Attenuators

Dual sided reflectors are required every three posts to ensure adequate visibility of guide rail systems bi-directionally in dark and poor weather conditions.

13.9 Shallow Culverts

OPSD 912.245: Type M Steel Beam Guide Rail Long Span Treatment Installation (7.62 metres)

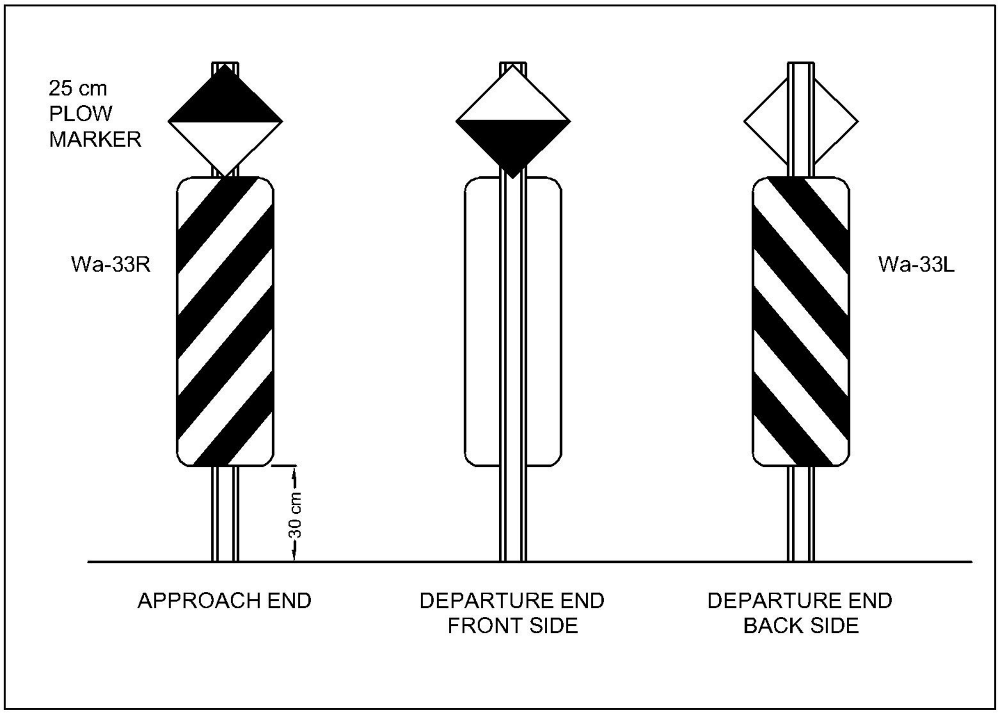
OPSD 912.246 Type M Steel Beam Guide Rail Long Span Treatment Installation (5.71 metres)

13.10 Hazard / Plow Markers and Reflectors

Figure 6 illustrates the regional standard for the appropriate installation of guide rail hazard and plow markers. Wa-33L and Wa-33R stickers placed on extruder heads are no longer necessary.

Dual sided reflectors are required every three posts to ensure adequate visibility of guide rail systems bi-directionally in dark and poor weather conditions.

Figure 6 – Plow Hazard Markers



14. Commissioning of Signals

The Region of Durham shall commission all new signals under Durham Region and Local Municipalities jurisdiction.