TRUE NORTH SAFETY GROUP

RED HILL VALLEY PARKWAY INQUIRY

PRINCIPAL DESIGN AND MAINTENANCE STANDARDS, GUIDELINES AND GENERAL PRACTICES FOR ONTARIO HIGHWAYS

Your File: 96189
TNS File No.: **220007**

Prepared For:

Mr. Robert A. Centa
Paliare Roland Rosenberg Rothstein LLP
155 Wellington Street West, 35th Floor

Toronto, ON, M5V 3H1

March 9, 2022

Russell Brownlee
B.Sc., M.A. Sc., FITE, RSP_1, P.Eng.

TABLE OF CONTENTS

1.0 INTRODUCTION

Paliare Roland Rosenberg Rothstein LLP retained True North Safety Group as an independent contractor to provide transportation safety expert consulting services to the Red Hill Valley Parkway Inquiry, Justice Herman Wilton-Siegel, Commissioner.

On February 1, 2022, we were asked to prepare an expert report regarding the principal design and maintenance standards, guidelines and general practices for highways in Ontario related to the following:

- Pavement friction.
- Posted, operating and design speeds.
- Sightlines.
- Lane and shoulder widths.
- Roadway alignment and grades.
- Crossfall and drainage.
- Traffic control devices.
- Roadside safety.
- Road maintenance.

2.0 PRINCIPAL DESIGN AND MAINTENANCE STANDARDS, GUIDELINES, AND GENERAL PRACTICES

2.1 Scope

The Ontario Highway Traffic Act (HTA)[1] defines a "highway" to include "*a common and public highway, street, avenue, parkway, driveway, square, place, bridge, viaduct or trestle, any part of which is intended for or used by the general public for the passage of vehicles and includes the area between the lateral property lines thereof*".

For the purposes of this report, the term "*highway*" will be used to define a free flow facility with grade-separated interchanges, restricted access, and prohibition of pedestrians and cyclists, i.e., controlled access highway, freeway, or expressway. All other road facilities noted above in the HTA definition will be referred to in this report as local or municipal roads.

As previously discussed, we do not have extensive expertise in pavement design or friction testing. Therefore, we have limited our discussion of pavement friction to the requirements/guidance outlined in geometric design manuals.

2.2 Assessment Period

An assessment period of 2002 to 2020 was established to generally encompass the design, operations, and maintenance periods of the Red Hill Valley Parkway. Where applicable, we have made reference to a range of standards/guidance that may have changed during the assessment period.

2.3 Highway Design

2.3.1 Standards, Guidelines and Policies

Highway geometric design guidance includes the following primary components:

- Sight distances
    - Stopping sight distance to allow motorists to perceive, react and stop for an object in their path at the design speed, i.e., sufficient sight distance over a hill to observe and react to an object or stopped vehicle in the travel lane on the far side of the hill.
    - Decision sight distance to allow motorists sufficient time to make a decision regarding maneuvering their vehicle or adjusting their speed in

[1] Highway Traffic Act, R.S.O. 1990, CHAPTER H.8.

complex situations[2] where information may be perceived incorrectly, decisions are required, or control actions are required (as opposed stopping sight distance which involves a complete stop for an obstacle).

  - Sight lines approaching and at the at-grade intersections to observe and react to the traffic control and conflicting road users, i.e., a vehicle stopped at an intersection attempting to pick a gap in traffic to make a turn at or cross the intersection;

- Lane and shoulder widths;
- Vertical curves representing the hills and valleys experienced as you travel along the highway alignment;
- Grades - Overall uphill (i.e., rise) and downhill (i.e., fall) of the highway surface. Roadway grades are positive if rising in the direction of travel and negative if falling in the direction of travel. The grade along a roadway is expressed as a percentage; that is rise or fall in metres over a horizontal length of 100 m;
- Pavement crossfall which is the slope of the roadway from the pavement surface towards the edges of the highway to facilitate surface water drainage off the roadway;
- Horizontal curves including:
  - Circular curves – with a design speed related to the curve radius, wet weather friction values[3] and superelevation;
  - Spiral curves – a curve with a constantly varying radius, to provide a smooth transition between a tangent road section and the circular curve; and
  - Superelevation – design with the outside road edge to be higher than the inside road edge to counteract the horizontal forces on a vehicle around a curve.
- Interchange design; and
- Roadside safety including ditches, fixed hazards, and protection[4].

The principal design standards/guidelines for the design of highways in Ontario are:

- **1985 Geometric Design Standards for Ontario Highways, Ministry of Transportation of Ontario[5] (the '1985 MTO Design Guide')** – The 1985 MTO Design Guide was developed for use on Provincial highways and roadways; however, some municipal entities have adopted it for the design and contract specifications of their roadways. It has been our experience, that this latter group included mostly

[2] For example, complex intersections or interchanges, unusual or unexpected changes in the roadway environment, construction zones, demanding driver workload areas due to a heavy traffic/conflict, advertising, and/or traffic control devices.
[3] Pavement friction design values will be address in a subsequent section of this report.
[4] Roadside design will be addressed in a subsequent section of this report.
[5] Geometric Design Standards for Ontario Highways, Ministry of Transportation of Ontario, 1985.

counties, smaller rural communities, and indigenous road authorities that may have received their technical knowledge transfer from regional MTO offices.

- **1999 Transportation Association of Canada's Geometric Design Guide for Canadian Roads[6] (the '1999 TAC Guide') including the 2017 update[7] (the '2017 TAC Guide')** – The 1999 TAC Guide and 2017 TAC Guide were developed to achieve design consistency amongst Canadian federal, provincial, territorial, and municipal road authorities. In 2017, the MTO adopted the entirety of the 2017 TAC Guide except the roadside design chapter. It has been our experience that most major cities and towns, and many counties, applied the 1999 and 2017 TAC guides.

2.3.2 Compliance and Application

Ontario municipalities are not legally bound to follow any of the above design standards or guidelines. Industry good practice is to apply either the 1985 MTO Design Guide or the 1999/2017 TAC Guide, with jurisdictional design exceptions. **Table 1** provides the intent and context for application of the TAC guides.

In general, it has been our experience that major cities in Ontario applied and specified the 1999/2017 TAC Guide for highway design, unless they were making modifications to a provincial highway within their jurisdiction that was the subject of a connecting link agreement[8] with MTO. In these latter instances, MTO practices would be specified.

[6] Geometric Design Guide for Canadian Roads, Transportation Association of Canada, 1999.
[7] Geometric Design Guide for Canadian Roads, Transportation Association of Canada, 2017.
[8] Under a connecting link agreement, a local municipality operates and maintains an MTO roadway through a build-up area of a community. When infrastructure or operational modifications are required to the connecting link, they are generally modified based on MTO requirements, as MTO is the facility owner. This circumstance will be inherently applicable to other standard/guideline areas discussed in this report.

Table 1: 1999/2017 TAC Guide application guidance.

Reference	Application
1999 TAC Guide	Ideally, it was hoped that this Guide would allow the sponsoring federal, provincial and territorial agencies to discontinue maintenance of their own guides. It will become apparent to the reader and the user of this Guide that that hope was not entirely realistic. Consideration of design trade-offs, particularly those related to safety, and introduction of the design domain concept certainly serve to discourage "table-picking". However, a designer should not be expected to return to first principles every time a design decision is required. Some of these decisions will be made as a matter of policy by user agencies. These will need to be set out by individual agencies in documents supplementary to this Guide.
1999 TAC Guide	Standards Over the past several decades, design standards, usually based on laws of physics or empirical data, have been provided to designers. Increasingly, designers have come under pressure to reduce construction costs by using lower standards, on the assumption that even minimum standards are always acceptable. Design dimensions that do not meet standards do not necessarily result in an unacceptable design - and dimensions that meet standards do not guarantee an acceptable design. In assessing the quality of a design, it is not appropriate simply to consider a checklist of standards. The design has to be reviewed with judgement; standards merely assist the reviewer in making those judgements. This Guide, therefore, does not attempt to establish "standards" and, indeed, does not use the term.

Reference	
2017 TAC Guide	Historically, road design "standards" usually based on laws of physics or empirical data have been provided to designers. These "standards" were not intended to be rigid, or to be applied uniformly in all cases. Different road authorities in Canada placed different emphasis on quality of service, cost, environmental issues and road safety. Such differences were considered matters of policy, but it has generally been assumed that design merely had to meet "standards" and the results would be satisfactory. In most cases, that was a valid assumption, since traditional design "standards" based on laws of physics offer substantial margins of safety under most operating conditions.
2017 TAC Guide	The role of guidelines is to provide information and background to assist the designer in choosing the appropriate combination of features, dimensions, and materials for a given design. However, it is important to understand that guidelines themselves do not state the dimensions for any given design. That is the designer's responsibility.

2.4 Pavement Friction Design

2.4.1 Standards, Guidelines and Policies

The pavement friction value, represented by the coefficient of friction ('f'), represents the available friction between vehicle tires and the roadway. Friction values used in highway design have measured values either longitudinally (i.e., the design friction value assumed between the road and tire for a vehicle to stop within the stopping sight distance) or laterally (i.e., the lateral friction required for a vehicle to travel around a curve in the roadway). **Figure 1** shows the lateral friction concept associated with a vehicle travelling around a high-speed curve with the roadway superelevated to the inside of the curve.

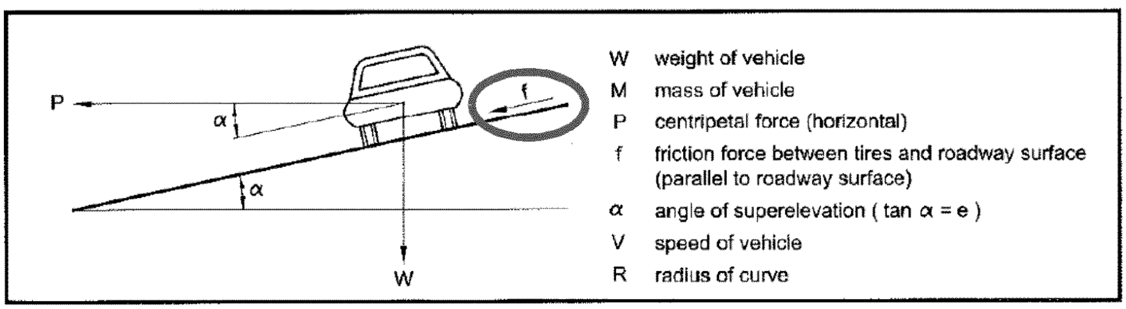

Figure 1: Dynamics of a vehicle on a horizontal curve (TAC, 1999/2007).

The 1999/2017 TAC Guide and the 1985 MTO Design Guide recommend conservative design values[9] for available friction based on worn pavement, worn tires and wet

[9] Friction values assumed in design do not represent the available (i.e., actual) friction between the tires and road, but a much lower value with safety and driver comfort factors considered.

pavement conditions. The highway design does account for intermittent reduced friction conditions due to snow, slush or icy road surface conditions. Pavement friction is required to maintain traction around curves and allow for acceptable braking, as required for stopping sight distance. **Figure 2** shows the rounded friction value assumptions for stopping sight distance on level pavement[10] outlined in the 1999 TAC Guide[11] (i.e., longitudinal friction).

The 1999 TAC Guide applies a range of friction values between 0.28 to 0.38 as a function of the design speed to calculate stopping sight distance. The 2017 TAC Guide applies a constant 3.4 m/s^2 deceleration rate, which is approximately equivalent to a constant friction value of 0.343. The effect of the assumption of a constant deceleration value in the 2017 TAC Guide is marginally lower stopping sight distance requirements at higher design speeds (80 to 120 km/h) under the current standards.

[10] Stopping sight distances are adjusted for uphill or downhill grades/slopes.
[11] Similar lateral friction values are assumed in Table C2-1 (Minimum Stopping Sight Distance on Wet Pavement) in the 1985 MTO Design Guide.

Table 1.2.5.3 Stopping Sight Distance for Automobiles[4] and Trucks with Antilock Braking Systems[8]

Design Speed (km/h)	Assumed Operating Speed* (km/h)	Perception and Reaction time (s)	Perception and Reaction distance (m)	Coefficient of Friction	Braking Distance (m)	Stopping Sight Distance (rounded) (m)
40	40	2.5	27.8	0.38	16.6	45
50	47 - 50	2.5	32.7 - 34.7	0.35	24.8 - 28.1	60 - 65
60	55 - 60	2.5	38.2 - 41.7	0.33	36.1 - 42.9	75 - 85
70	63 - 70	2.5	43.7 - 48.6	0.31	50.4 - 62.2	95 - 110
80	70 - 80	2.5	48.6 - 55.5	0.30	64.2 - 83.9	115 - 140
90	77 - 90	2.5	53.5 - 62.5	0.30	77.7 - 106.2	130 - 170
100	85 - 100	2.5	59.0 - 69.4	0.29	98.0 - 135.6	160 - 210
110	91 - 110	2.5	63.2 - 76.4	0.28	116.3 - 170.0	180 - 250
120	98 - 120	2.5	68.0 - 83.3	0.28	134.9 - 202.3	200 - 290
130	105-130	2.5	72.9 - 90.3	0.28	155.0 - 237.6	230 - 330

Note: * Range of assumed operating speed is from average running speed for low-volume conditions to design speed.

Figure 2: Stopping sight distance for automobiles and trucks with antilock braking systems (1999 TAC Guide).

Figure 3 shows the maximum lateral friction value assumptions for the design of horizontal curves in the 1999 TAC Guide[12]. These lateral friction values are based on a tolerable degree of occupant discomfort and provide a reasonable margin of safety against skidding under normal driving conditions. Road curves are designed to avoid skidding conditions; therefore, the lateral friction factors for roadway design are substantially less than the available coefficient of friction between vehicle tires and the roadway. The 1999 TAC Guide lateral friction values shown in **Figure 3** are consistent with existing design guidance in the 2017 TAC Guide.

[12] A similar range and magnitude of lateral friction values are assumed in the 1985 MTO Design Guide; however, there are slight variations in actual values.

Table 2.1.2.1 Maximum Lateral Friction for Rural and High Speed Urban Design[1]

Design Speed (km/h)	Maximum Lateral Friction for Rural and High Speed Urban Design
40	0.17
50	0.16
60	0.15
70	0.15
80	0.14
90	0.13
100	0.12
110	0.10
120	0.09
130	0.08

Figure 3: Maximum lateral friction for design (1999 TAC Guide).

2.4.2 Compliance and Application

Ontario municipalities are not legally bound to follow any of the above design standards or guidelines. Industry good practice is to apply either the 1985 MTO Design Guide or the 1999/2017 TAC Guide for pavement friction and the associated geometric design components noted above. In general, it has been our experience that major cities in Ontario applied and specified the 1999/2017 TAC Guide for highway design during the assessment period.

2.5 Traffic Control Devices

2.5.1 Standards, Guidelines and Policies

Traffic control devices include signs, markings, and delineation on our highways. The principal designs standards/guidelines for the design of highways in Ontario are:

- **Ontario Traffic Manual**[13] - The purpose of the Ontario Traffic Manual (OTM) is to provide information and guidance for transportation practitioners and to promote uniformity of treatment in the design, application and operation of traffic control devices and systems across Ontario. **Table 2** provides the primary OTM books applicable to highways. It has been our experience that the OTM is the primary resource applied by MTO and most municipalities in Ontario.
- **1985/1995 Manual of Uniform Traffic Control Devices for Canada (MUTCDC)** [14] **including the 2014**[15] **and 2021**[16] **updates** – The purpose of the MUTCDC is to provide national standardization for the user of traffic control devices for the control of traffic and the provision of information to drivers and other road users. It had been our experience that some Ontario municipalities have applied the entirety of, or specific guidance/signs outlined in the MUTCDC; however, these are the exception.

Table 2: Ontario Traffic Manual (OTM) books applicable to highways.

OTM Book	Traffic Control Device	Publication Date
1	Introduction	2001
2	Sign Patterns and Fabrication	2004
5	Regulatory Signs	2000
6	Warning Signs	2001
7	Temporary Conditions	2014
8	Guide and Information Signs	2010
10	Dynamic Message Signs	2007
12	Traffic Signals	2012

13 Ontario Traffic Manual, Ministry of Transportation of Ontario, 2000.
14 Manual of Uniform Traffic Control Devices for Canada, Transportation Association of Canada, 1985-1995.
15 Manual of Uniform Traffic Control Devices for Canada, Transportation Association of Canada, 2014.
16 Manual of Uniform Traffic Control Devices for Canada, Transportation Association of Canada, 2021.

2.5.2 Compliance and Application

In general, it has been our experience that major municipalities in Ontario apply the OTM for traffic control device guidance. Ontario municipalities are not legally bound to follow OTM as noted in **Table 3**; however, it has been applied as industry good practice by Ontario municipalities for the past two decades.

Table 3: OTM application guidance.

Application Guidance
The traffic practitioner's fundamental responsibility is to exercise engineering judgement and experience on technical matters in the best interests of the public and workers. Guidelines are provided in the OTM to assist in making those judgements, but they should not be used as a substitute for judgement.
Design, application and operational guidelines and procedures should be used with judicious care and proper consideration of the prevailing circumstances. In some designs, applications, or operational features, the traffic practitioner's judgement is to meet or exceed a guideline while in others a guideline might not be met for sound reasons, such as space availability, yet still produce a design or operation which may be judged to be safe. Every effort should be made to stay as close to the guidelines as possible in situations like these, to document reasons for departures from them, and to maintain consistency of design so as not to violate driver expectations.

2.6 Design Speed and Posted Speeds

2.6.1 Standards, Guidelines and Policies

The principal standards/guidelines for the selection of design speed and posting of speed limits on Ontario highways are:

- **The Highway Traffic Act**[17] – provides regulations related to unposted statutory rates of speed[18] in Ontario (i.e., 50 km/h within a local municipality or urban built-up areas and 80 km/h for rural and high-speed environments), and the ability and general provisions for provincial and municipal road authorities to prescribe a rate of speed different from the statutory rates.
- **OTM Book 5: Regulatory Signs** – provides guidance on the design and placement of maximum speed limit signs once a road authority determines the applicable rate of speed to post.
- **OTM Book 6: Warning Signs** – provides guidance on determining and posting advisory and ramp speeds for specific roadway attributes that require advance warning as they may not meet the intended operating, design or posted speed of the overall highway.
- **1985 MTO Design Guide and the 1999/2017 TAC Guides** – provide general guidance and ranges for selecting design speeds and posted speeds for various classifications of roadway facilities; however, they to do not provide prescriptive guidance on selecting or posting speed limits.
- **Methods and practices for setting speed limits: An informational report**[19] **(the 'FHWA speed report')** - a guideline produced by the Federal Highway Administration describes three approaches for setting speed limits including an engineering approach, expert system approach, and safe systems approach.
- **Canadian Guidelines for Establishing Posted Speed Limits**[20] **(the 'TAC Speed Guide')** - provides recommendations to assist transportation practitioners to determine speed limit management procedures, which enhances the effectiveness and credibility of posted speed limits. The guidelines provide an evaluation tool to assess appropriate posted speed limits based on the classification, function, and physical characteristics of a roadway. An automated spreadsheet is provided to facilitate the evaluation of posted speed limits.

[17] Highway Traffic Act, R.S.O. 1990, c. H.8
[18] All unposted roadways are assumed to have a 50 or 80 km/h rate of speed based on their location and environment noted above. This speed is inferred and can be enforced by police services. If a road authority wishes to post a speed on a roadway different than the statutory speeds outlined in the HTA, it may do so through regulation (for provincial highways) or by-law (for municipal roadways), and it must be explicitly posted.
[19] Methods and practices for setting speed limits: An informational report (No. IR-133). Federal Highway Administration, 2012.
[20] Canadian Guidelines for Establishing Posted Speed Limits, Transportation Association of Canada, 2009.

2.6.2 Compliance and Application

There is no commonly applied standard/guideline establishing posted speed limits on highways in Ontario, beyond the statutory speed outlined by the HTA. There are no legal or regulatory requirements for establishing the appropriate design speed or posted speed on Ontario roadways.

Typically, common practice is to select a 'design speed' of 10 to 20 km/h over the posted speed limit for a paved roadway. The design speed is applied in decision-making regarding the appropriate road design features (i.e., road/shoulder widths, horizontal curves and vertical curves, and roadside design and protection) and traffic control devices. The 1985 MTO Design Guide allows a design speed range of 90 to 120 km/h to be selected for highways, with a 90 km/h design speed to be considered only in the instance of urban freeways.

Based on our experience, the design speed of a planned highway is generally selected as a function of the roadway classification and the intended posted speed. We are unaware of any instances where a road authority has proactively and explicitly applied one of the speed limit setting/assessment tools noted above (i.e., the FHWA Speed Report or the TAC Speed Guide) at the planning and design stages of a highway. Generally, the overall design criteria are specified at the outset of the design process including the design speed.

Once the design speed is selected, the highway features are designed, at a minimum, to the prevailing guidance outlined in **Section 2.3**. Where specific highway features or operations cannot be provided to meet the design speed criteria and/or motorist expectations of the posted speed, regulatory and warning traffic control devices are used to set expectations for appropriate operating speeds, i.e., the application of OTM Book 5 and 6 guidance.

It is our experience that Ontario road authorities apply a range of methods to assess the posted speed limits along their existing roadways[21] with the most common being the 85th percentile method[22] or the application of the TAC Speed Guide methodology. The assessment of the posted speed of an existing roadway is generally undertaken based on collision history, speed compliance issues, speeding complaints or substantial changes to the nature and function of the roadway compared to when it was designed and constructed.

---

[21] Roadways that have been constructed and are in operations.
[22] Setting the posted speed limit at or within 5 to 10 km/h of the 85th percentile speed. The 85th percentile speed is measured in the field and represents the speed at which 85 percent of the traffic is travelling at or below.

2.7 Illumination

2.7.1 Standards, Guidelines and Policies

The principal guidelines for highway illumination on Ontario municipal highways are:

- **2006 Guide for the Design of Roadway Lighting**[23] **(the 'TAC Illumination Guide')**.
- **2001 Illumination of Isolated Rural Intersections**[24] **(the 'TAC Rural Illumination Guide')**.
- **2000 Roadway Lighting, ANSI/IESNA RP-8-00**[25] **('RP-8-00') and update in 2014**[26] **('RP-8-14')**.
- **2012 FHWA Lighting Handbook**[27].

The MTO applies the Ministry Policy for Highway Illumination[28] for its highways; however, we do not have experience with municipal road authorities applying the MTO policies.

2.7.2 Compliance and Application

In general, it has been our experience that major municipalities in Ontario apply the TAC Illumination Guide and/or RP-8-00/RP-814 guidelines. We have applied these illumination guidelines in consulting work and legal liability matters, as they are the primary guidelines we see referenced in municipal design guidance, tenders, and contracts.

Ontario municipalities are not legally bound to follow any of the above illumination guidelines, warranting criteria, or specifications. **Table 4** provides application guidance excerpts from the TAC Illumination Guide and RP-8-00. The TAC Illumination Guide and RP-8-00/RP-814 guidelines represent industry good practice regarding recommended lighting levels once the decision is made to illuminate a municipal highway.

Table 4: TAC Illumination Guide application guidance.

Reference	Application Guidance
TAC Illumination Guide	The contents of this Guide have no legislative authority and are not to be interpreted as minimum standards by which road authorities are to be judged. Similarly, this manual is not intended to be used as a basis for establishing civil liability.

[23] Guide for the Design of Roadway Lighting, Transportation Association of Canada, 2006.
[24] Illumination of Isolated Rural Intersections, Transportation Association of Canada, 2001.
[25] Roadway Lighting, ANSI/IESNA RP-8-00, 2000.
[26] Roadway Lighting, ANSI/IESNA RP-8-00, 2014.
[27] FHWA Lighting Handbook, Transportation Research Board (TRB), 2012.
[28] Ministry Policy for Highway Illumination, Policy, Planning and Standards Division, Directive #PLNG-B-05, 2002.

Reference	
TAC Illumination Guide	The purpose of this Guide is to provide comprehensive design guidelines for the use of lighting devices for roadways and associated facilities. The contents of this Guide have no legislative authority and are not intended to be interpreted as minimum standards by which roadway lighting is to be judged.
RP-8-00	**1.0 INTRODUCTION** **1.1 Purpose of this Standard Practice** The primary purpose of this Standard Practice is to serve as the basis for design of fixed lighting for roadways, adjacent bikeways, and pedestrian ways. The Standard Practice deals entirely with lighting and does not give advice on construction. Its purpose is to provide recommended practices for designing new continuous lighting systems for roadways. It is not intended to be applied to existing lighting systems until such systems are redesigned. It has been prepared to advance the art, science, and practice of roadway lighting in North America. Roadway lighting includes pedestrian and bikeway lighting when it is associated with the public right-of-way (**see Figure 2**). The decision to provide or upgrade roadway lighting at a particular location should be made on the basis of a study of local conditions. Once a decision has been made to provide lighting, this publication provides the basis for designing an appropriate system.

2.8 Road Maintenance

2.8.1 Standards, Guidelines and Policies

The principal standards/guidelines for highway maintenance of Ontario municipal highways are:

- **Minimum Maintenance Standards for Municipal Roadways (MMS)**[29] – Establishes maintenance standards for highway maintenance related to roadway and shoulder surface conditions, winter maintenance, illumination, traffic signs, and traffic signals. The standards are non-prescriptive regarding the methods or materials for maintenance and do not include pavement friction.

[29] Minimum Maintenance Standards for Municipal Roadways, O. Reg. 239/02, and its amendments, 2007, 2010, 2013 and 2018.

- **The 2003 Ministry of Transportation of Ontario Maintenance Manual[30] (the 'MTO Maintenance Manual')** - The MTO Maintenance Manual is the MTO's governing document for addressing inspection maintenance and repair activities for summer and winter highway maintenance operations. It provides a province-wide reference of MTO's current maintenance standards, practices, and technologies. The MTO Maintenance Manual includes maintenance quality standards (MQS) and maintenance best practices (MBP) for a range of infrastructure elements.

Some municipalities undertake road needs studies[31] on a regular cycle and commonly refer to one or more of the following in undertaking these studies:

- Inventory Manual for Municipal Roads, MTO, 1999.
- Flexible Pavement Condition Rating – Guidelines for Municipalities (SP-022), MTO, 1989.
- Manual for Condition Rating of Flexible Pavements – Distress Manifestations (SP-024), MTO, 2016.

2.8.2 Compliance and Application

The MMS is applied by many municipal road authorities. Municipalities are not required to adopt the MMS; however, once adopted it provides the basis for establishing the state of repair of a roadway. The MMS requirements are non-prescriptive regarding the methods or materials for undertaking maintenance on a highway.

There are many highway and roadside municipal maintenance responsibilities that are not included in the MMS. It has been our experience that municipalities apply jurisdiction-specific policies/practices for many of these other maintenance needs, and there are no commonly applied standards/guidelines for the maintenance of Ontario municipal highways in this regard. While we have observed the occasional municipal road authority reference the MTO maintenance manual, its application/adoption is not commonplace.

2.9 Roadside Design

2.9.1 Standards, Guidelines and Policies

Roadside design relates to the road safety concepts, quantitative analysis of risk and evaluation of forgiving, mitigating and protective devices once a vehicle leaves the travelled portion of the roadway. The clear zone is a fundamental concept applied through the provision of an appropriate road/roadside cross-section and drainage elements to allow errant vehicles to recover safely within the roadside.

[30] Maintenance Manual, Ministry of Transportation of Ontario, 2003.

[31] A Road Needs Study is undertaken to provide an overview of the overall condition of a municipality's road system for project planning and budgeting. The study provides a rating of the general condition of the road system by road section, including such factors as structural adequacy, drainage, and surface condition, and may include a high-level review of horizontal and vertical geometric alignment elements.

The principal standards/guidelines for roadside design on Ontario highways are:

- **1993 Roadside Safety Manual, Ministry of Transportation of Ontario[32] (the '1993 MTO RSM') and its 2017 update (the '2017 MTO RDM')[33]** - the MTO guidance is issued primarily for the direction and guidance of MTO staff and engineering consultants for design of provincial highway projects, and it may also be used as a design guideline by other road authorities in Ontario.
- **The 1999/2017 TAC guides[34]** – provide guidance for Canadian road authorities related to roadside design and protection.
- **Ontario Provincial Standards (OPS)**[35] - The OPS organization produces a comprehensive set of standards and design drawings for use by provincial and municipal road authorities throughout Ontario. OPS specifications and drawings are updated to current practice on a regular cycle of 3 to 5 years.

2.9.2 Compliance and Application

Ontario municipalities are not legally bound to follow any of the above roadside design guidelines, specifications, or design standards.

The 1993 MTO RSM was considered industry good practice in Ontario when released; however, it was not updated for more than two decades, and many Ontario municipal road authorities looked to more current guidance in the 1999 TAC Guide and other North American research for their roadside safety needs. In general, the 1999 TAC Guide guidance reflected more current US research/guidance documented in the Roadside Design Guide, American Association of State Highway and Transportation Officials (AASHTO) guidelines[36] (AASHTO RDG).

In 2017, MTO and TAC released updated guides/manuals, which generally reflect the AASHTO RDG guidance, including recommended clear zone areas. It has been our experience that the majority of the larger municipal road authorities on Ontario applied the TAC guides over the assessment period.

Once the decision was made to provide mitigation or protection of roadside hazards, the majority of Ontario municipalities referenced the OPS in their tender design specifications and contracts.

[32] Roadside Safety Manual, Ministry of Transportation of Ontario, 1993.
[33] Roadside Design Manual, Ministry of Transportation of Ontario (MTO), 2017.
[34] Geometric Design Guide for Canadian Roads, Transportation Association of Canada, 1999 and 2017.
[35] Ontario Provincial Standards (OPS and OPSD), Ministry of Transportation of Ontario available through www.library.mto.gov.on.ca. Various dates.
[36] Roadside Design Guide, American Association of State Highway and Transportation Officials (AASHTO), 2011.

3.0 CLOSING WORDS

We trust that the above assessment responds to your request. Should additional information become available, we reserve the right to amend our opinion.