METROLINX

GO Transit Grade Crossing Design Standard

RC-0506-05RCM-01

Revision 00
Date: July 2022

GO Transit Grade Crossing Design Standard

RC-0506-05RCM-01

Publication Date: July 2022

Preface

This is the first edition of the GO Transit Grade Crossing Design Standard. It describes the design practice and requirements for elements of the Grade Crossing Warning Systems (GCWS) deployed across Metrolinx owned territories. The application of any given element at a specific Grade Crossing will be decided on a case-by-case basis. This document does not define the minimum requirements that must be implemented at every Grade Crossing; it defines the minimum requirements for a given element of the GCWS that must be met at all locations where the element will be implemented.

This document was developed by the Signals & Communications Office and Track Infrastructure Office, Engineering and Asset Management Division, Metrolinx.

Suggestions for revision or improvements can be sent to the Metrolinx, Attention: Manager of Grade Crossings who shall introduce the proposed changes to the Metrolinx Signals and Communications Office and Track Infrastructure Office. The Director of the Signals and Communications Office and Director of Track Infrastructure Office ultimately authorize the changes. The submitted suggestions must include a description of the proposed change, background of the application and any other useful rationale or justification, and the person's name, company affiliation (if applicable), e-mail address, and phone number.

Amendment Record

Revision	Date (DD/MM/YYYY)	Description of Changes
00	11/07/2022	Initial release.

Contents

Figures

1. Introduction

1.1 Purpose

1.1.1 The minimum requirements for Grade Crossings in Metrolinx Territory are specified in the Transport Canada Grade Crossings Standards (GCS).

1.1.2 The purpose of this document is to specify the GO Transit Grade Crossing Design Standard that will supplement the GCS, to address the following Grade Crossing Enhancements and Supplemental features that are planned to be deployed in Metrolinx Territory:

a) Lane channelization (e.g.: medians, flexible bollards),

b) Exit gates, including Vehicle Detection System functionality,

c) Pedestrian gates,

d) Multi-Train Warning Signs,

e) Roadway-embedded and sidewalk-embedded Light-Emitting Diode (LED) arrays,

f) Traffic queue management,

g) Road vehicle logging,

h) Electrification integration,

i) Failure monitoring and remote reporting, and

j) Supplemental elements, including

i) Perimeter fencing and gates,

ii) Anti-trespass panels,

iii) Pavement markings,

iv) Signage, and

v) Construction & temporary crossings.

1.1.3 This document is not intended to specify that the above Grade Crossing Enhancements and Supplemental features must be implemented at every Grade Crossing. The decision to implement any feature at a given Grade Crossing will be made on a site-by-site basis in accordance with section 1.6.

1.1.4 This document does not specify GCWS requirements for private Grade Crossings.

1.1.5 For Grade Crossings owned by Metrolinx (located on Metrolinx property), the requirements of section 11 of this GO Transit Grade Crossing Design Standard document do not apply. For those crossings, the requirements specified in the current GO Design Requirements Manual (DRM) shall apply.

1.2 Citations

1.2.1 The documents listed in Table 1-1: are referenced in the body of this GO Transit Grade Crossing Design Standard.

TABLE 1-1: REFERENCED DOCUMENTS

#	Document #	Issue Date	Document Name
1	SOR/2014-275	Dec 28, 2020	Transport Canada “Grade Crossings Regulations” (GCR)
2	Not Applicable	Jan 1, 2019	Transport Canada “Grade Crossings Standards” (GCS)
3	TC # 12526323	2019-10-30	Transport Canada “Grade Crossing – Handbook” (GCH)
4	ROW Access Control Policy	July 13, 2006	Transport Canada Railway Right of Way Access Control Policy
5	AREMA C&S Manual	2021	American Railway Engineering and Maintenance-of-Way Communications and Signals Manual
6	MUTCD (CDN)	5th Edition	Transportation Association of Canada (TAC) Manual of Uniform Traffic Control Devices for Canada
7	FHWA-SA-18-040/ FRA-RRS-18-001	July 2019	Highway-Rail Crossing Handbook, 3rd Edition
8	Institute of Transportation Engineers (ITE)	ISBN No: 1-933452-12-9.	Preemption of Traffic Signals Near Railroad Crossings, A Recommended Practice
9	RC-0506-03SIG-01	Oct 30, 2020	Metrolinx GO Signals & Communications Standards – General Instructions (GI’s)
10	RC-0506-03SIG-02	Oct 30, 2020	Metrolinx GO Signals & Communications Standards – Standard Codes of Practice (SCP’s)
11	RC-0506-02TRK	Sept 2019	Metrolinx GO Transit Track Standards (GTTS)
12	RC-0401-06	TBD	Metrolinx Fencing & Anti Trespassing Requirements
13	RC-0506-03SIG-08	Apr 2020	Metrolinx GO Signals & Communications Standards – Wayside Signal Structures Specification
14	IEC 60529	Ed 2.1 Feb 2001	Degrees of protection provided by enclosures
15	RC-0401-02	TBD	Metrolinx Whistle Exemption Process Guidelines
16	BS EN 50121-4	Jan 2017	Emission and Immunity of Signalling and Telecommunications Apparatus
17	Not Applicable		Ontario Electrical Safety Code
18	EN50129	Apr 2020	Railway Applications – Communication, signalling and processing systems – Safety related electronic systems for signalling
19	GO-DRM-STD-Rev 4	Sep 2021	GO Design Requirements Manual (DRM)
20	Not Applicable	March 2018	Metrolinx GO Static Signage Catalogue
21	DS-03	Version 3.4, August 2019	Metrolinx Wayfinding Design Standard
22	CSA G40.20-13 / G40.21-13	7th Ed., R2018	General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel
23	CSA S6:19	12th Ed., 2019	Canadian Highway Bridge Design Code
24	CSA W47.1:19	7th Ed., 2019	Certification of Companies for Fusion Welding of Steel

#	Document #	Issue Date	Document Name
25	CSA W48-18	4th Ed., 2018	Filler Metals and Allied Materials for Metal Arc Welding
26	CSA W59-18	12th Ed., 2018	Welded Steel Construction
27	OPSD 980.101	2017-11-01	Ontario Provincial Standards Drawing for Pedestrian Barricade, Installation
28	978-1-4868-5420-2	June 2021	Ontario Traffic Manual (OTM), Book 18, Cycling Facilities

1.2.2 "GO Transit Signal Standards" refers in this document collectively to the GO Transit Signal Standards General Instructions RC-0506-03SIG-01 and Codes of Practice RC-0506-03SIG-02.

1.2.3 In general, in this GO Transit Grade Crossing Design Standard, the order of precedence is as follows:

a) GCR and GCS, including any references to MUTCD (CDN) and ITE,

b) SCP's and GI's,

c) GCH, including any references to MUTCD (CDN) and ITE,

d) AREMA C&S Manual, and

e) MUTCD (CDN).

1.3 Abbreviations

1.3.1 The abbreviations listed in Table 1-2 apply in this GO Transit Grade Crossing Design Standard.

TABLE 1-2: ACRONYMS

CCTV	Closed-Circuit Television
CR	Clearance to Road
CS	Clearance to Sidewalk
CSD	Critical Safe Distance
DSA	Detailed Safety Assessment
EGCT	Exit Gate Clearance Time
EGOM	Exit Gate Operating Mode
EMC	Electromagnetic Compatibility
GCS	Transport Canada Grade Crossing Standards
GCH	Transport Canada Grade Crossing Handbook
GCR	Transport Canada Grade Crossing Regulations
GCWS	Grade Crossing Warning System

IHTSD	Interconnected Highway Traffic Signal Device
MTCD	Minimum Track Clearance Distance
MTWS	Multi-Train Warning Sign
OCS	Overhead Contact System
RRFB	Rectangular Rapid Flashing Beacon
RVDS	Road Vehicle Detection System
VDC	Voltage, Direct Current

1.4 GO Transit Track Standards Definitions

1.4.1 Grade Crossing is an intersection where a road, path, or railway crosses railway tracks at the same level. Grade crossings are also known as level crossings, railway crossings or train crossings.

1.4.2 Restricted Crossing is any crossing that is not included in the definition of an Unrestricted Crossing.

1.4.3 Unrestricted Crossing is a public Grade Crossing or a Grade Crossing whose road is one of the following:

a) recreation road or trail or a pedestrian or bicycle path maintained by a club, association or other organization, including a snowmobile or hiking trail,

b) road or a pedestrian or bicycle path of a commercial or industrial establishment, including a business operated from a residential or farm property, that is used in connection with the establishment by persons other than employees of the establishment,

c) road that serves fewer than three principal residences,

d) road that serves three or more seasonal residences access to which is not controlled by a gate equipped with a lock,

e) road that connects two public roads, or

f) road maintained by a resource company, such as a company involved in forestry or mining activities.

1.5 Transport Canada Grade Crossing Handbook (GCH) Definitions

1.5.1 Crossing Surface means the part of a road that lies between the ends of a railway tie and that has the width shown in Figure 3-1 of the GCS.

1.5.2 Crossing User means vehicle driver, pedestrian, cyclist, and person using assistive devices.

1.5.3 Emergency Notification Sign means the sign referred to in Figure 8-5 of the GCH. It is used by employees of railway or road authorities, as well as the public, to report incidents, malfunctions or threats to the safety of railway operations.

1.5.4 Grade Crossing Handbook refers to the Grade Crossing Handbook (GCH) published by the Department of Transport (Transport Canada) on July 8, 2014.

1.5.5 Grade Crossing Regulations refers to the Grade Crossing Regulations (GCH) published by the Department of Transport (Transport Canada) on November 28, 2014.

1.5.6 Grade Crossing Standards refers to the Grade Crossings Standards (GCS) published by the Department of Transport (Transport Canada) on January 1, 2019.

1.5.7 Number of Tracks Sign means the sign referred to in Article 8.1.2 of the GCS and, for the purposes of sections 58 and 73 of the GCR, the sign referred to in Article 4 of Part B of the GCS.

1.5.8 Obstruction of a Public Crossing, with respect to section 97 of the GCR, means leaving railway equipment on a crossing surface or otherwise obstructing the flow of road traffic for more than five minutes—including by activating a warning system or a warning system with gates—when vehicular or pedestrian traffic is waiting to cross.

1.5.9 Pedestrians include people walking, running, or standing; manual/motorized wheelchair or scooter users; people using canes or walkers; people pushing strollers or carts; dismounted cyclists; and users of various other low speed forms of human locomotion (e.g.: skateboards).

1.5.10 Prepare to Stop at Railway Crossing Sign means the sign referred to in Article 18.1 of the GCS.

1.5.11 Private Authority means a person, other than a road authority, who has a right with respect to a private Grade Crossing.

1.5.12 Private Grade Crossing means a Grade Crossing that is not a public Grade Crossing, where railway tracks intersect with a road that is typically owned and used by private authorities, such as farmers, commercial businesses, or private individuals.

1.5.13 Public Grade Crossing means a Grade Crossing where railway tracks intersect with a road that is owned or maintained by a public authority, such as a province, municipality, or band council, and used by the general public.

1.5.14 Railway Crossing Ahead Sign means the sign referred to in Article 8.2.1 of the GCS.

1.5.15 Railway Crossing Sign means the sign and post referred to in Article 8.1.1 of the GCS and the sign referred to in Article 4 of Part B of those Standards.

1.5.16 Road Approach means the part of a road, other than the crossing surface, that lies between the point that marks the start of the stopping sight distance (SSD) and the point that marks the front of a design vehicle when it is past the clearance point as shown in Figure 10-1 of the GCS.

1.5.17 Road Crossing means that part of a road that passes across, over or under a line of railway, and includes any structure supporting or protecting that part of that road.

1.5.18 Shoulder refers to the portion of roadway that is contiguous with the travelled way intended for emergency stopping, and or lateral support of the roadway structure. It may also be configured to be accessible for cyclist and may vary in width from one jurisdiction to another.

1.5.19 Sidewalk refers to a travelled way intended for pedestrian use, following an alignment generally parallel to that of adjacent roadway.

1.5.20 Travelled Way means that part of a road intended for vehicular use, excluding shoulders.

1.5.21 Safe Railway Operations, in respect of the Railway Safety Act (RSA), includes actions and situations that do not constitute a threat to or that enhance the safety of railway operations, railway equipment, and persons and property transported by or crossing railways, and of persons, goods and property in the vicinity of a railway.

1.5.22 Separate Grade Crossing means two adjacent and separate roads that are used by motor vehicles and that cross one or more lines of railway.

1.5.23 Stop Ahead Sign means the sign referred to in Article 8.3.1 of the GCS.

1.5.24 Stop Sign means the sign referred to in Article 8.4.1 of the GCS.

1.5.25 Traffic Control Device means:

a) a Stop sign,

b) a Stop Ahead sign,

c) a Railway Crossing Ahead sign,

d) an Advisory Speed Tab sign,

e) a Prepare to Stop at Railway Crossing sign, including the interconnection with the warning system, or

f) a traffic signal, including the interconnection with the warning system.

1.5.26 Vehicle includes an automobile, a motorcycle, a motor assisted bicycle and any other vehicle propelled or driven otherwise than by muscular power but does not include a street car or other motor vehicle running only upon rails, a power-assisted bicycle, a motorized snow vehicle, a traction engine, a farm tractor, a self-propelled implement of husbandry or a road-building machine.

1.5.27 Warning System means an automated system or advanced warning device (AWD), other than an interconnected traffic signal, that indicates the approach or presence of railway equipment at a Grade Crossing and that is composed of any combination of light units, bells, gates, operating mechanisms, and circuits.

1.6 Detailed Safety Assessment

1.6.1 The Grade Crossings Enhancements include elements that are applicable in varying degrees. For example, if a pedestrian sidewalk is determined to be required on only one side of the road, then no more than two pedestrian gates will be required. The site-specific requirements for determining the sidewalk needs and consequently the associated devices to be used at the Grade Crossing, should be addressed by the production of a Detailed Safety Assessment (DSA) as described in GCH Article 31, through the work of a DSA Team.

1.6.2 A DSA Team should conduct a location-specific risk assessment for each Grade Crossing location, to determine the extent of application of each of the Enhancements addressed in this standard. The DSA for each Grade Crossing shall be performed in the context of the GCR, GCS and GCH (Section 9) and AREMA C&S Manual Part 3.1.1 to identify the gaps and mitigations and determine the stakeholders for the mitigations, whether internal or external to Metrolinx.

1.6.3 This GO Transit Grade Crossing Design Standard will apply to all configurations of Grade Crossing in Metrolinx Territory, subject to the DSA at each location and potentially other design considerations. For example, a decision may be taken to implement passive instead of the standard dynamic Multi-Train Warning Sign (MTWS), if pedestrian traffic volume is particularly low.

1.6.4 Information on the frequency and severity of violations by pedestrians or motorists at the Grade Crossing under consideration is required as an input to the DSA exercise, with the data collected as logs of previous incidents or by Closed-Circuit Television (CCTV) monitoring. This information will be used to ensure that the enhancement features are tailored to address the specific violation tendencies at each location. Over the longer term, further CCTV data or other data gathering means will be used to confirm that the Enhancements have been effective at addressing the violations, or to identify further refinements that may be necessary.

1.6.5 Consideration of whistle cessation in the context of the DSA shall follow RC-0401-02, Metrolinx Whistle Exemption Process Guidelines.

1.6.6 The DSA shall identify and mitigate all risks and hazards to the public (e.g. pinching, crushing, etc) associated with the deployment of any and all GCWS components (e.g. powered compound gates, dolly arms).

a) At crossing locations where the counterweights of a gate are adjacent to a sidewalk, a means shall be provided in the form of guards, guide rails or other similar device to protect the public from being injured (pinched, hit, etc.) by the counterweights and other moving components of the gate drive mechanism.

b) The guards, guide rails or other similar means shall not prevent or impede access for personnel to perform maintenance activities. An approach where the device can be easily removed by maintenance personnel may be utilized.

2. Baseline Concepts

2.1 Public vs. Private Crossings

2.1.1 Along Metrolinx rail corridors there are railway tracks that intersect roads, paths, and trails owned and maintained by varying jurisdictions and authorities. Public and private Grade Crossings can thus be viewed as types of intersections defined by Transport Canada based on its function, use, and ownership.

2.1.2 While Grade Crossings are designated unrestricted or restricted crossings according to the GO Transit Track Standards, this document refers to Grade Crossings per the Transport Canada definitions for public and private crossings.

2.1.3 As with all road intersections, Grade Crossings shall be designed with the objective to facilitate the safe and efficient movement of pedestrians, motorists, and vehicles.

2.1.4 Further, Section 26.2 of the Railway Safety Act (RSA) states that “the users of a road shall give way to railway equipment at a road crossing if adequate warning of its approach is given.” As part of Metrolinx’s shared responsibility in this requirement, this GO Transit Grade Crossing Design Standard and the Transport Canada Grade Crossing Handbook, detail the components of design required to provide adequate user warning.

2.1.5 Installation, maintenance, and construction work requirements and procedures are outlined in the GO Transit Track Standards, GI’s and SCPs.

2.1.6 The Grade Crossing Enhancements specified in sections 3 through 8 of this GO Transit Grade Crossing Design Standard apply only to Public Crossings.

2.2 Grade Crossing Layouts

2.2.1 Across the Metrolinx rail network, road approaches, site conditions and terrain vary between Grade Crossings. To maintain consistency in overall safety, all new and existing Grade Crossings on the Metrolinx rail corridor shall meet requirements in the Grade Crossing Handbook, GO Transit Track Standards, GI’s, SCPs, and the requirements herein.

2.2.2 Before any maintenance or construction work at Grade Crossings is performed, important procedures and directions detailed in Section 14.2 of the GO Transit Track Standards shall be followed to ensure all railway requirements are met. As the railway is responsible for the physical maintenance of a surface of the travelled roadway to a defined distance per Article 14.2.8 of the GO Transit Track Standards, GO Transit specifications for track design, excavation, and drainage at crossing surfaces shall also be adhered to.

2.2.3 Grade crossing angles and gradients shall follow the minimum and maximum limits outlined in Article 6 in the GCH and Section 14.3 of the GO Transit Track Standards.

2.2.4 Sightlines at crossings determined in Article 7 of the GCH shall be maintained by eliminating obstructions by buildings or structures, trees, crops, brush, snowbanks, and any unattended equipment or stored material.

2.2.5 Grade crossings shall also be constructed, rehabilitated, and maintained according to the layouts illustrated in **Figure B-1**, **Figure B-2, Figure B-3, Figure B-4** and **Figure B-5.** Note that dimensions specified in this document and shown in these figures correspond to a non-electrified railway. The additional clearance requirements for electrification are discussed in section 9 but have not been quantified nor reflected in this document.

2.2.6 The convention used in this document for dimensional units is to specify imperial units, with the metric equivalent shown in brackets in the text in the body of this document rounded off to one decimal. The metric equivalent will not be shown in the figures. In the case where dimensional requirements have been specified in metric units in this document, the imperial equivalent has not been shown.

2.3 Crossing Surface

2.3.1 Crossing surfaces shall be constructed per standard types listed in Section 14.4 and Appendix U of the GO Transit Track Standards (GTTS) and provide a smooth and continuous surface for safe and comfortable crossing per Article 5 in the Grade Crossing Handbook.

2.3.2 The ends of crossing surfaces shall be sloped towards the top of railway ties in compliance with GTTS Article 14.3.33.

2.3.3 The road approach, crossing, travelled way, and shoulders that comprise the crossing surface shall be free of defects such as potholes, rough surfaces, cracks and signs of wear. This reduces the risk of tripping and falling for pedestrians, cyclists and users of wheelchairs or other mobility assistive devices.

2.3.4 The vertical differences between the rail and adjacent surfaces shall be minimized according to the limits in Table 5-1 of the GCH and crossing surfaces shall comply with the required flange-way widths and depths in GTTS Article 14.3.29.

2.3.5 The width of crossing surfaces varies between crossings and is defined by Transport Canada and GTTS Article 14.3.28 as the total width of the travelled way, pedestrian path, and shoulders if applicable, plus a 0.50 m buffer on either side. All widths are measured at right angles from the centerline of the roadway. Note: if required by the Metrolinx Manager of Track Infrastructure, the width of the crossing surface may be extended beyond above requirements to allow for track unit operation.

2.3.6 Crossing surfaces may be separate if the space between a road and sidewalk, path, or trail exceeds 1.0 m. Otherwise, crossing surfaces shall be continuous.

2.3.7 Crossing Surface (m) = Travelled Way + Pedestrian Path + Shoulders + 2 x 0.50 m

where the Travelled Way is the width of the road intended for vehicular use and pedestrian path includes any sidewalk, path, or trail.

2.4 Crossing Plan Illustrations

2.4.1 Crossing plan illustrations are included in Appendix B of this GO Transit Grade Crossing Design Standard.

2.4.2 Standard layouts depicted in **Figure B-1**, **Figure B-2** and **Figure B-3** guide the design of the Supplemental Elements (reference section 11 herein) of public crossings with a single track, public crossings with multiple tracks and private crossings with single or multiple tracks, respectively.

2.4.3 Site conditions and any additional safety precautions for individual crossings shall determine the desired limits of fencing, the location of man-gates the layout of anti-trespassing mats and installation of signage.

2.4.4 **Figure B-4** and **Figure B-5** depict the arrangement of the Grade Crossing Enhancements for right-angled and acute-angled Grade Crossings.

3. Exit Quadrants

3.1 General

3.1.1 The preferred mechanism for preventing motorists from entering the Grade Crossing through the exit quadrants is the implementation of channelization which involves establishing a visual and physical barrier between the road lanes entering the crossing from the lanes exiting the crossing.

3.1.2 Exit gates should only be considered for deployment at an exit quadrant that cannot be segregated through channelization from the entrance quadrant on the same side of the railway right of way, located as shown in the bottom of **Figure B-4** and **Figure B-5** as applicable, with the objectives to:

a) Deter vehicles from driving around lowered entrance gates to access the Grade Crossing in a willful violation,

b) Protect against road users mistakenly entering the Grade Crossing via an exit quadrant rather than correctly, via the corresponding entrance quadrant, and

c) Create an effectively “sealed corridor” for train travel that is isolated from vehicles, cyclists, and pedestrians.

3.2 Channelization – Road Traffic

3.2.1 Channelization can be achieved by installing either or both:

a) a mountable raised curb median, and

b) "traffic separators" with flexible vertical panels (bollards).

3.2.2 These features shall present motorists that are approaching the Grade Crossing with a visual impediment to discourage them from driving into the opposing, exit traffic lane(s), to get around a lowered Grade Crossing entrance gate.

3.2.3 Since these features will not be installed on the railway right-of-way, they are typically provided by the Road Authority. The design requirements in terms of height, length, width, colour and markings shall be jointly developed with the Road Authority and may be different between municipalities.

3.3 Exit Gate Design Considerations

3.3.1 The requirements for entrance gates and pedestrian gates specified in GCH Part 15.2, including references to the AREMA C&S Manual, also generally apply to exit gates.

3.3.2 The scope of deployment of exit gates, including which quadrants require exit gates shall be confirmed by a DSA, that identifies and mitigates any hazards that are relevant for the specific Grade Crossing, in context.

3.3.3 If it is not possible to install adequate channelization, the deployment of exit gates shall be considered based on an evaluation of parameters such as the following:

a) the number of incidents involving motorists driving around lowered entrance gates,

b) sightline limitations,

c) proximity of adjacent intersections, roads or driveways to the crossing,

d) vehicle clearance distance for the Design Vehicle for the Grade Crossing,

e) high frequency of multiple trains, and

f) high train speed.

3.3.4 At Grade Crossings that are equipped with an exit gate(s), the Clearance Distance shall be calculated in accordance with GCH Section 10.1.

3.3.5 Exit gate management systems consist of the following elements:

a) Exit gate mechanism, including motors, gate arms and flashers as shown in **Figure 3-1,** and

b) Safety critical logic equipment to implement Dynamic EGOM, as detailed in this Section 3.3.

3.3.6 Exit gate(s) shall operate in Dynamic Exit Gate Operating Mode (EGOM) as described in AREMA C&S Manual Part 3.1.15, based on inputs from the Road Vehicle Detection System specified in in section 3.8.

3.3.7 Exit gate(s) shall start downward motion only if the vehicle detection system indicates no vehicles are located within the configured detection area described in Section 3.8.

3.3.8 The following design elements for exit gates shall apply:

a) Once the exit gates are activated, subsequent detection of a road vehicle by the Vehicle Detection System shall trigger their de-activation to raise the corresponding exit gate.

b) The occupation of any crossing island circuit shall not modify or override the activation or de-activation of the exit gate.

c) Exit gate(s) shall be individually controlled for each roadway approach (i.e.: each direction of road traffic).

d) When the GCWS is deactivated after passage of the train(s), the entrance gate(s) shall remain lowered until the corresponding exit gate begins to raise. The control circuitry shall be designed to check the position of the exit gate(s) to confirm they begin to raise prior to raising the corresponding entrance gate(s) in accordance with AREMA C&S Manual Part 3.1.15 E 4b (3).

3.4 Exit Gate Physical Characteristics

3.4.1 Exit gates physical characteristics are identical to entrance gates with the exception that the exit gate’s fail-safe position shall be vertically up under the assistance of gravity.

3.4.2 Exit gates shall have the same number and layout of lights as entrance gates but, unless otherwise required by a DSA, shall only have front flashing lights (i.e. facing away from the tracks).

3.4.3 The exit gates flashing lights shall operate synchronized with the main flashers and the lights of entrance and pedestrian gates.

3.4.4 Exit gates shall be as shown as in **Figure 3-1** and shall comply with the requirements specified in GCS Section 12.1, including:

a) Clearance from the road and curb,

b) Physical dimensions,

c) The gate arm reflective materials and patterns in accordance with GCS Section 12.1 (d),

d) The gate arm lengths in accordance with GCS Section 12.1 (e),

e) Monitoring requirement,

f) Fail Safe Requirement,

g) Electromagnetic Compatibility (EMC) requirement, and

h) Battery backup requirement.

3.4.5 Exit gates shall be equipped with short counterweights that minimize potential of interference of a furrow of snow left by removal crews that might obstruct gate operation in either direction.

3.4.6 The counterweights shall not physically encroach on the sidewalk at any point.

3.4.7 Exit gates of length greater than 16 feet (4.9m) may be of articulated type design as shown in **Figure 3-2**.

3.4.8 If the distance from the mast centerline to the tip of the gate would exceed 38 feet (11.6m), then an aligned pair of exit gates shall be used in a tandem configuration from a median as shown in AREMA C&S Manual Figure 3136H-2.

3.4.9 When gates are installed in medians, the median width should be a minimum of 10.5 feet (3.2m) from face of curb to face of curb. If a DSA determines that 10.5 feet cannot be provided, based on field conditions, actual width of the median shall not be less than 8.5 feet (2.6m), in any case, in accordance with AREMA 3.1.35 C 2.

FIGURE 3-1: TYPICAL EXIT GATE

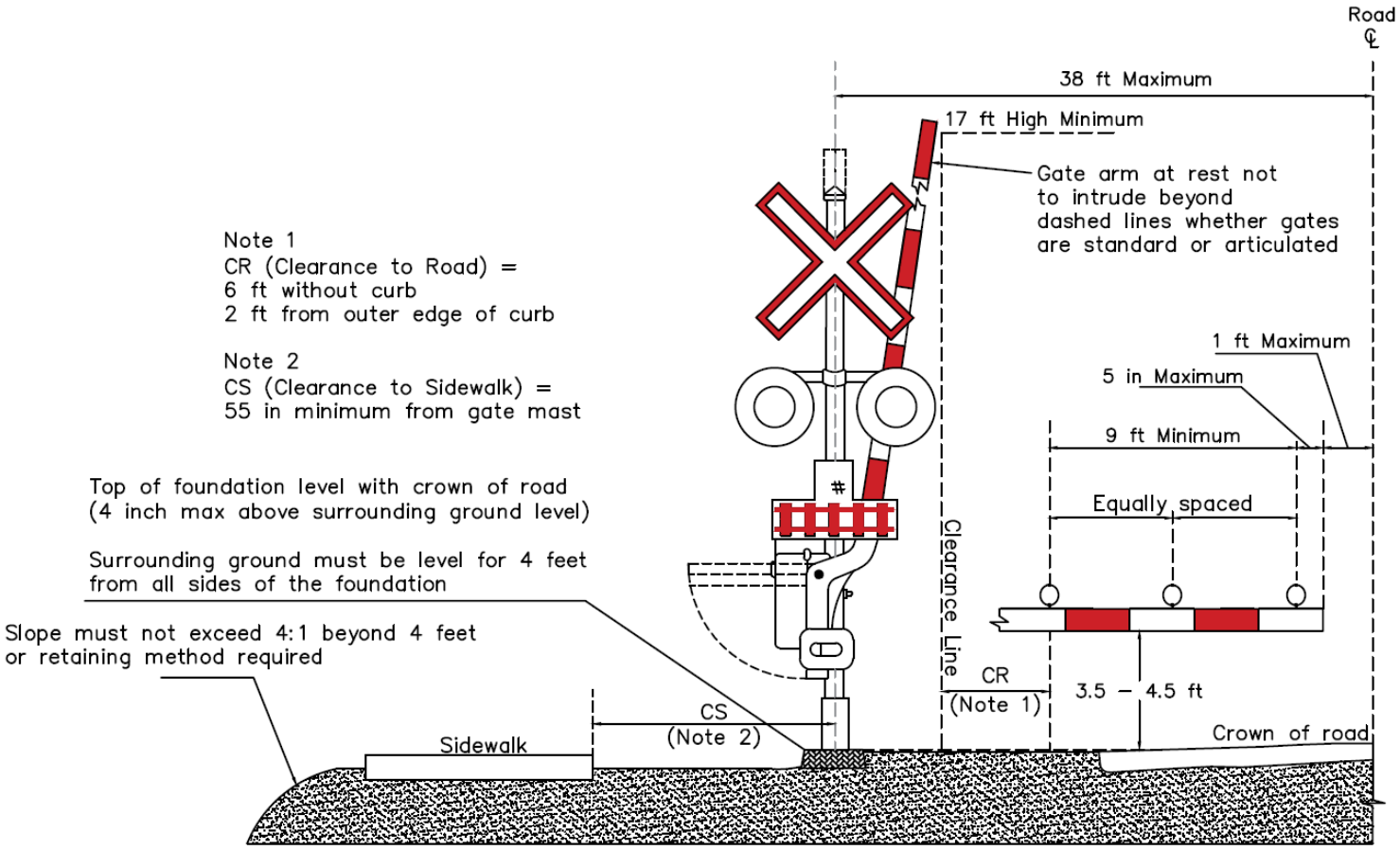
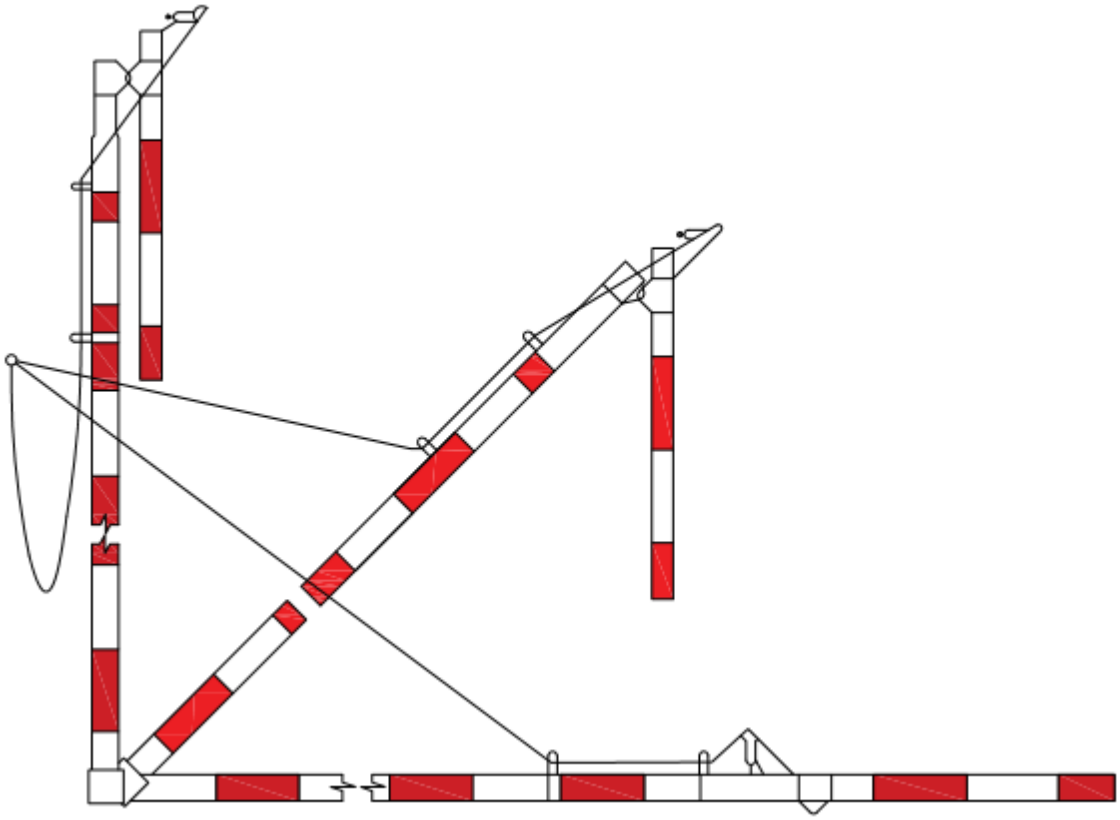


FIGURE 3-2: ARTICULATED GATE CONCEPT



3.5 Exit Gate Operational Requirements

3.5.1 Exit gate operations shall comply with GCS Section 15.2, AREMA C&S Manual Parts 3.1.15 and 3.1.25, including:

a) the exit gates shall be lowered by the application of power and raised primarily by gravity, assisted by power, in accordance with AREMA C&S Manual 3.2.15 U,

b) smooth, uniform operation, without rebound, and securing of the gate when in the raised position in accordance with GCS Section 15.2,

c) exit gates shall also activate when initiated by the bungalow test key,

d) exit gates shall raise when the bungalow test key switch is in the gate relief position (commands gates to be raised, with bells and flashers remaining active),

e) persistence to achieve the position corresponding with the control apparatus, when gate arms encounter obstacles while descending or ascending, upon removal of the obstacles, in accordance with GCS Section 15.2,

f) high-wind gate arm support in accordance with AREMA C&S Manual Parts 3.2.10 C. 4. & 3.2.22,

g) a means to rotate the gate mechanism 90 degrees, or easily disconnect gate arm support for servicing, in accordance with AREMA C&S Manual Part 3.2.15 C.7, and

h) a means to prevent accidental rotation of the mechanism when in normal position in accordance with AREMA C&S Manual Part 3.2.15 C.7.

3.6 Exit Gate Power Requirements

3.6.1 Where a Grade Crossing is fitted with exit gates, they shall be powered from a 9-16 VDC battery bank that is compatible with the existing power supplies used for any Metrolinx GCWS.

3.7 Exit Gate Installation Requirements

3.7.1 Exit gates shall be positioned as shown as in **Figure B-4** or **Figure B-5**, as applicable, in accordance with the GCS Sections 12.1, 15.2 and AREMA C&S Manual Part 3.1.36 and 3.2.5, including:

a) in accordance with **Figure 3-1**, no component of the exit gate that is in the raised position under normal or fault conditions, whether utilizing a standard or articulated gate arm, shall encroach the area bounded by a 17 ft high vertical clearance line that is located 2 feet (0.6m) from the edge of the curb of the roadway or, if there is no curb, 6 feet (1.8m) from the edge of the travelled roadway.

b) Gate arm relative position perpendicular to the longitudinal axis of the road approach shall be in accordance with GCS Section 15.2. Gate arm location in relation to clearance from the centerline of track shall be in accordance with AREMA C&S Manual Part 3.1.36 C. 6.

c) The exit gate clearance at vertical from overhead power, transit, or other live wires when either in normal operating configuration or rotated 90 degrees for servicing shall be in accordance with Ontario Electrical Safety Code Tables 33 and 34.

3.7.2 The exit gate mechanism foundation height, and the height of the light unit above the crown of the road shall be the same as entrance gates.

3.7.3 The ground surrounding the exit gate shall be level for a minimum of 4 feet (1.2m) and slope no more that 4:1 beyond this limit or a retaining method shall be applied.

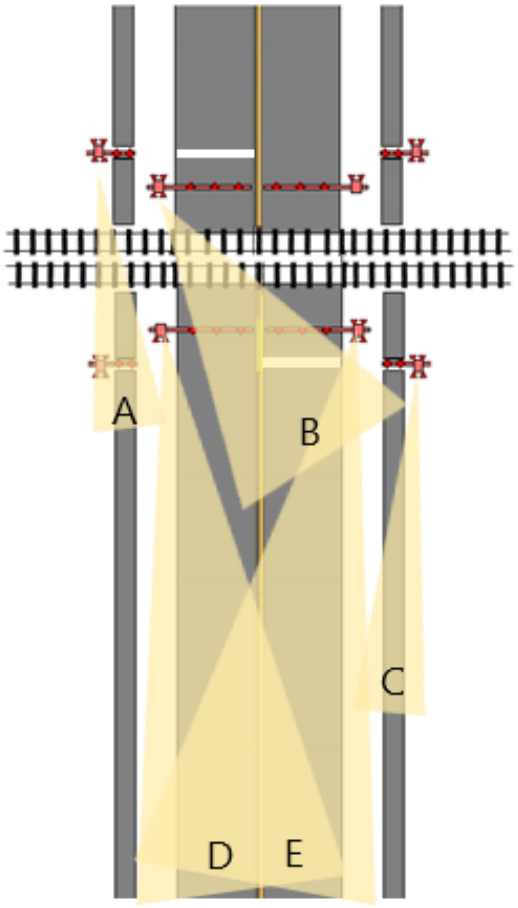
3.7.4 Exit gate arms shall extend to no more than 2 feet (0.6m) from the centerline of the roadway or median curb. Where exit gates are installed directly across from the corresponding entrance gate, the gate ends shall be separated by no more than 2 feet of each other as shown in **Figure B-4**.

3.7.5 At locations where the entrance and exit gate arms on one side of the tracks are offset more than 2 feet (0.6m) from each other such that road vehicles could drive between the gate arms, channelization (e.g.: a median island or bollards) shall be installed in accordance with **Figure B-4**.

3.7.6 When channelization is implemented for this purpose alone, it shall be a minimum of 6 feet (1.8m) in length and 7 inches (0.2m) or more in height.

3.7.7 Alignment of exit gate light units shall be as shown in **Figure 3-3**.

FIGURE 3-3: GATE MAST LIGHT ALIGNMENT



Alignment point at reference letter viewed at a height of 5 feet 6 inches above the road or sidewalk

A - Pedestrian gate back lights aligned 10 feet in front of opposite pedestrian gate in centre of the sidewalk

B - Entrance gate back lights aligned 50 feet in front of opposite entrance gate at centre of the road.

C - Pedestrian gate front lights aligned 100 feet in centre of sidewalk

D - Exit gate front lights aligned equivalent distance to E in centre of left lane

E - Entrance gate front lights aligned as per SPC 706, Table 706-3.

3.8 Road Vehicle Detection System

3.8.1 At all Grade Crossing that are equipped with an exit gate(s), a Road Vehicle Detection System (RVDS) shall be provided on the associated road lanes to ensure the exit gate remains or is commanded to the upright position while the MTCD is occupied by a road vehicle.

3.8.2 The RVDS shall employ proven-in-service technology that is compatible with 2x25KV electrification.

3.8.3 The RVDS shall detect the full range of motor vehicles that will use the Grade Crossing and not just the Design Vehicle used to calculate the clearance time.

3.8.4 The RVDS shall detect all vehicles, including passenger motor vehicles, school buses, trucks, motorcycles, and bicycles.

3.8.5 The RVDS shall cover the entire area of the Grade Crossing associated with each exit gate as shown in **Figure B-4** and **Figure B-5**, as applicable to the Grade Crossing geometry, extending laterally from the curb or edge of the road to the road centerline and extending longitudinally from 10 feet (3.0m) in front of the entrance-side rail to 2 feet (0.6m) beyond the exit gate horizontal resting point.

3.8.6 The RVDS shall comply with the SIL 4 safety integrity level specified in CENELEC standard EN50129 or equivalent.

3.8.7 The RVDS shall provide individually isolated outputs for each detector that are energized to indicate “not occupied”, in such a manner that a failed output circuit or wiring fault will result in a de-energized state and “occupied indication”.

3.8.8 The RVDS shall include the following physical characteristics:

a) capable of operating in the Grade Crossing environment in accordance with AREMA C&S Manual section 11, including heavy vibration, all-weather including accumulation of ice and/or snow on the road surface, road salt or deicing products, and the impact of potential snow removal equipment,

b) exposed components shall be waterproof in compliance with IEC standard 60529 rating IP68,

c) maintainable or repairable so as not to have significant impact to railway operations or roadway traffic utilizing quick changeout modular or redundant standby components, and

d) resistant to vandalism such that it is not rendered inoperative or giving false indication through tampering.

3.8.9 The RVDS shall operate as follows:

a) relative to the failsafe requirement, the RVDS in normal operation shall not fail to detect any vehicle and, under any failure condition, shall default to a vehicle detected status, such that gates remain up,

b) shall be unaffected by train or railway equipment such as the passage along the tracks of track machines, Hi-Rail trucks or rail mounted equipment, and

c) shall not generate false highway vehicle occupied indications to cause interference with railway operations or roadway traffic.

3.8.10 The RVDS shall comply with the following electrical requirements:

a) shall operate under battery back-up power compatible with existing power supplies at Metrolinx Grade Crossings and continue to function for the hours specified in Metrolinx SCP-1402; and

b) shall not generate or induce levels of energy into the rails or other railway communication medium of such magnitude that will affect the signalling train detection system by causing false occupancy or false vacancy of trains under any normal or abnormal mode of operation.

3.8.11 The RVDS shall comply with the following installation requirements:

a) shall be minimally invasive to the road surface and shall be adoptable to any type of road surface,

b) shall be flush with or independent from the road surface once installed,

c) shall not accumulate water, snow, ice under any conditions, and

d) shall tolerate all plausible types of compressive point loads in all weather conditions without performance degradation.

3.9 Refuge Area for Road Vehicles

3.9.1 A refuge area is an additional space at a defined distance from the clearance point of the track(s) to provide space for a road vehicle that has passed over the rails to safely clear the rails in the event they are impeded by a lowered exit gate.

3.9.2 Since the lowering of each exit gate will be inhibited by the associated RVDS, there is typically no requirement to implement road vehicle refuge areas for exit quadrants in Metrolinx Territory. A refuge area for road vehicles shall only be considered by the DSA if it is not possible to equip with a RVDS the road lanes associated with an exit gate.

3.9.3 If a refuge area is determined to be necessary, it shall be of sufficient length to accommodate the Design Vehicle and, if the Entrance and Exit Gates on the same side of the railway cannot be aligned, channelization (e.g.: a median island or bollards) shall be implemented between the Entrance and Exit Gates as shown in **Figure B-5**.

3.10 Exit Gate Fault Monitoring and Failure Handling

3.10.1 Exit gate operation shall be monitored and recorded with date and time stamp. Storage capacity shall be provided locally to store a minimum of 30 days of data. (GCS and GCH Section 12.2).

3.10.2 In compliance with the requirements specified in GCS Section 12.2, the following events shall be recorded:

a) GCWS gate control output for activation and deactivation,

b) gate in vertical position (gate UP position),

c) gate descends to a point (angle of) 10 degrees from the horizontal (gate Down position),

d) activation of the test switch, and

e) vehicle detection system health and occurrences where vehicle detection prevents normal operation of the exit gates.

3.10.3 Exit gates shall comply with the loss of power requirements specified in AREMA C&S Manual Parts 3.2.15, including:

a) The torque requirements for the exit gate in loss of power situation (AREMA C&S Manual 3.2.15 D),

b) Means to adjust the torque of the gate arm where counterweighting is employed, and

c) Means to ascend solely by force of gravity from the horizontal to the clear position (70-83 degrees) under a loss of power condition or loss of gate control as described in AREMA C&S Manual 3.2.15 U.

3.10.4 Exit gate failure modes relating to flashing lights, gate arm lights, bells or other audible warning device and vehicle detection system shall comply with AREMA C&S Manual 3.1.15.

3.10.5 In case of power or system failure, exit gates shall be adjusted to fail in the raised position at no less than 70 degrees from horizontal.

3.10.6 Failure of the Road Vehicle Detection System shall result in a detected and occupied state to the crossing control equipment with the corresponding exit gate(s) remaining raised.

3.10.7 Under Dynamic EGOM, the control circuitry shall check the position of the entrance gate(s) to confirm they are lowered. In the event any entrance gate does not indicate it is lowered within a predetermined number of seconds after release (10-15 seconds), the associated exit gate(s) shall be fully raised so as not to restrict a vehicle on the crossing. (AREMA C&S Manual Part 3.1.15 E 4a (2)).

3.10.8 When deactivating the GCWS, in the event any exit gate fails to raise, the corresponding entrance gate shall remain lowered. The GCWS shall monitor the exit gate(s) position and inhibit the raising of an entrance gate until it confirms the corresponding exit gate has begun to raise (AREMA C&S Manual Part 3.1.15 E 4b (3)).

3.11 Inspection and Testing

3.11.1 Inspection and testing of exit gates, gate skirts, bells and lights and Road Vehicle detection System shall comply with the requirements specified in Metrolinx SCPs and GIs.

4. Pedestrian Gates

4.1 General

4.1.1 Pedestrian gates shall be installed for a sidewalk, path, or trail, whether or not the crossing is part of a road crossing location, to alert and control pedestrian and cyclist traffic to an approaching or occupying train, as illustrated in **Figure 4-1** or **Figure 4-2**, as applicable.

4.1.2 The pedestrian gates shall comply with the location, operational requirements, and physical characteristics specified in this Section 4.

4.1.3 Pedestrian gates shall be used in conjunction with fencing to discourage unauthorized entry into the active crossing area by pedestrians.

4.2 Application Criteria

4.2.1 Pedestrian Gates shall be deployed at each quadrant of a Grade Crossing that is equipped with a municipal sidewalk.

4.2.2 As shown in **Figure B-4** and **Figure B-5**:

a) the fencing along the track (parallel to the track) shall be extended to the pedestrian gate to prohibit pedestrians from going around the pedestrian gate,

b) an exit swing gate shall provide a path of egress to accommodate the exit of any pedestrians that did not exit the active crossing area before the gate arms were lowered, and

c) the sidewalk shall be widened if required to provide a path through the exit swing gate.

4.2.3 If it is not possible to provide the fencing and exit swing gate specified in section 4.2.2:

a) a pedestrian refuge area shall be provided at the pedestrian gate in accordance with the installation requirements specified in section 4.6, and

b) in this situation, the fencing along the track shall not be extended to the pedestrian gate and the municipal sidewalk shall not be widened or split to provide a path through the gap that is left between the fencing and the pedestrian gate.

4.3 GCWS Timing Parameters

4.3.1 The various timing parameters specified in Grade Crossing Handbook Article 10 and Grade Crossing Standards section 16 shall be incorporated in the warning time and the gate delay to properly accommodate for motor vehicles, pedestrians and cyclists.

4.3.2 The Warning Time for crossings equipped with pedestrian gates shall be the value calculated in accordance with section 16.1.1 of Grade Crossing Standards (GCS) with the following modifications.

a) The “departure time for pedestrians” specified in 16.1.1 c) of the GCS shall be the greater of the values calculated over the following distances:

i) grade crossing clearance distance (cd) as defined in GCS 10.1, and

ii) the clearance distance SPT(cd) defined in GCH 10.4.2 using a walking speed of 3.0 ft/s (0.9 m/s), except in the case where the crossing is within 250m of a hospital or retirement residence in which case 2.5 ft/s (0.7 m/s) shall be used.

b) The “gate arm clearance time” specified in 16.1.1 d) of the GCS shall be the greater of:

i) the entrance gate arm clearance time calculated in accordance GCS 10.4.1; and

ii) the gate delay calculated in accordance with 4.3.3 below.

4.3.3 A gate delay shall be applied to both entrance gates and pedestrian gates so that they operate in unison. Ideally, the gate delay should not exceed 14s since longer times may be misinterpreted by an impatient motorist or pedestrian as a malfunction. To define the gate delay the following two values shall be calculated: entrance gate arm clearance time in accordance with GCS 10.4.1 and pedestrian gate arm clearance time in accordance with GCH 10.4.2 using a walking speed of 3.5 ft/s. The gate delay shall be defined based on the following criteria.

a) If the entrance gate arm clearance time is greater than pedestrian gate arm clearance time, the gate delay shall be set to the entrance gate arm clearance time, even if greater than 14s.

b) If the pedestrian gate arm clearance time is greater than entrance gate arm clearance time, the gate delay shall be set to:

i) the entrance gate arm clearance time if the entrance gate arm clearance time is greater than 14s, or

ii) the pedestrian gate arm clearance time if both the entrance gate arm clearance time and pedestrian gate arm clearance time are less than or equal to 14s, or

iii) 14s if the entrance gate arm clearance time is less than 14s and the pedestrian gate arm clearance time is greater than 14s.

4.4 Design Considerations

4.4.1 Pedestrian gate shall comply with GCH Part 15.2, including references to the AREMA C&S Manual.

4.4.2 Pedestrian gate arms shall operate simultaneously with the Grade Crossing entrance gate mechanisms to raise and lower in unison as specified in GCH 15.2.

4.4.3 Consideration of the various timing parameters specified in GCH Article 10 and GCS 16 shall be incorporated in the warning time calculations to properly accommodate for pedestrians, cyclists and persons using assisted devices.

4.4.4 Existing entrance gates that cover both roadway and sidewalk as shown in **Figure 4-2** are acceptable but due to the difference in timing and operation, exit gates shall not be used to serve the purposes of pedestrian gates.

4.4.5 In situations where geography or property restraints prohibit the installation of a dedicated pedestrian gate, a pedestrian gate arm integrated with the entrance gate mechanism as shown in **Figure 4-3** may be used. Due to the difference in timing and operation, this type of integrated gate shall not be used on exit gates to serve the purposes of pedestrian gates.

4.4.6 The following features shall be deployed to augment the pedestrian gates, but may be provided in collaboration with the road authorities, and in accordance with the specifications of the local municipality:

a) A tactile walking surface indicator (tactile plate) shall be provided in advance of the crossing warning system to assist persons visually impaired or using assistive devices with a reliable, recognizable indication that they are approaching a hazard in accordance with GCH Appendix M Design Guidance for Vulnerable Road Users.

   i) The surface treatments shall be of visually contrasting materials, and

   ii) the tactile plate shall be centered on the sidewalk and located such that the closet edge of the plate is 2.0 m from the centerline of the pedestrian gate mast.

b) Flangeway gap fillers shall be provided to ensure a smooth and continuous crossing surface and reduce the risk of small wheels or objects getting stuck in the flangeway in accordance with GCH Appendix M Design Guidance for Vulnerable Road Users.

4.5 Physical Characteristics

4.5.1 Pedestrian gates shall incorporate the following physical characteristics configured as shown in **Figure 4-1, Figure 4-2** or as applicable, and in compliance with GCS and GCH Section 12.1:

a) gate arm skirt and lights as outlined in Section 4.8,

b) gate arm reflective materials and patterns that comply with GCS Section 12.1 (d),

c) means to rotate gate mechanism 90 degrees, or easily disconnect gate arm support for servicing in accordance with AREMA C&S Manual Part 3.2.15 C. 7,

d) means to prevent accidental rotation of the mechanism when in normal position in accordance with AREMA C&S Manual Part 3.2.15 C. 7, and

e) equipped with a pair of mast lights for each direction of travel.

4.5.2 In the case of a dedicated pedestrian gate mast as shown in **Figure 4-1,** the flashing lights and crossbucks shown mounted on the mast are not required if the centerline of the sidewalk is 10 feet (3.0m) or less from the centre of the associated entrance or exit gate mast, provided that the local conditions permit an unobstructed sightline from the sidewalk to the flashing lights on the entrance or exit gate.

4.5.3 Road entrance gates that also serve as pedestrian gates shall be as shown as in **Figure 4-2**.

FIGURE 4-1: DEDICATED PEDESTRIAN GATE WITH SKIRT

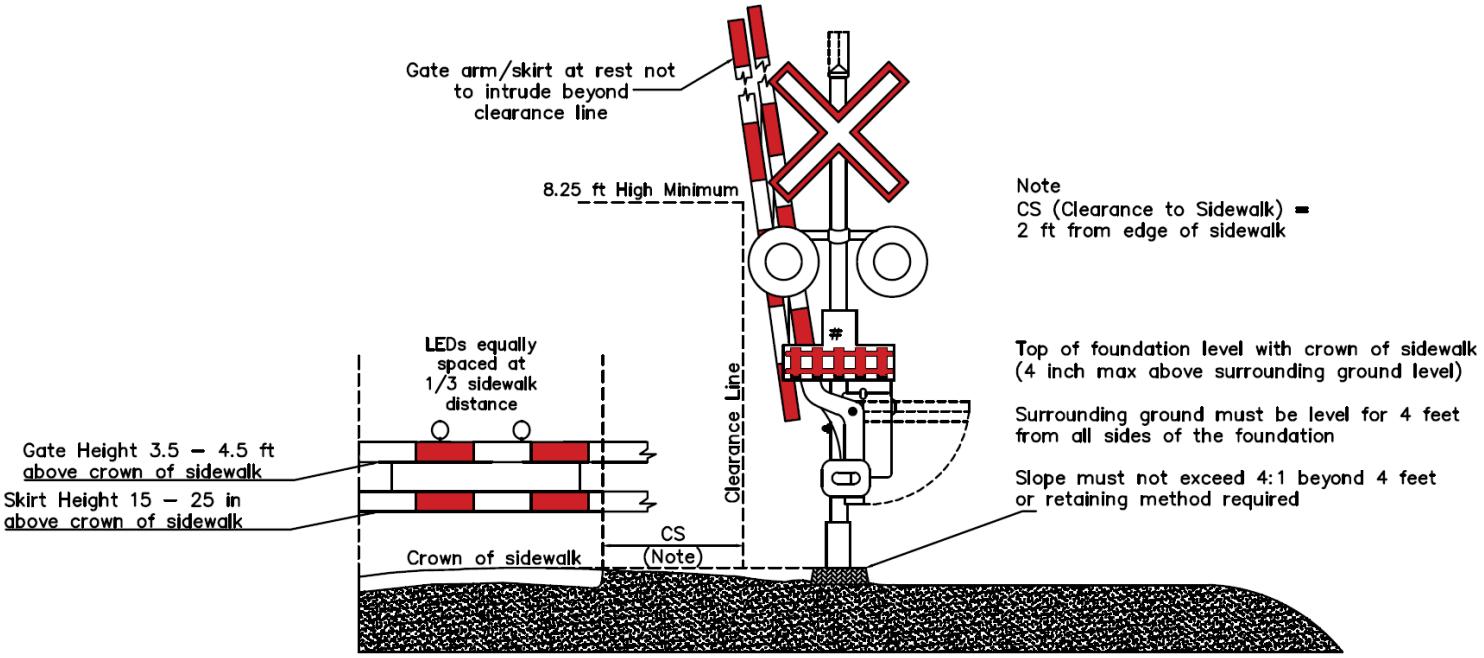


FIGURE 4-2: COMBINED ENTRANCE & PEDESTRIAN GATE

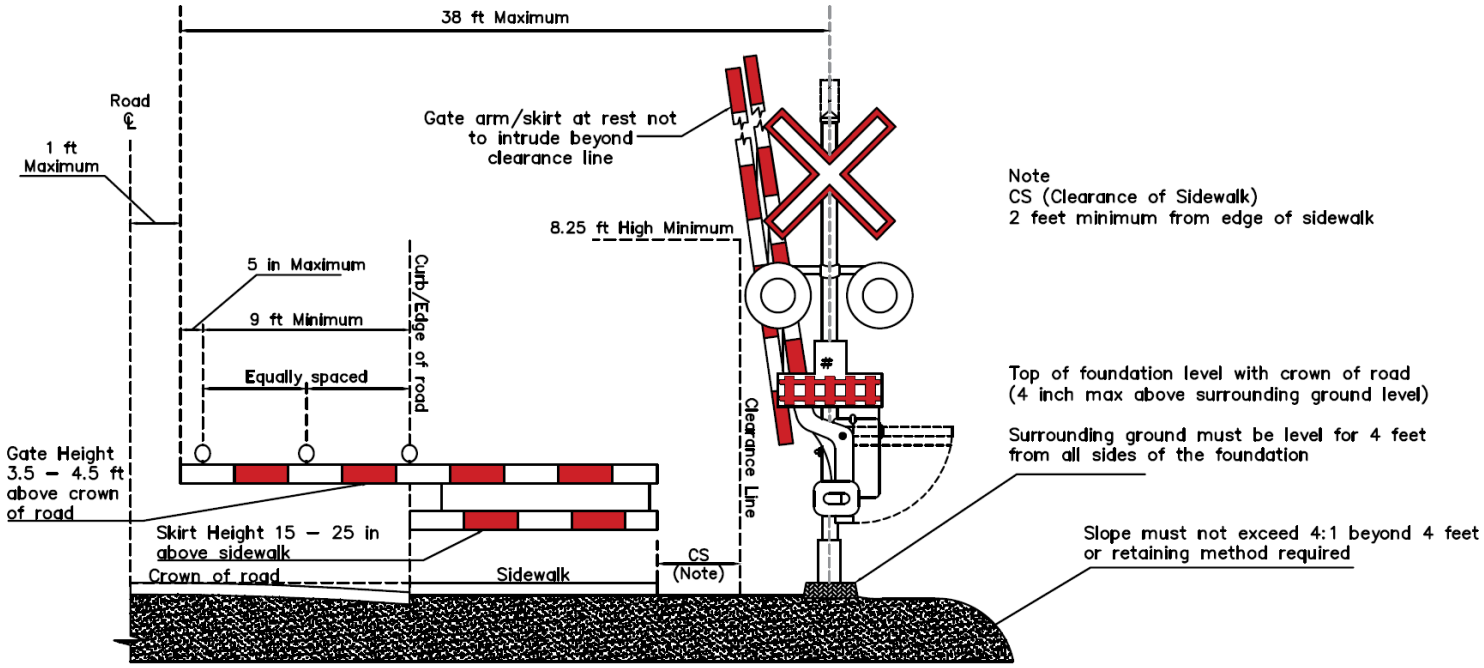
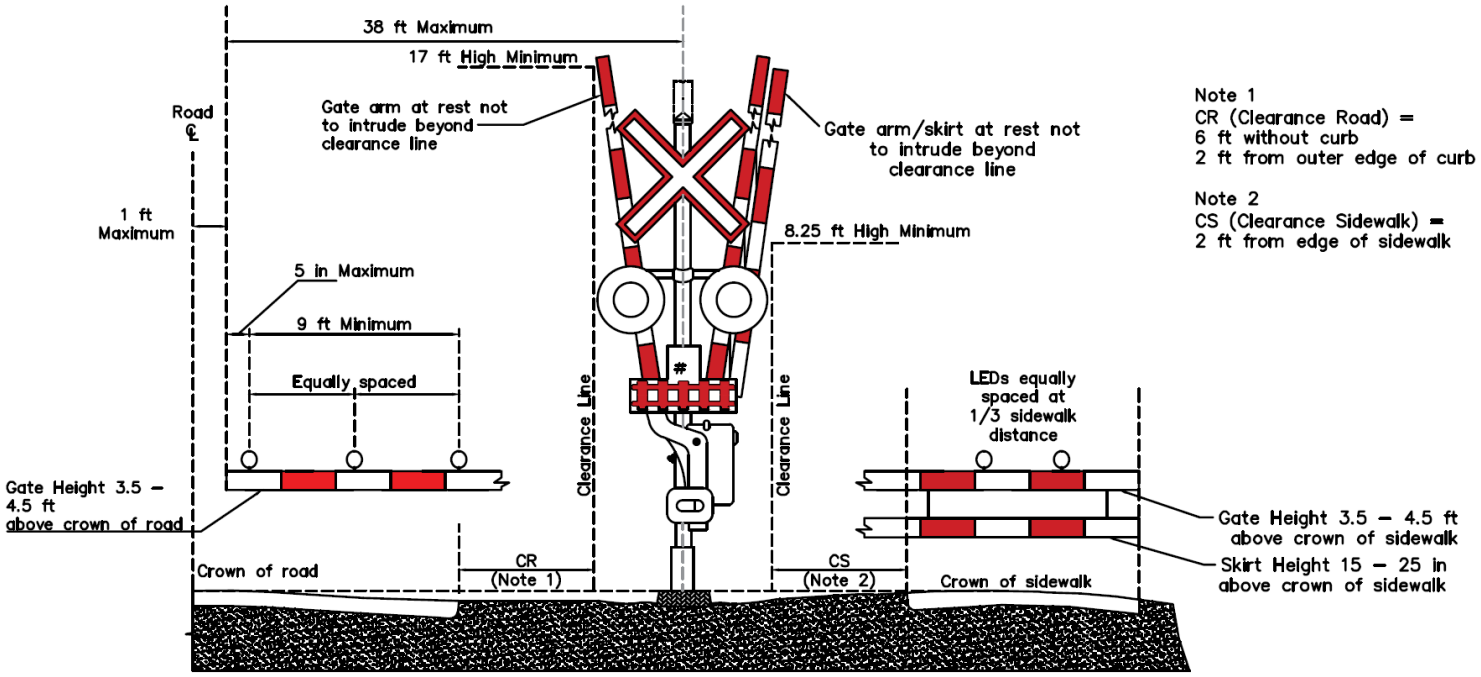


FIGURE 4-3: PEDESTRIAN & ENTRANCE GATE WITH SHARED MECHANISM



4.6 Installation Requirements

4.6.1 Pedestrian gates shall be installed as shown as in **Figure 4-1**, **Figure 4-2**, or **Figure 4-3** as applicable.

4.6.2 Pedestrian gate installation shall comply with GCS Sections 12.1, 15.2 and AREMA C&S Manual Part 3.1.36, and the following requirements:

a) Pedestrian gate masts should be located on the field side of the sidewalk, away from the road as shown in **Figure B-4** or **Figure B-5** as applicable, to provide clear separation of the pedestrian lights from the roadway lights.

b) Pedestrian gates shall be located no closer than 10 feet (3.0m) from the nearest rail of the track, measured perpendicularly, in compliance with AREMA C&S Manual Part 3.1.36.

4.6.3 Fencing, railings and exit swing gates shall be located no closer than 10 feet (3.0m) from the nearest rail of the track, measured perpendicularly.

4.6.4 Exit swing gates shall be located no closer than 5 ft (1.5m) from the curb or the edge of the travelled roadway, measured perpendicularly.

4.6.5 If space is provided for a pedestrian refuge area (with reference to the left-hand quadrants of **Figure B-4** and **Figure B-5)**, it shall:

a) be at least the width of the sidewalk,

b) have a minimum length of 4 feet (1.2m) along the sidewalk, starting 10 feet (3.0m) from the nearest rail measured perpendicular to the rail, such that the pedestrian gate shall be

located a minimum of 4 feet (1.2m) from the start of the refuge area measured along the sidewalk,

i) have a minimum length of 6 feet (1.8m) at crossings located within 500m of facilities expected to be accessed or exited by a high number of people at specific times (e.g. schools, public transit stations, sports complexes),

c) be equipped with a yellow-coloured railing of minimum 5 foot (1.5m) length on the field side of, and perpendicular to, the sidewalk, starting at the refuge area boundary as defined in 4.6.3 b),

d) be equipped, if space permits, with a yellow-coloured railing on the road side of and perpendicular to the sidewalk aligned with the refuge area boundary per 4.6.3 b) and extending to the edge of the curb at the roadway, with the railings angled as necessary if installed in a quadrant for which the rails cross the sidewalk at an acute angle, to ensure that the entire railing is clear of the nearest rail by a minimum of 10 feet (3.0m).

4.6.6 Markings shall be applied to the sidewalk as follows:

a) All markings on the sidewalk shall comply with the requirements of sections 11.3.1 through 11.3.4.

b) White pedestrian guidelines shall be painted longitudinally along each edge of the sidewalk.

c) Between the white guidelines, cross-hatching shall be applied along the sidewalk to indicate to pedestrians the region in which they should not stop and stand, bounded longitudinally along the sidewalk either by:

i) the track-side border of a pedestrian refuge area, if a refuge area exists, or

ii) the pedestrian gate arm if no refuge area exists.

d) The transverse border of the cross-hatching shall be yellow and positioned perpendicular to the sidewalk.

e) Cross-hatching shall not be applied to any pedestrian refuge area.

f) The cross-hatching shall:

i) be of the same yellow colour used for the road crosshatching as specified in section 11.3.6,

ii) have a line width of 100 mm,

iii) form a pattern of single X’s with each X being the width of a standard 5 ft wide sidewalk as shown in **Figure B-4,**

iv) include silica sand additive to increase friction on pedestrian walking surfaces, and

v) include a minimum of two coats of paint.

4.6.7 The situations with and without a pedestrian refuge area are shown in **Figure B-4** or **Figure B-5**.

4.6.8 Gate arm relative position shall be perpendicular to the longitudinal axis of the sidewalk, pathway, or trail approach in accordance with GCS Section 15.2.1.

4.6.9 The minimum clearance distance from the face of a curb or the edge of sidewalk, path or trail to the clearance line as shown in **Figure 4-1**, **Figure 4-2** and **Figure 4-3**, as applicable.

4.6.10 The gate arm clearance line, the foundation height, and the height of the light unit above the crown of the sidewalk, pathway or trail shall be as indicated in **Figure 4-1**, **Figure 4-2** and **Figure 4-3**, as applicable.

4.6.11 The ground surrounding the pedestrian gate shall be level for a minimum of 4 feet (1.2m) in behind and to the sides of the foundation. The slope of the ground shall be no more that 4:1 beyond this limit or a retaining method shall be applied.

4.6.12 Each gate arm shall extend across the full width of the sidewalk, path, or trail in accordance with GCS Section 12 (f)(i).

4.7 Operational Requirements

4.7.1 All pedestrian gates shall be considered for the purpose of operation as entrance gates to a Grade Crossing.

4.7.2 Pedestrian gates shall comply with the requirements specified in GCS Section 15.2, AREMA C&S Manual Parts 3.2.15 U., 3.3.30 D. and 3.1.35(5), including:

a) The descent and ascent time ranges in accordance with GCS Section 15.2.

b) The descending starting point in accordance with GCH Section 10.4.1, 10.4.2.

c) The gate horizontal position prior to train's arrival of 5 seconds in accordance with GCS Section 15.2.

d) Gate arms operating uniformly, smoothly, without rebound, and held securely when in the raised position in accordance with GCS Section 15.2.5.

e) If the gate arm strikes or fouls any object during its descent or ascent it shall readily stop and, on removal of obstruction, assume the position corresponding with the control apparatus in accordance with GCS Section 15.2.6.

4.7.3 The pedestrian gates shall be driven by a 9 – 16VDC power supply of the same type as the entrance gates.

4.7.4 Pedestrian gates shall comply with the loss of power requirements specified in AREMA C&S Manual Parts 3.1.28 and 3.2.15, including:

a) descent solely by force of gravity from the clear to the horizontal position under a loss of power condition and loss of gate control in accordance with AREMA C&S Manual, Part 3.2.15 U. The torque requirements for the pedestrian gate in loss of power situation shall be as specified in AREMA C&S Manual 3.2.15 D, and this GO Transit Grade Crossing Design Standard;

b) maximum descent time for the gate under a loss of power condition, in accordance with AREMA C&S Manual, Part 3.2.15 U; and

c) battery ampere hour capacity to maintain the operations of the gates for the hours specified in Metrolinx SCP-1402.

4.7.5 Pedestrian gate monitoring shall comply with the requirements specified in GCS & GCH Section 12.2, including:

a) gates in vertical position (gate UP position) in accordance with GCS Section12.1 (a),

b) gates descent to a point (angle of) 10 degrees from the horizontal (Gate Down position) in accordance with GCS Section 12.1 (b), and

c) Gate Control, Bell and Light Out Detection.

4.8 Pedestrian Gate Skirt

4.8.1 Pedestrian gate skirts shall be configured as shown in **Figure 4-1**, **Figure 4-2** and **Figure 4-3**, as applicable.

4.8.2 Pedestrian Gate Skirt Physical Characteristics

a) The skirt shall be of uniform dimensions, colour and general appearance as the gate to which it is attached.

b) The skirt shall be of lightweight materials with no hard surface or sharp edges that may potentially contact a pedestrian.

c) The skirt shall be designed so that it can be retrofitted to existing Grade Crossing gates.

d) Pedestrian gate skirts shall be installed as shown as in **Figure 4-1**, **Figure 4-2** or **Figure 4-3** in accordance with the following:

i) The skirt shall be installed between the bottom of the gate to which it is attached and the surface of the pedestrian pathway at a height of between 15 (0.4m) and 25 inches (0.6m).

ii) The skirt shall be within the “envelope” of the gate to which it is attached when projecting the gate from the top to the pedestrian pathway.

iii) Consideration for proper manufacturer specified gate torque and balance shall be given when installing gate skirts to an existing location.

4.8.3 Pedestrian Gate Skirt Operation

a) Pedestrian gate skirt operation shall comply with the following requirements:

i) The skirt shall be operated in unison with the gate to which it is attached.

ii) The skirt shall not compromise, in any way, the safety and normal operation of the gate to which it is attached when it is in its normal operation or failure mode.

iii) When the gate to which a skirt is attached is raised, the skirt shall retract to comply with clearance distance from the sidewalk, path or trail and avoid, in any way, obstructing or interfering with pedestrian flow through the Grade Crossing.

4.9 Criteria for Bells, Lights and Flashers for Pedestrian Gates

4.9.1 Bells, lights and flashers for pedestrian gates shall comply with the requirements related to the pedestrian gates specified in GCS Section 15.1.3 and AREMA C&S Manual Parts 3.1.1, 3.1.15, 3.1.25, and 3.2.5.

4.9.2 Light units used on pedestrian gate masts shall comply with the Standards for LED Modules in Warning Systems in accordance with GCS Appendix A.

4.9.3 In the case of a sidewalk, path or trail that is less than 11.5 feet (3.5m) wide, two red LEDs shall be provided on each gate arm located so that the lights are over the two points dividing the sidewalk, path or trail into thirds. The two gate arm lights shall flash alternately in unison with the entrance gate lights.

4.9.4 A bell shall be provided in every quadrant equipped with a pedestrian gate, shared roadway gate or roadway gate adjacent to a sidewalk if required in accordance with Grade Crossing Standards Section 15.1.3.

4.9.5 Front-facing light units installed exclusively for sidewalks, paths or trails shall be aligned to be visible through a point 5.5 feet (1.7m) above the centre of the sidewalk, path or trail and 100 feet (30.5m) in advance of the nearest rail on both sides of the line of the railway or point at which the set of light units first become visible if less than 100 feet (30.5 m), in accordance with GCS 14.6.1 and **Figure 3-3**.

4.9.6 Back-facing light units installed exclusively for sidewalks, paths, and trails shall be aligned to be visible through a point 5.5 feet (1.7m) about the centre of the sidewalk, path, or trail and 10 feet (3.0m) in advance of the opposite pedestrian gate as illustrated in **Figure 3-3**.

4.10 Fencing, Railings and Exit Swing Gates

4.10.1 Fencing shall comply with the Metrolinx Fencing Guidelines RC-0401-06 and railings shall comply with OPSD 980.101.

4.10.2 If an exit swing gate is provided in accordance with section 4.2.2, it shall:

a) be integrated with the associated fencing,

b) only open in one direction (away from the tracks),

c) open when physically pushed with a force not required to be greater than 5 pounds-force (22 Newtons),

d) include a mechanism to ensure that the gate will return to the closed position when it is not being physically pushed open,

e) return within 3 seconds from the fully open position to the fully closed position when released from force with a uniform closing speed,

f) be operable by a person using a wheelchair, scooter, or other mobility-assisting device,

g) include a means that is not accessible to the general public to allow maintenance crews to latch the gate open to perform snow removal or other activities,

h) provide, when fully opened, a minimum clear path of 5 feet (1.5m) in the case where it is installed adjacent to a fixed object (eg pedestrian gate mast, railing, fence, wall, etc),

i) provide, when fully opened, a minimum clear path of 38 inches (0.95m) in the case where it is installed adjacent to the tip of a lowered pedestrian gate,

j) be installed so that its top edge is positioned 35 to 40 inches (0.9 to 1.0 m) above the crown of the sidewalk,

k) be installed so that its bottom edge is positioned 15 to 19 inches (0.4 to 0.5m) above the crown of the sidewalk),

l) be orientated and positioned such that the opening of the gate does not trap or obstruct pedestrians and

m) incorporate permanent, static signage containing messaging consistent with that illustrated in Figure 4-4, including prohibitory (white background) “Do Not Enter” sign and permissive (blue background) “Safe Exit from Tracks” sign.

FIGURE 4-4: EXIT SWING GATE SIGNAGE

Visible to Pedestrians Approaching the Grade Crossing[1]

Visible to Pedestrians Leaving the Grade Crossing

4.10.3 All signage associated with Grade Crossings shall comply with the Metrolinx GO Static Signage Catalogue and the Metrolinx Wayfinding Design Standard, to the extent specified. Colours shall comply with Metrolinx GO Static Signage Catalogue.

4.10.4 If a sidewalk is located immediately adjacent to a roadway surface, a railing at least 10 feet in length shall:

a) be provided to divide sidewalk from the immediately-adjacent road surface,

b) be installed along the road-side of the sidewalk,

[1] “Do Not Enter” icon presented in Metrolinx GO Static Signage Catalogue, March 2018, section 3.3, page 25.

c) be located so as to start a maximum of 6 inches from the pedestrian gate on the non-track-side and extend away from the tracks.

4.10.5 The combination of fencing and exit swing gate shall be aligned or adjacent to the associated pedestrian gate but positioned such that the egress path for pedestrians is physically clear of the moving components of the gate so that the pedestrians are not at risk of being hit or pinched by the gate's moving components such as counterweights.

a) at crossings located within 500m of facilities expected to be accessed or exited by a high number of people at specific times (e.g. schools, public transit stations, sports complexes), the exit swing gate shall be positioned a nominal distance of 6 feet (1.8m) from the pedestrian gate along the sidewalk on the non-track side of the pedestrian gate.

4.10.6 In the case cited in section 4.2.3 where it is not possible to install fencing and exit swing gate, fencing shall nonetheless be provided to the extent possible, to ensure that pedestrians are kept physically clear of the moving components of the gate such that they are not at risk of being hit or pinched by the gate mechanisms.

4.11 Pedestrian Gate Inspection and Testing

4.11.1 Inspection and testing of pedestrian gates, gate skirts, bells, lights and flasher shall comply with the requirements specified in Metrolinx SCPs and GIs.

5. Multiple-Train Warning Sign

5.1 General

5.1.1 Grade Crossings having at least one municipal sidewalk and more than a single track shall be equipped with dynamic Multiple-Train Warning Signs (MTWS's), visible to pedestrians, cyclists, and other persons, including those using assistive devices. Dynamic MTWS's shall augment the static MTWS's, not replace them, as defined in this section 5.

5.1.2 Each dynamic MTWS shall be equipped with visual and audible notification capabilities as specified in this section.

5.2 Design Considerations

5.2.1 A dynamic MTWS shall be implemented at locations where the occurrence of a second/subsequent trains coming can potentially occur during regular or recovery operations at locations having pedestrian gates and more than a single track.

5.2.2 Dynamic MTWS signs shall be as shown in **Figure 5-2**.

5.2.3 The GCWS shall activate the dynamic MTWS signs only in cases where two trains may be present in, or approaching, the Grade Crossing, as further detailed in section 5.6.1.

5.2.4 Dynamic MTWS supporting structure designs shall be in accordance with the following:

a) all structural elements shall be designed in accordance with CSA S6:19,

b) structure shall be designed to resist wind load, ice load, and with an infinite fatigue life,

c) structural steel shall conform to CSA G40.20-13/G40.21-13 Grade 350W unless otherwise noted,

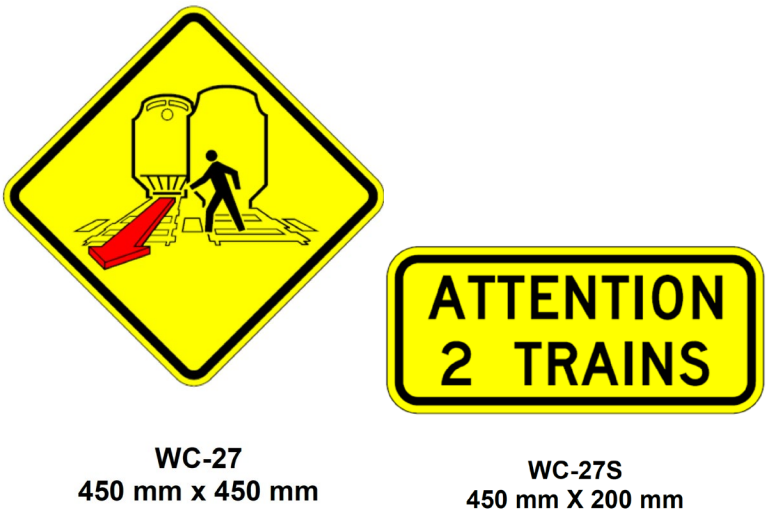
d) angles, plates, and channels shall conform to CSA G40.20-13/G40.21-13 grade 300W, and

e) all welding shall conform to CSA W48-18 and W59-18 and shall be undertaken by a fabricator qualified in accordance with CSA W47.1:19.

5.3 Physical Characteristics

5.3.1 A static MTWS is provided by the municipal road authority as shown as in **Figure 5-1** and a dynamic MTWS sign shall be as shown as in **Figure 5-2**. Dimensions shown in **Figure 5-1** are minimum values and in **Figure 5-2** are nominal values.

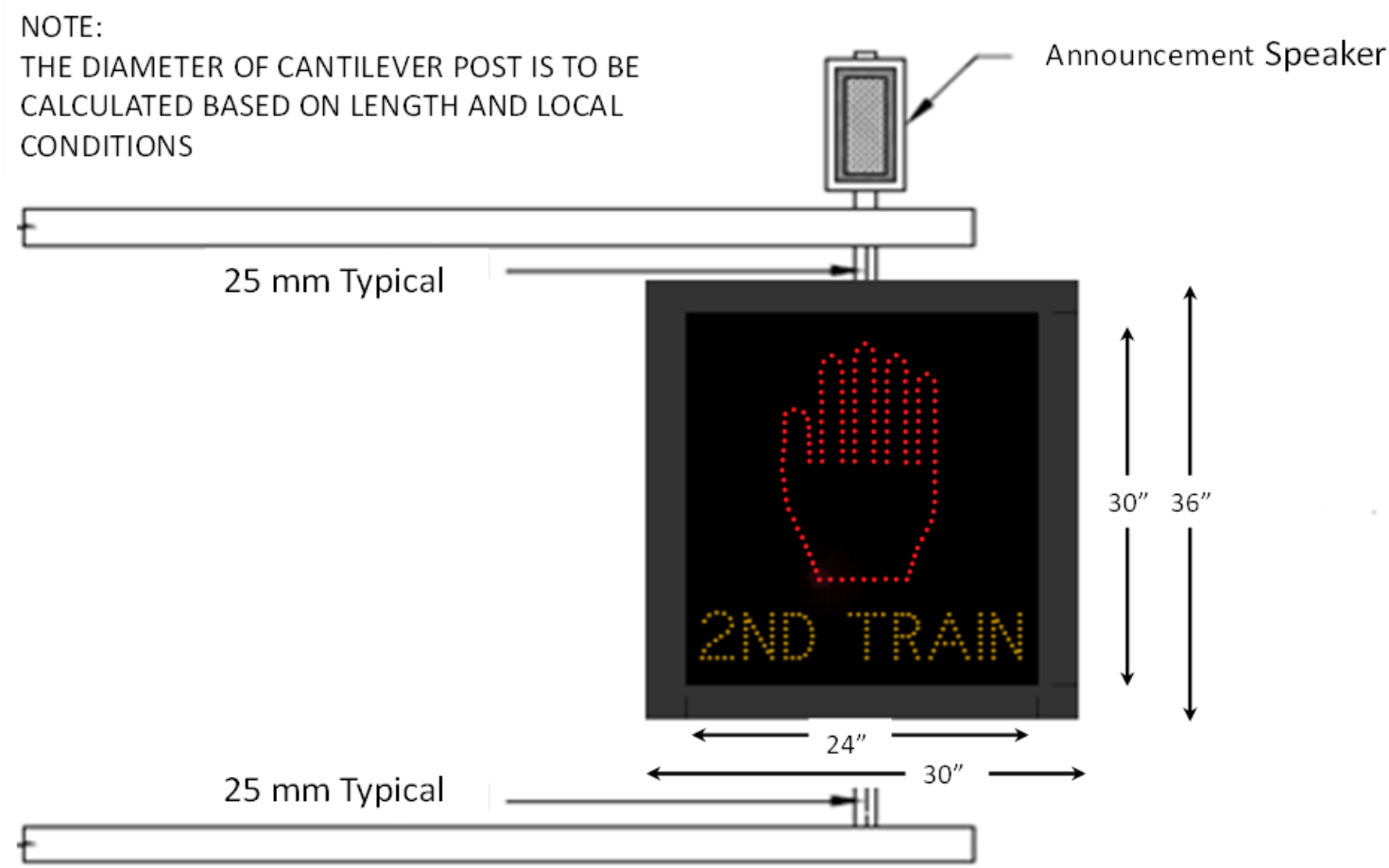
FIGURE 5-1: STATIC MULTI-TRAIN SIGN – PHYSICAL CHARACTERISTICS



WC-27
450 mm x 450 mm

WC-27S
450 mm X 200 mm

FIGURE 5-2: DYNAMIC MTWS PHYSICAL CHARACTERISTICS – STOP HAND



5.3.2 The active components of dynamic MTWSs shall have the following characteristics:

a) waterproof in compliance with IEC standard 60529 rating IP65 or better and sealed by epoxy as required and

b) unaffected by adverse weather conditions or accumulation of dust, ice, snow, or water.

5.4 Installation Requirements

5.4.1 The dynamic MTWS shall be installed at a minimum distance of 10 feet (3.0m) from the nearest rail.

5.4.2 To the extent possible, the MTWS should be installed at the optimal spacing of 6 feet (1.8m) from the associated pedestrian gate, with the MTWS being closer to the rail. The pedestrian gate shall not be moved away from the track for the sole purpose of accommodating this optimal spacing.

5.4.3 The dynamic MTWS shall be mounted in accordance with one of the following configurations:

a) on the entrance or exit gate assembly in accordance with **Figure 5-3**, or

b) on a new, stand-alone mast in accordance with **Figure 5-4**, or

c) on the pedestrian gate mast as shown in **Figure 5-5** in the case where the pedestrian gate mast does not need to be equipped with flashing lights and crossbuck in accordance with section 4.5.2.

FIGURE 5-3: DYNAMIC MTWS INSTALLATION – CANTILEVERED OFF ENTRANCE GATE

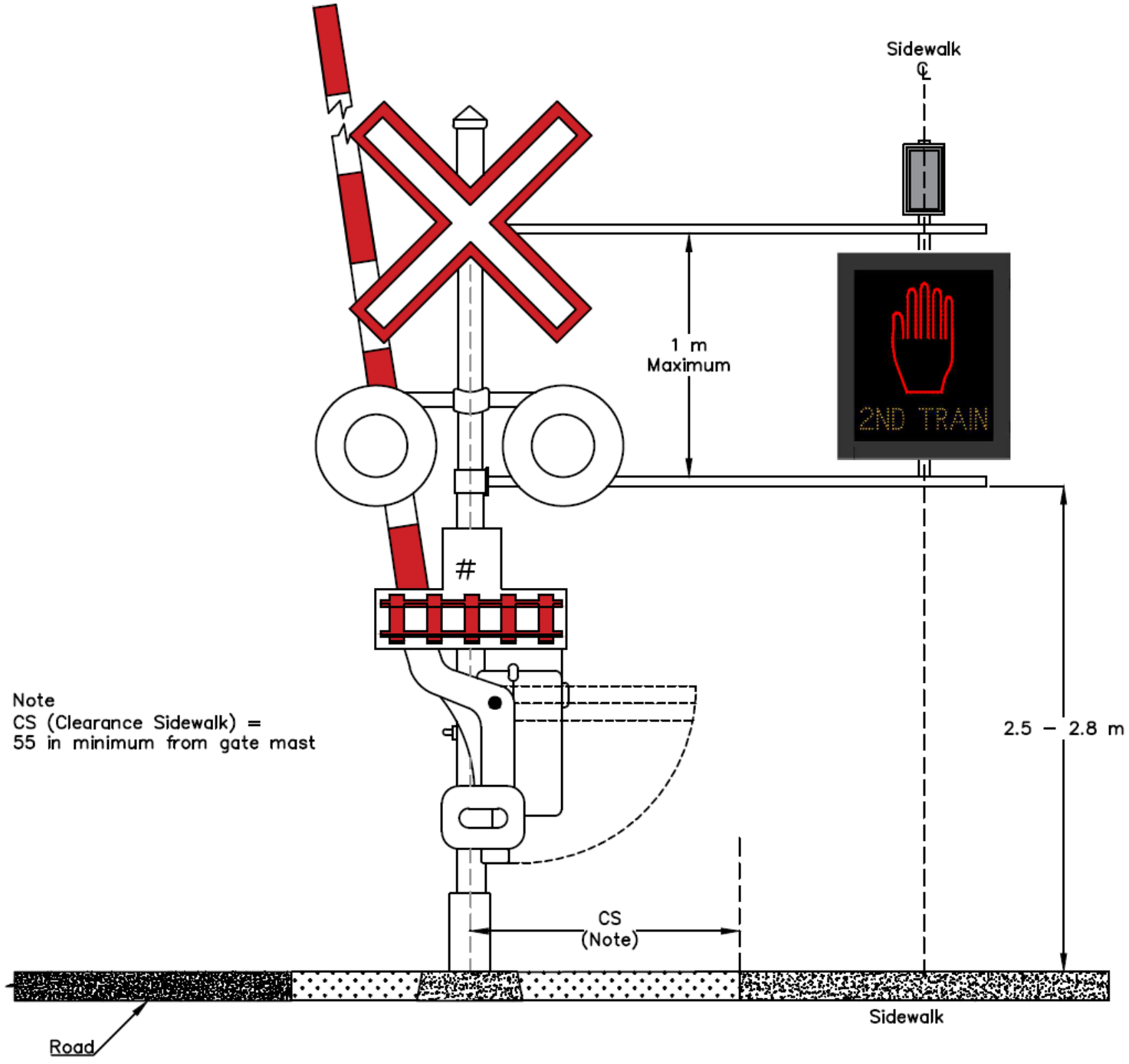


FIGURE 5-4: DYNAMIC MTWS INSTALLATION – DEDICATED MAST

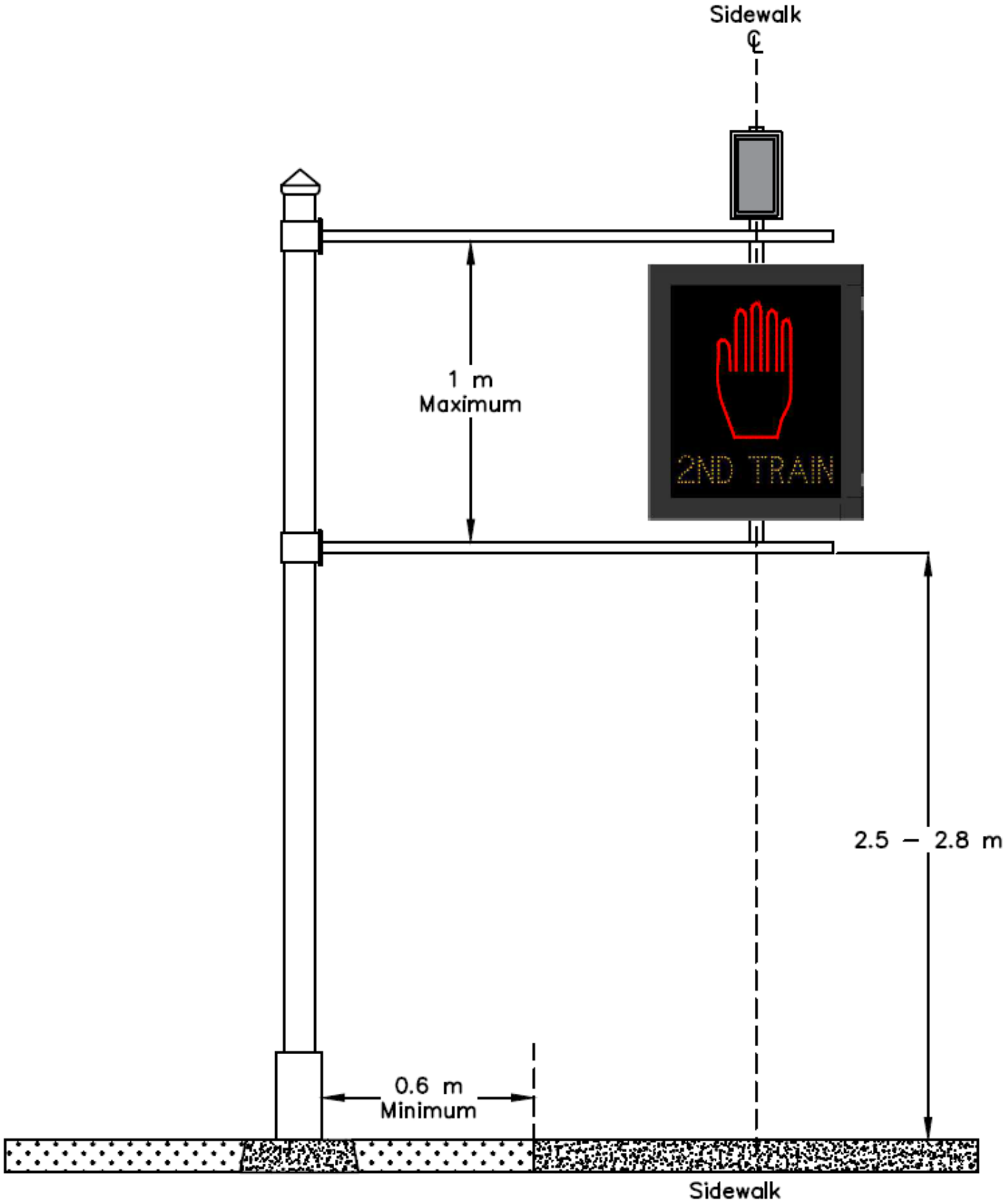
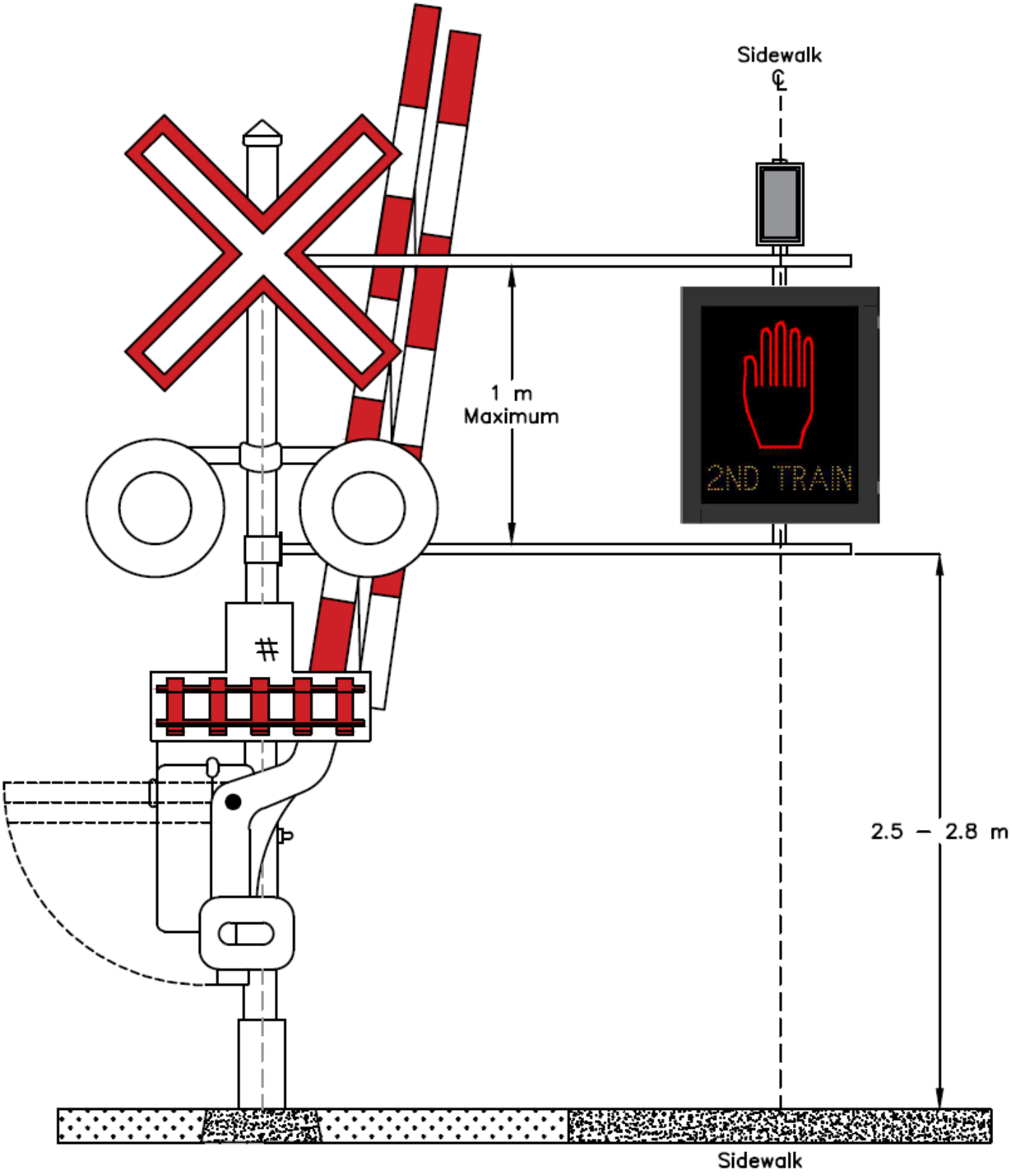


FIGURE 5-5: DYNAMIC MTWS CANTILEVERED OFF PEDESTRIAN GATE



5.5 Sighting Requirements

5.5.1 Each dynamic MTWS shall incorporate back-to-back sign faces.

5.5.2 The dynamic MTWS shall comply with the sighting requirements for the pedestrian signs specified in GCS Sections 13.4 and 14.6, and the following:

a) Each MTWS sign face shall be independently adjustable both laterally and vertically, and tilted 30 degrees downwards, to ensure adequate viewability for pedestrians that are approaching the Grade Crossing on the sidewalk.

b) The flashing element of the MTWS (the “Stop Hand” symbol) shall flash uniformly at a rate of 45 to 65 flashes per minute.

c) The MTWS shall be visible from at least 100 feet (30.5m) distance during bright daylight, night, fog, rain, and snow, with a viewing angle no greater than 32 degrees from the horizontal throughout the approach from 50 feet (15.2m) to 6 feet (1.8m).

5.6 Operational Requirements

5.6.1 Activation and Deactivation

a) The GCWS shall activate the MTWS under the following scenarios:

i) when a GCWS is already active for a train or in the process of deactivating, and another train subsequently enters the approach to the Grade Crossing or if the GCWS receives a DTMF command from another source to activate the crossing; and

ii) when a GCWS is not activated but a train occupies the Grade Crossing approach (e.g.: near-side station stop, far-side station stop, switching moves, DTMF activation / deactivation), and the train is visible, and another train subsequently enters the approach of the Grade Crossing.

b) The GCWS shall de-activate the MTWS whenever the GCWS is restored (de-activated).

c) Crossing circuits shall be so arranged that a failure of any entrance/exit/pedestrian gate mechanism to operate as intended shall not prevent dynamic MTWS from being activated.

5.6.2 Audible Component

a) An audible warning to pedestrians, cyclists, and other non-motorized vehicle road users shall be annunciated whenever the MTWS is activated.

b) The audible warning shall consist of a repeating voice stating “Danger! Another Train Coming!” spoken in English, alternating with “Danger! Un autre train arrive” spoken in French, with a 5 second gap between the repetitions.

c) One unidirectional speaker shall be mounted above each dynamic MTWS, directed along the pedestrian sidewalk away from the tracks, so that the audible warning can be heard by pedestrians approaching the crossing.

d) The audible warning shall be precisely synchronized among all speakers at a Grade Crossing.

e) The audio volume shall have a nominal value of 105dB(A), adjustable to be audible in the presence of noise emitted from nearby warning bells, road vehicles and approaching trains.

f) Audible warning device shall be installed as per guidelines mentioned in AREMA Parts 3.1.1 and 3.1.15.

5.6.3 Power Requirements

a) Dynamic MTWS's shall be powered by 9-16 VDC.

b) Each MTWS (comprising two faces) shall not consume more than 48W.

c) The announcement speaker shall be powered by 9 to 16 VDC and shall not draw more than 3A current.

d) In the event of a loss of power within the primary power source, the battery used for standby purposes shall be of sufficient capacity to maintain the operating requirements for the duration specified in SCP-1402.

e) The GCWS shall monitor health status of each dynamic MTWS.

f) Light emitting unit design criteria for the MTWS shall be as specified in AREMA C&S Manual Part 3.2.35.

g) Ground fault protection shall be provided to protect the DC power distribution system against any field elements.

5.6.4 Fault Monitoring and Failure Handling

a) Processor based control systems shall include diagnostic capabilities to assist in testing, troubleshooting, and maintenance of the dynamic MTWS system.

b) In the event any dynamic MTWS fails to activate or if it partially flashes, the GCWS system shall log the affected MTWS failure in the system logs.

5.7 Inspection and Testing

5.7.1 The Inspection and testing of dynamic MTWS sign shall be in accordance with Metrolinx SCPs and GIs.

5.7.2 The GCWS shall have a provision to test and simulate a 2nd train through a test switch.

6. Roadway and Sidewalk LEDs

6.1 Design Considerations

6.1.1 Embedded red flasher LEDs shall be installed on both the entrance and exit quadrants in the roadway as illustrated in **Figure B-4** or **Figure B-5,** as applicable.

6.1.2 Embedded white sidewalk LEDs shall be installed along both sides of each pedestrian sidewalk as indicated in **Figure B-4** and **Figure B-5,** as applicable.

6.2 Physical Characteristics

6.2.1 Embedded red flasher LEDs and embedded white sidewalk LEDs shall have the following characteristics:

a) able to endure snow plowing in winters,

b) waterproof in compliance with IEC standard 60529 rating IP68 or better and sealed by epoxy,

c) unaffected by adverse weather conditions or accumulation of dust, ice, snow, or water,

d) load rating of not less than 11,000 Lb. or 5000 kg compression,

e) lighting intensity of not less than 3,500,000 cd/m2,

f) beam trajectory of nominal +/- 4 degrees vertical and +/- 15 degrees horizontal, and

g) compatible with Asphalt/Concrete or any other type of road surface.

6.2.2 Embedded red flasher LEDs shall incorporate unidirectional faces.

6.2.3 Embedded white sidewalk LEDs shall incorporate bidirectional faces.

6.3 Red LED Electrical Characteristics

6.3.1 Embedded red flasher LEDs shall work with DC voltage between 9 to 16V with a nominal voltage of 14 V, fed from the operating battery bank at crossing bungalow.

6.3.2 The power consumption of each embedded LED shall be 4W maximum.

6.3.3 The power feed cabling to each group of embedded red flasher LEDs shall be configured as a loop, to ensure redundancy in case of damage to the cable between adjacent LEDs in a group.

6.3.4 All cables interconnections shall not be exposed at any place and shall be sealed with a waterproofing compound.

6.3.5 Ground fault protection shall be provided to protect the DC power distribution system against faults associated with any elements that are installed in the field.

6.4 White Sidewalk LED Electrical Characteristics

6.4.1 Embedded white LEDs shall be solar-powered.

6.4.2 Each LED shall be independent and not connected by cable to any other LED, controller, or power source.

6.4.3 Each LED unit shall be modular to permit the replacement of defective components without having to replace the housing.

6.5 Interface Requirements

6.5.1 Embedded red flasher LEDs shall be compatible with all types of existing Grade Crossing controller for driving their lighting circuits.

6.6 Installation Requirements

6.6.1 Embedded red flasher LEDs and embedded white sidewalk LEDs shall be arranged as shown as in **Figure B-4** and **Figure B-5** as applicable, and shall meet the following installation requirements:

a) minimally invasive to the road surface and shall be able to adopt any type of road surface,

b) red flasher LEDs shall be flush with the road surface once installed with all the protective covers,

c) white flasher LEDs shall be flush with the sidewalk surface such that they do not create a tripping hazard for pedestrians,

d) shall not accumulate dust, water, snow, ice under any conditions, and

e) shall endure the compressive point loads specified in 6.2.1 in all weather conditions without performance degradation.

6.6.2 Two embedded red flasher LEDs shall be installed directly under the lowered entrance gate arms in each road lane evenly spaced between road lane markings, medians, and roadway edges as shown in **Figure B-4** and **Figure B-5**.

6.6.3 In the case where the roadway has a designated bicycle lane, two additional red flasher LEDs shall be provided. The four LEDs that will cover the bicycle lane and the adjacent road lane shall be evenly spaced over the two lanes without being installed directly on any lane markings.

6.6.4 Embedded white sidewalk LEDs shall be installed along the sidewalk starting 5 feet (1.5m) from the running rail and extending to, or beyond, the pedestrian gate on both edges of the sidewalk such that each embedded white sidewalk LED is separated from the neighboring embedded white sidewalk LED by 3 feet (0.9m) (nominal), with a minimum of three LEDs provided on each edge of the sidewalk.

6.6.5 Embedded red flasher LEDs shall not be installed on dirt roads and embedded white flasher LEDs shall not be installed on dirt sidewalks.

6.7 Operational Requirements

6.7.1 Embedded white sidewalk LEDs shall illuminate constantly during non-daylight hours, irrespective of GCWS activation or de-activation, and visible from both approach directions along the sidewalk.

6.7.2 Each pair of red flasher LEDs in each road and bicycle lane shall flash alternatively in synchronism with the flashing lights of the associated entrance gate.

6.7.3 Embedded red flasher LEDs shall be visible only on the approach to the crossing in each lane and at a nominal distance of at least 375 feet (114.3m), adjustable at time of installation to ensure adequate visibility in the context of the specific crossing.

6.7.4 Embedded red flasher LEDs shall incorporate a failure monitoring output to indicate a light out condition.

6.8 Inspection and Testing

6.8.1 The Inspection and testing of embedded red flasher LEDs and embedded white sidewalk LEDs shall be in accordance with Metrolinx SCPs and GIs.

6.8.2 The visibility of embedded red flasher LEDs and embedded white sidewalk LEDs shall be periodically inspected and validated to mitigate changes in surrounding geography, road conditions and normal wear and tear to ensure they are in good working condition.

6.8.3 The GCWS shall have a provision to test and simulate embedded red flasher LEDs through a test switch.

7. Traffic Queue Management

7.1 General

7.1.1 In some circumstances, road vehicle traffic may become trapped within a crossing as a result of downstream queuing, such that one or more road vehicles may be stopped and unable to proceed at the time when the Grade Crossing is activated upon the approach of a train. This is extremely dangerous, and can be mitigated by the following means:

a) improving the flow of traffic downstream of the crossing, to pre-empt backups,

b) restricting the flow of traffic upstream of the crossing, in case of detected downstream backups and

c) reinforcing warnings to motorists not to enter the Grade Crossing unless they can be sure to proceed entirely through the Grade Crossing.

7.1.2 Road vehicle traffic queuing may result from a variety of geographical features in the vicinity of a Grade Crossing. Although a GCWS is not itself directly responsible for either of these mitigations, and the Road Authority has ultimate responsibility for the design, installation, and implementation of the Traffic Queue Management solutions, nevertheless the GCWS can be equipped with an interface to nearby traffic signals. This interface can be leveraged to improve downstream traffic flow to provide adequate free space beyond the Grade Crossing to allow refuge for the last road vehicles traversing the crossing when it is activated. Queue Management should follow the requirements of FDOT document https://safety.fhwa.dot.gov/hsip/xings/com_roaduser/fhwasa18040/chp2g.cfm

7.1.3 A Traffic Study shall be conducted to determine any traffic queuing issues, including the analysis of CCTV footage, traffic signal operating sequences, warning times and the impact of train operations on warning times. The Traffic study may recommend the implementation of some combination of Pre-Signals, Queue-Cutter Signals, traffic signal coordination, Active Warning Signs, railway warning devices, many of which would require the implementation of an interface between the GCWS at the crossing and nearby Interconnected Highway Traffic Signal Devices.

7.2 Potential Mitigations for Queuing

7.2.1 The following is a selection of potential mitigations that can be implemented to manage traffic queuing in the vicinity of Grade Crossings:

7.2.2 **Traffic Signal Coordination** means the use of road traffic signals to provide more green time and capacity at the traffic control signal downstream from a crossing, relative to the green time and capacity provided for movements approaching the crossing by the corresponding upstream signal.

7.2.3 **Advance Interconnection** means a notification to an Interconnected Highway Traffic Signal Device (IHTSD) by a GCWS, at a predetermined period in advance of the activation of the GCWS, that a train is approaching. This would be considered Interconnection with Pre-emption.

7.2.4 **Simultaneous Interconnection** is when notification of an approaching train is forwarded to the IHTSD simultaneously with the activation of the GCWS. This would be considered Interconnection with No Pre-emption.

7.2.5 **Pre-Signal** means a traffic signal that controls traffic approaching a Grade Crossing in conjunction with the traffic signals that control a highway intersection beyond the railway tracks. The Pre-Signal stops vehicular traffic before the Grade Crossing in cases where the Critical Safe Distance (CSD) is 50 feet (15.2m) or less, or 75 feet (22.9m) if the design vehicle is longer and is also used where the CSD is as much as 200 to 250 feet (61.0 to 76.2m), depending on vehicle lengths (in this case, it is not expected that all vehicles will be cleared from the CSD; only from the MTCD). Where the CSD is one design vehicle length or less, relocating the stop line upstream of the crossing may be sufficient to control queuing without the need for a pre-signal.

7.2.6 **Queue-Cutter Signal** means a traffic signal that holds traffic or “cut the queue" upstream from a Grade Crossing before a queue caused by a downstream traffic control signal or other roadway congestion can grow long enough to back up into the Grade Crossing. It is a traffic control signal which only controls traffic approaching a Grade Crossing and is operated independently of other traffic signals in the area. Queue-cutter signal operation may be based on downstream queue loop detectors, timed operations, or a combination of the two. The presence of an effective queue-cutter can eliminate the need for preemption of the downstream traffic signals.

7.2.7 **Active Warning Sign** means a sign to advise road users not to stop on the Grade Crossing, which is activated by active queue detection, when traffic has the potential to back up towards the Grade Crossing from a downstream STOP sign controlled intersection for which traffic signalization is not justifiable, or where traffic may occasionally back up due to special events.

7.3 Design Considerations

7.3.1 The design and operation of the interconnection of a GCWS and IHTSD shall be in accordance with:

a) Transport Canada Grade Crossing Standards,

b) Grade Crossing Handbook,

c) AREMA C&S Manual Parts 3.1.10, 16.30.10, and

d) GO-SCP-705 GCWS Safety Assurance Process.

7.3.2 Where IHTSD are interconnected with a GCWS, 4 hours continuous operation battery back-up shall be provided.

7.4 Inspection and Testing

7.4.1 Interconnection to IHTSD shall be maintained, inspected, and tested in accordance with design plans and forms to ensure that they operate as intended, and in accordance with Metrolinx GI-310(b)(2).

7.4.2 A label shall be installed in the traffic signal controller cabinet and the GCWS housing informing maintenance personnel of the interconnection. The label shall provide contact information for both the public agency responsible for the traffic signals and the Metrolinx Network Operation Centre (NOC).

8. Road Vehicle Logging

8.1 General

8.1.1 The logging of the quantity of road vehicles that travel across each Public Grade Crossing in each direction shall be implemented.

8.2 Design Considerations

8.2.1 Vehicle logging shall be implemented using any of a variety of technologies, including:

a) intelligent imaging processing, or

b) magnetometer logging stud.

8.3 Physical Characteristics

8.3.1 Vehicle logging components shall have the following characteristics:

a) Be unaffected by adverse weather conditions or accumulation of dust, ice, snow, or water,

b) Able to endure snow plowing in winters,

c) Waterproof in compliance with IEC standard 60529 rating IP68 or better, sealed by epoxy, and

d) Load rating, if embedded in the roadway, of not less than 11,000 Lb. or 5000 kg compression and compatible with Asphalt/Concrete or any other type of road surface.

8.4 Electrical Characteristics

8.4.1 Any logging system that requires external power shall consume less than 25W continuous and shall be compatible with a DC supply voltage between 9 to 16V with a nominal voltage of 14V to be fed from the operating battery bank at crossing bungalow.

8.4.2 The logging system shall incorporate a suitable, open-standard interface to support data collection, such as Ethernet, USB or Wi-Fi.

8.4.3 The logging system shall have sufficient capacity to store data for a period of at least 6 months.

8.4.4 Any cable interconnections shall not be exposed at any place and shall be sealed with a water proofing compound.

8.4.5 Ground fault protection shall be provided to protect the DC power distribution system against faults associated with any components installed in the field.

8.5 Installation Requirements

8.5.1 Installation of any roadway-embedded hardware required to support vehicle logging shall:

a) be minimally invasive to the road surface and shall be able to adopt any type of road surface, and

b) be flush with the road surface once installed with all the protective covers.

8.5.2 If logging studs are employed, they shall be arranged with at least one per vehicle lane, normally placed in the entrance quadrant.

8.6 Operational Requirements

8.6.1 The vehicle logging function shall:

a) detect any vehicle including all passenger motor vehicles, school buses, trucks and motorcycles,

b) be unaffected by train or railway equipment such as track machines, Hi-Rail trucks or rail mounted equipment,

c) be compatible with 2x25kV electrification,

d) not incorrectly detect as a vehicle any pedestrians, bicycles or any type of debris that is likely to be found in the vicinity of the Grade Crossing, and

e) not generate or induce levels of energy into the rails or other railway communication medium of such magnitude that will affect the signalling train detection system by causing false occupancy or false vacancy of trains under any normal or abnormal mode of operation.

8.7 Inspection and Testing

8.7.1 The inspection and testing of the vehicle logging function shall be in accordance with Metrolinx GIs.

8.7.2 The accuracy of counts produced by the vehicle logging function shall initially be validated to identify the accuracy of counts of vehicles and may need to be periodically re-validated to mitigate changes in surrounding geography, road conditions and normal wear and tear.

9. Electrification Integration

9.1 Electrification Clearance

9.1.1 At locations where the OCS passes through a Grade Crossing, the Grade Crossing equipment may need to be located further away from the tracks than would be required at a non-electrified crossing. This section identifies the constraints that will need to be managed.

9.1.2 The location and placement of the OCS equipment and the GCWS devices shall be coordinated to mitigate any physical and electrical interference.

9.1.3 Electrical clearances shall be measured to the closest point of the GCWS devices, whether a gate tip, signal hood or background, sign, mast, or bracket, and not to the centerline of the mast.

9.1.4 The design and location of the GCWS gates shall accommodate wind deflection considering all applicable factors including materials and construction of the gates, the speed of the wind and the angle of the gate with respect to the wind.

9.1.5 Placement of GCWS devices shall be analyzed based on the following, to avoid encroachment into any energized element of the OCS:

a) The angle of road to the crossing,

b) The horizontal limit of the OCS wires from the centerline of the nearest track,

c) The recommended electrical clearance, safety clearance and mechanical clearance as per electrification design,

d) The maximum vertical and horizontal sags or deflections of the nearest OCS wires, and

e) The gate tip angle and length of the gate arm.

9.2 EMC/EMI

9.2.1 An EMI analysis shall be conducted to identify sensitive receptors and emitters of the GCWS equipment installed within the influence zone of the OCS.

9.2.2 All GCWS equipment supplied shall comply with an EMI/EMC Control Plan in compliance with EN 50121.

9.3 Grounding – Bonding and Surge Protection

9.3.1 All Grade Crossing metallic equipment and accessories shall be grounded and bonded in compliance with:

a) “AREMA Manual for Railway Engineering Volume 3, Chapter 33, Part 5 – Railway Electrification Compatibility with Signal Systems”, and

b) “IEC 62128-1 “Railway applications – Fixed installations – Part 1: Protective provisions relating to electrical safety and earthing”.

9.3.2 Surge protection shall be provided to protect against transients due to lightning, traction power surges and fault conditions such as broken OCS wires.

9.3.3 Installation and testing of the grounding system shall be in accordance with applicable Metrolinx SCPs and GIs.

9.4 Over-Height Warning

9.4.1 As part of the electrification of the railway, an over-height warning system may be installed by others. This may involve any combination of fixed signage, fixed passive devices to indicate height limitations and active devices to detect and provide warnings for over-height vehicles.

9.4.2 If a warning system has been provided at a given crossing, the Grade Crossing equipment specified in this document shall be compatible and integrated with the over-height warning system.

10. Failure Monitoring and Remote Reporting

10.1 General

10.1.1 GCWS equipment shall provide data recording and remote reporting functions for failure monitoring and diagnostic purposes.

10.1.2 The GCWS shall provide the following functions: data recorder, data analyzer (may be provided as an offline capability) and remote reporting.

10.1.3 Remote reporting GCWS functions shall comply with AREMA C&S 3.1.29.

10.1.4 Devices that provide the data recorder function shall incorporate the following features:

a) Monitor site event status of all specific events,

b) Record logs related to each event with date and time stamping at source,

c) Synchronization of the internal clock(s) with the Master Clock System,

d) Ability to transfer each recorded event to an output device,

e) Generate alarms to all central control stations throughout the communication network,

f) Respond to local and remote data access requests,

g) Access each specific event and identity all relevant details (e.g.: location, mile, subdivision),

h) Retention of all data in the event of power failure via non-volatile memory or internal battery,

i) Retain data for a minimum of 60 days before overwriting or deleting, and

j) Allow access to diagnostic data in real time.

10.1.5 GCWSs shall log all historical events, commands, and alarm conditions.

10.1.6 Devices which communicate remotely using shared public/private communication networks shall have security provision like protection against unauthorized users to access data.

11. Supplemental Elements

11.1 Perimeter Fencing and Gates

11.1.1 Railway authorities are responsible for maintaining public safety by restricting unauthorized access to a railway right-of-way. This responsibility is outlined in the Railway Right of Way Access Control Policy set out by Transport Canada, to which all Metrolinx-owned Grade Crossings shall adhere.

11.1.2 As incidents associated with unauthorized access by pedestrians and vehicles become prominent, access control measures to protect the rail corridor shall be used. Such include fencing and vehicle and/or man-gates with a Metrolinx approved lock on both sides of the Grade Crossing, per the Metrolinx Fencing & Anti Trespassing Requirements RC-0401-06.

11.1.3 As Metrolinx rail corridors span a multitude of urban, suburban, and rural areas, fencing on the perimeter of Grade Crossings and man-gates for train crew access shall be installed and maintained subject to crossing type, location, and volume of crossing users.

11.1.4 Considering the low volume of crossing users along private Grade Crossings in rural areas, perimeter fencing and man-gates are not required. In urban areas however, it is important to ensure the proper installation and maintenance of these access control measures as further detailed in the Metrolinx Fencing & Anti Trespassing Requirements RC-0401-06.

11.1.5 Direction for fencing and gate layout and positioning specific to each crossing shall be provided by Metrolinx in contract specifications.

11.2 Anti-Trespass Panels

11.2.1 Anti-Trespass Panels (ATPs) as specified in the Metrolinx Fencing & Anti Trespassing Requirements RC-0401-06 shall be installed at public Grade Crossings as required by a DSA, between property line fencing to further mitigate unauthorized trespasser access to its rail corridors.

11.3 Pavement Markings

11.3.1 Pavement markings serve to convey regulatory and warning messages to road users in addition to signs and signals. At Grade Crossings, pavement markings contribute to crossing user safety by delineating Grade Crossing surfaces and defining paths to guide pedestrians and motorists through a hazardous area.

11.3.2 As pavement markings have limitations in durability and visibility when subject to heavy traffic and winter weather, appropriate material shall be used. Metrolinx-owned Grade Crossings shall comply with the following specifications, in addition to the pavement marking requirements in Article 8 of the GCH.

11.3.3 Roadway paint and reflective material in all applications shall adhere to the following MTO specifications, as applicable:

a) OPSS 1712 – Organic Solvent Based Traffic Paint, or

b) OPSS 1713 – Material Specification for Thermoplastic Pavement Marking Materials, or

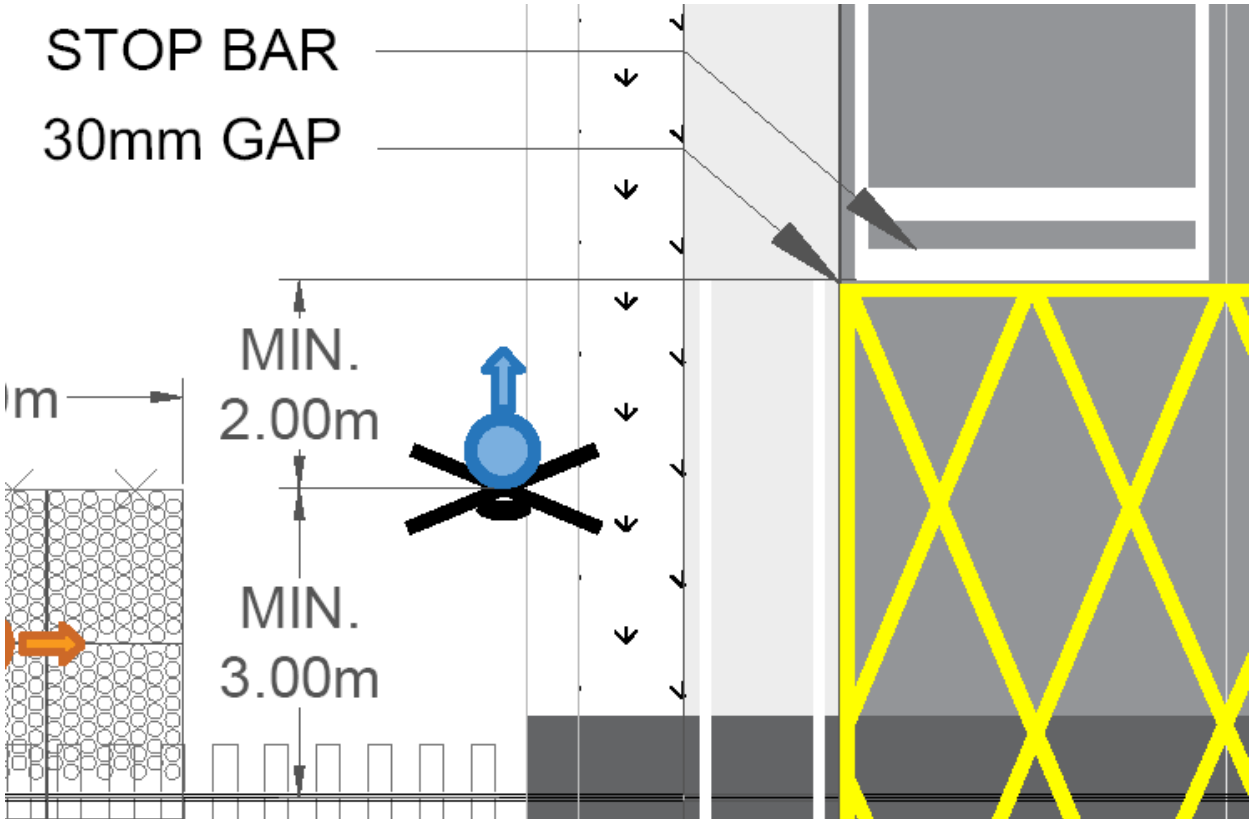
c) OPSS 1716 – Water-Borne Traffic Paint.

11.3.4 Roadway paint and reflective material in all applications shall adhere to the following MTO specification, as applicable: OPSS 1750 – Traffic Paint Reflectorizing Glass Beads.

Stop Bars

11.3.5 As per Article 8 of the GCH, Grade Crossings without a warning system require stop bars to be installed on the paved road approach at a minimum of 5.0 m distance taken perpendicular from the nearest rail. The markings of the stop bars are installed and maintained by the governing road authority. Where the Railway Crossing sign or signal mast is installed more than 3.0 m in advance of the nearest rail, the stop bars shall be located a minimum of 2.0 m in advance of the centre of the Railway Crossing sign or signal mast on the paved road approach, as shown in **Figure 11-1**.

FIGURE 11-1: STOP BAR LOCATION



Crosshatching

11.3.6 Crosshatching shall be used as illustrated in **Figure 11-2** to define the extents of Grade Crossing surfaces, in which crossing users must yield the right of way to incoming trains. Crosshatching shall be marked accordingly:

a) colour: yellow with reflective beads,

b) crosshatch line width: 250 - 300 mm,

c) border line width: 250 - 300 mm,

d) silica sand additive to increase friction on pedestrian walking surfaces,

e) extend from nearest rail at least 4.7 m or 30 cm from the stop bar at public Grade Crossings and up to the Railway Crossing sign-post at private Grade Crossings, and

f) a minimum of two coats of paint shall be applied.

11.3.7 Though the overall shape and number of crosshatched lines will vary between Grade Crossings, a standard hatching pattern shall be used to form a box enclosing diagonal crosshatch lines.

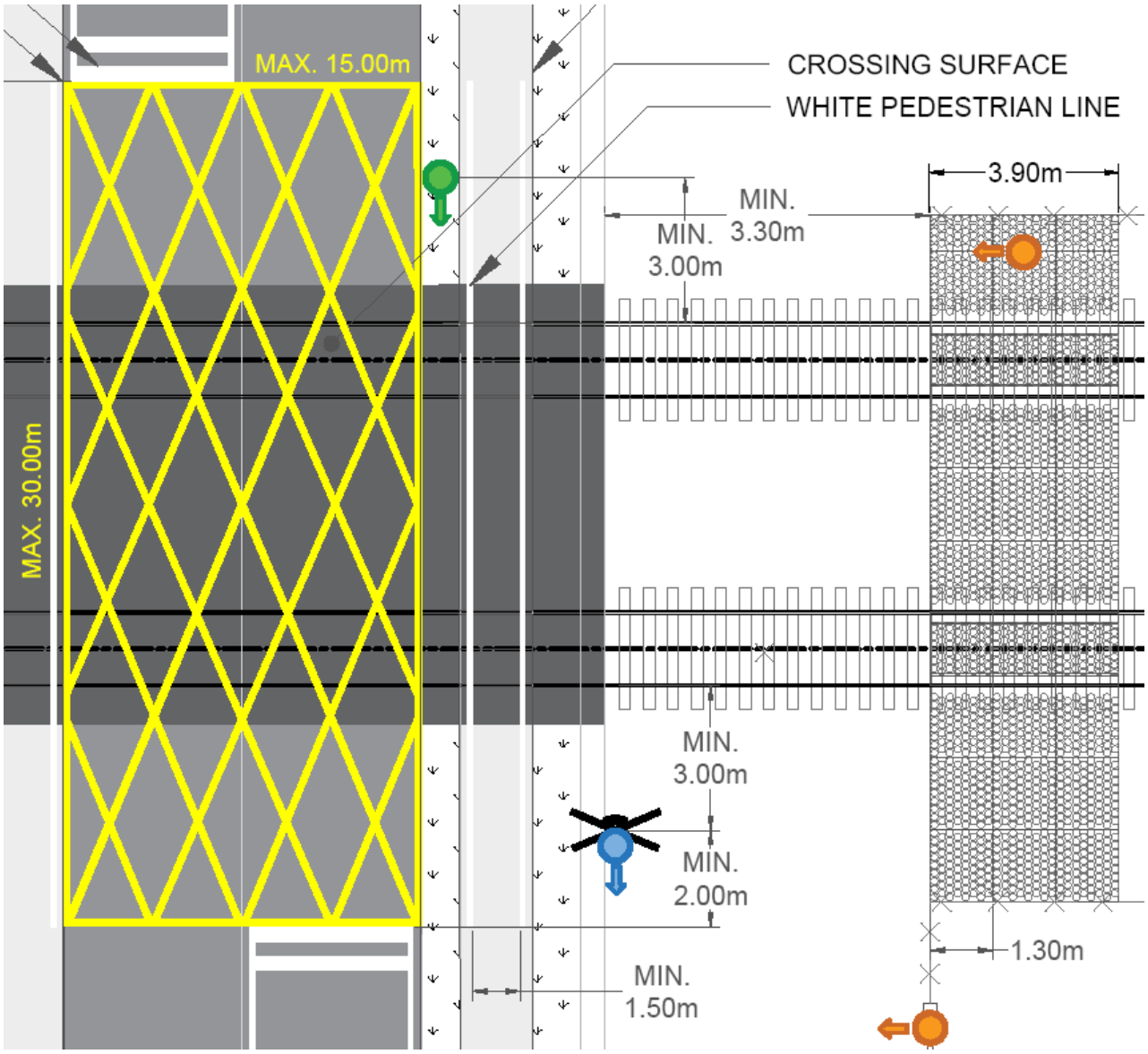
11.3.8 Two main diagonal lines shall form an ‘X’, each connecting a pair of opposite corners within the bordering box.

11.3.9 Diamond shaped units shall then be marked by running diagonal lines from the midpoint of each perimeter line to the midpoint of the adjacent perimeter line.

11.3.10 Crosshatches shall fill a rectangular enclosure to dimensions that do not exceed a length and width of 30 m and 15 m respectively, unless otherwise approved by Metrolinx.

11.3.11 A sample of crosshatching for roadway surfaces crossing multiple tracks is depicted in **Figure 11-2**.

FIGURE 11-2: CROSSHATCHING AND PEDESTRIAN GUIDELINES



Pavement Edge Lines

11.3.12 Pavement edge lines shall be used to further define the pavement limits at Grade Crossings where the crossing angle, taken from the tangent of the centreline of the road to the tangent of the centreline of rail, is less than 30 degrees or greater than 150 degrees.

11.3.13 Pavement edge lines shall lie outside of crosshatching and be marked accordingly:

a) colour: white with reflective beads,

b) line width: 100 mm,

c) one line at each edge of the roadside or at locations approved by Metrolinx, and

d) a minimum of two coats of paint shall be applied.

Pedestrian Guidelines

11.3.14 Pedestrian guidelines shall be applied to pavement surfaces to indicate the pathway intended for pedestrian use. These include people walking, running, standing, manual or motorized wheelchair or scooter uses, dismounted cyclists, and users of other low speed forms of human locomotion (e.g.: skateboards). Pedestrian guidelines shall be marked on sidewalks, paths, or trails across Grade Crossings accordingly:

a) colour: white with reflective beads,

b) line width: 100 mm,

c) extent from nearest rail: at least 5.0 m or up to the stop bar,

d) with a minimum distance of 1.5 m between the inside edges of guidelines,

e) silica sand additive to increase friction, and

f) a minimum of two coats of paint shall be applied.

11.3.15 Considering the low volume of crossing users expected across private Grade Crossings in rural areas, pedestrian guidelines are not required. Pedestrian guidelines for public Grade Crossings are depicted in **Figure 11-2**.

Advance Crossing Markings

11.3.16 As per Section 8.8 of the GCH, advance crossing markings installed and maintained by the governing road authority shall be placed on each paved approach lane to Grade Crossings.

11.3.17 Where a new crossing is being constructed or modified from an existing configuration, advance crossing markings shall be installed or modified accordingly by the party completing the work.

11.3.18 Markings shall be implemented for crossings where crossing signals or automatic gates are located, and at all other crossings where the prevailing speed of roadway traffic is 40 km/h or greater.

11.3.19 According to the Manual of Uniform Traffic Control Devices for Canada, advance crossing markings shall consist of an ‘X’, where the midpoint of the marking shall be placed 10.0 m from the Railway Crossing Ahead sign.

11.3.20 Line widths of this marking shall range between 300 mm to 500 mm.

11.4 Signage

11.4.1 Adequate signage shall be implemented at and ahead of Grade Crossings as a measure of safety and precaution for vehicles, motorists, and pedestrians.

11.4.2 Metrolinx requires the following signs installed on its corridor for best practice, in addition to the mandatory sign requirements in Article 8 of the GCH.

11.4.3 The placement of all signs shall avoid interference with the visibility of sightlines, warning systems, or other traffic control devices and avoid obstruction by overhanging trees or vegetation.

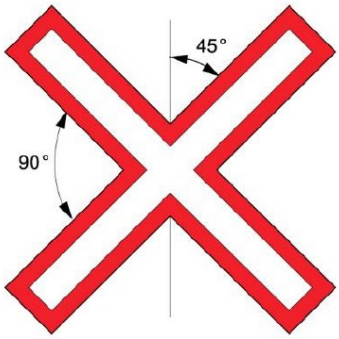
11.4.4 On the approach of Grade Crossings, a Railway Crossing Sign, Number of Tracks Sign, Emergency Notification Sign (ENS) and Stop Sign (if applicable), shall be placed on a supporting post at a minimum distance of 3.0 m perpendicular to the nearest rail edge. The supporting wooden post shall be constructed per Section 8.1.7 of the GCH to ensure that it will break safely in the event it is struck by a vehicle.

11.4.5 All signage installed on the Metrolinx rail corridor shall be designed, manufactured and installed in accordance with GTTS Standard Plan series GTS-0720.

Railway Crossing Sign

11.4.6 Railway Crossing Signs as illustrated in **Figure 11-3** to provide warning of a Grade Crossing shall be installed at both public and private Grade Crossings.

FIGURE 11-3: RAILWAY CROSSING SIGN



11.4.7 In electrified territory, an amended Railway Crossing Sign shall be used, compliant with Transport Canada guidelines, which includes a lightning bolt or some other symbol to warn users of additional hazards relating to railway electrification.

11.4.8 Signs on supporting posts shall be located 0.3 m to 2.0 m from the face of a curb or outer edge of road shoulder, or 2.0 m to 4.5 m from the edge of a travelled way.

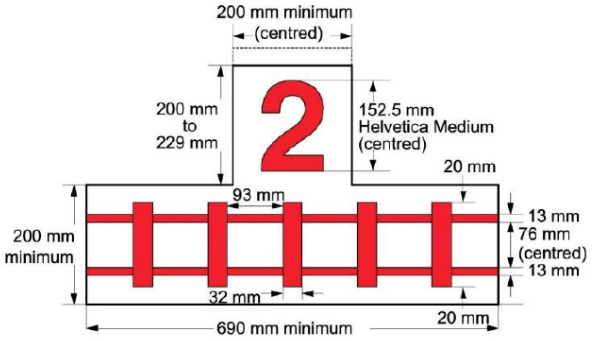
11.4.9 Where a sidewalk, path, or trail with a centreline that is 3.6 m or more from a Railway Crossing Sign supporting post beside a road, a separate Railway Crossing sign shall be installed.

11.4.10 Signs shall have retroreflective coatings, sheetings, and dimensions detailed in the GCH.

Number of Tracks Sign

11.4.11 Signs as illustrated in **Figure 11-4** indicating the number of tracks at a Grade Crossing shall be placed on supporting posts beneath Railway Crossing Signs.

FIGURE 11-4: NUMBER OF TRACKS SIGN

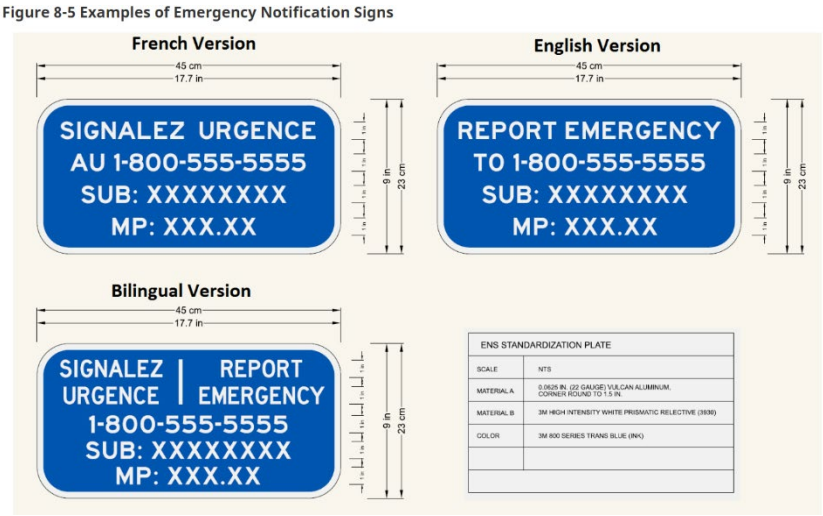


11.4.12 Number of Tracks signs shall be installed at both public and private Grade Crossings, with retro-reflective coating, symbols, and dimensions as specified in the GCH.

Emergency Notification Sign (ENS)

11.4.13 Emergency Notification Signs (ENSs) as illustrated in **Figure 11-5** shall be installed at both public and private Grade Crossings.

FIGURE 11-5: EMERGENCY NOTIFICATION SIGN (ENS)



11.4.14 These signs provide crossing users with the information needed to report or notify Metrolinx about emergencies or malfunctioning warning systems or traffic control devices.

11.4.15 As per Section 14.3 in the GO Transit Track Standards, an emergency phone number, subdivision name and mile post location will be indicated in English, unless otherwise indicated by Metrolinx.

11.4.16 ENSs shall be installed beneath Number of Track Signs on supporting posts, and at the side of signal bungalows oriented parallel to the road.

11.4.17 Signs shall have retroreflective coatings, sheetings, and dimensions as specified in the GCH.

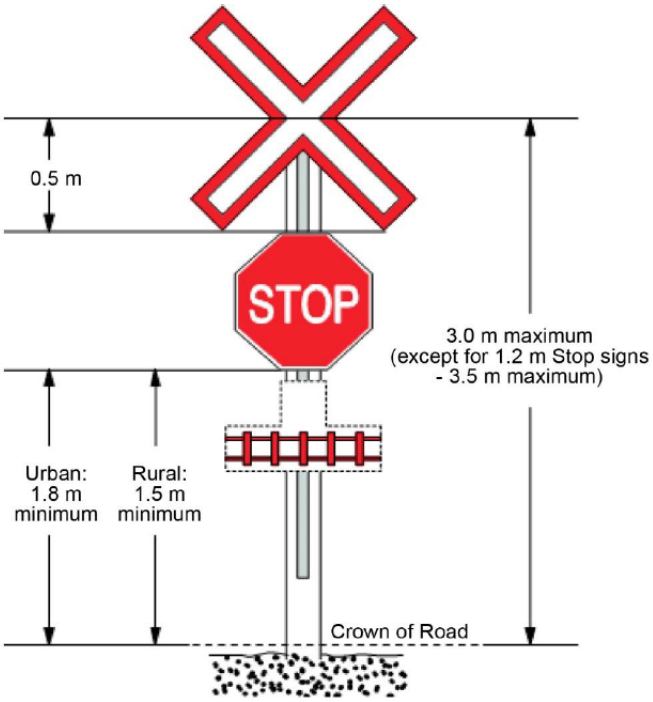
Stop Sign

11.4.18 Where deemed applicable by the Ontario Ministry of Transportation, Stop Signs as illustrated in **Figure 11-6** shall be installed at public or private Grade Crossings without a warning system.

11.4.19 Stop Signs shall be placed either on the supporting post between the Grade Crossing and Number of Tracks sign, or on their own post.

11.4.20 The Stop Signs shall be configured in accordance with **Figure 11-6** and located in accordance with section 11.4.5.

FIGURE 11-6: STOP SIGN PLACEMENT (TRANSPORT CANADA, 2019)



Anti-Trespass Signs

11.4.21 Anti-trespass signs shall be installed at Grade Crossings on the Metrolinx rail corridor.

11.4.22 These signs aim to provide clear warning and information to prohibit illegal access and parking within the Metrolinx right-of-way.

11.4.23 A set of Private Property Signs, Tow Away Zone Signs, and Connex Mental Health Signs as illustrated in **Figure 11-8** and **Figure 11-9** shall be installed on perimeter fencing at all four quadrants of public Grade Crossings.

11.4.24 Where fencing is not available, installation on a standard u-post is acceptable.

11.4.25 All signs shall be oriented parallel to the road and on the same side as man-gates, as indicated in **Figure 11-7**.

FIGURE 11-7: SIGNAGE LOCATIONS

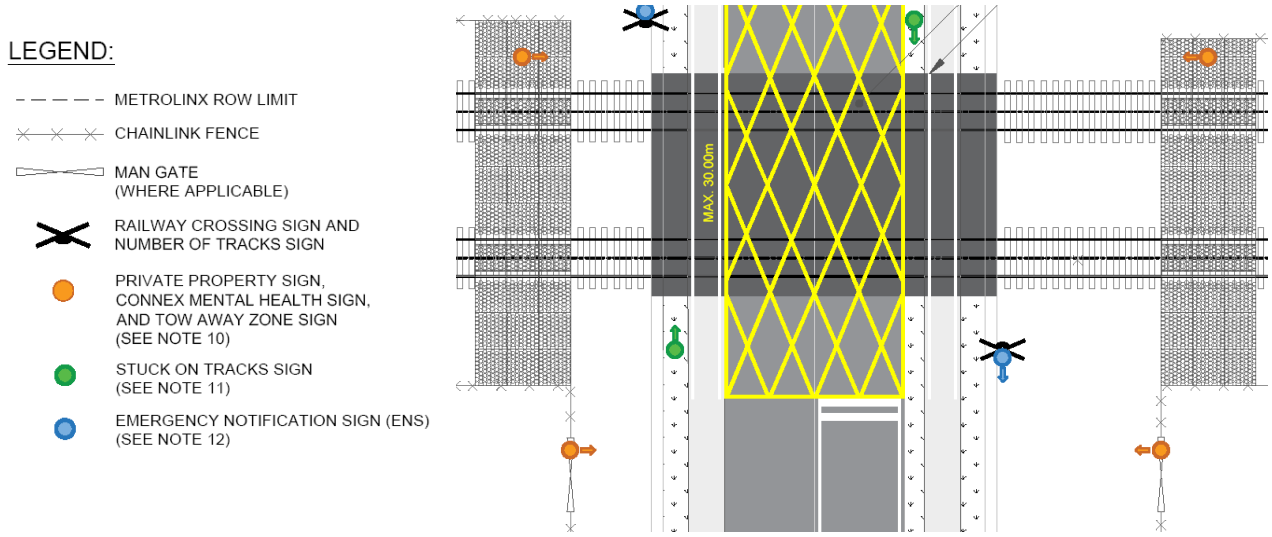


FIGURE 11-8: PRIVATE PROPERTY AND TOW AWAY ZONE SIGNS

FIGURE 11-9: CONNEX MENTAL HEALTH SIGN

Stuck on Track Sign

11.4.26 Stuck on Track Signs as shown in **Figure 11-10** shall be installed at public Grade Crossings to provide the information and procedure required to report an emergency in which a pedestrian, motorist, or vehicle user is stuck on or near railway tracks.

11.4.27 Two signs shall be installed on individual u-posts or fencing posts; each located on the exits of the crossing as indicated in **Figure 11-7**, facing traffic within the Grade Crossing.

11.4.28 Signs shall be placed within Metrolinx right-of-way limits, unless otherwise directed by Metrolinx and to the satisfaction of the governing jurisdiction or authority.

FIGURE 11-10: STUCK ON TRACKS SIGN

Cyclists Dismount Sign

11.4.29 Signs instructing cyclists to dismount and push their bicycles across crossings shall be installed at all public and private Grade Crossings.

11.4.30 Two Cyclists Dismount and Walk Signs as shown in **Figure 11-11** shall be installed on individual u-posts; each located on the entries of the crossing.

11.4.31 Signs shall be skewed at an angle less than 60 degrees taken from the tangent of the centreline of the road to the tangent of the centreline of rail.

11.4.32 Per Ontario Traffic Manual (OTM) Book 18 requirements, the signs shall be placed within Metrolinx right-of-way limits unless otherwise directed.

FIGURE 11-11: DISMOUNT AND WALK SIGN

Rb-70 (OTM)
(300 mm x 300 mm)

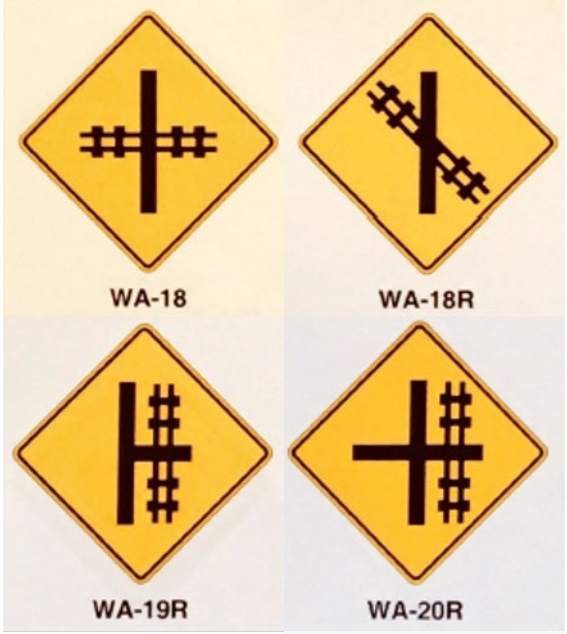
Advance Warning Signs

11.4.33 Signs providing advanced warning ahead of all Grade Crossings are required by applicable standards in the Grade Crossing Handbook.

11.4.34 A Railway Crossing Ahead Sign, Advisory Speed Tab Sign, and Stop Ahead Sign illustrated in **Figure 11-12** will be installed and manufactured according to specifications in Articles 8.2 and 8.3 of the GCH by the governing road authority.

11.4.35 Where a new crossing is being constructed or modified from an existing configuration, advance warning signs shall be installed or modified accordingly by the party completing the work.

FIGURE 11-12: ADVANCE WARNING SIGNS



Railway Crossing Ahead	Advisory Speed Tab	Stop Ahead

11.5 Construction & Temporary Crossings

11.5.1 All new construction and temporary crossings shall meet requirements in Section 14.6 of the GO Transit Track Standards including procedures regarding crossing surfaces, ballast protection, rail, ties, fencing, and gates.

11.5.2 Requirements for the temporary planking of tracks may be found in Section 14.7 of the GO Transit Track Standards.

11.5.3 Tracks requiring planking for construction purposes shall be constructed as per GO Transit Track Standards Section 14.6 and Appendix V – Temporary Construction Crossings and shall be approved by the Senior Manager of Track and Structures.

Appendix A: Metrolinx-Owned Grade Crossings[2][3]

Mile	Crossing Name	Road Authority	Type
Bala Subdivision (Mile 2.06 - Mile 15.91, S-N)			
4.43	Pottery Rd.		Level
4.92	Beechwood Dr.		Level
7.70	Hydro		Level, Private
12.20	*Oriole Station*		
12.20	*Old Cummer Station*		
Don Subdivision (Mile 206.40 - Mile 209.50, N-S)			
207.29	Pedestrian Trail		Level, Pedestrian
Guelph Subdivision (Mile 30.00 - Mile 63.40, E-W)			
30.83	Trafalgar Rd.		Level
33.54	4th Line		Level
34.25	3rd Line		Level
34.57	Farm Crossing		Level, Farm
34.85	Private Crossing		Level, Private
35.48	Eastern Ave.		Level
35.60	*Acton Station*		
35.69	Mill St. Hwy. 7		Level
36.20	Main St. N.		Level
36.75	Farm Crossing	Closed	Level, Farm
37.20	Dublin Line		Level
38.21	County Line		Level
39.22	7th Line		Level
40.56	Harris St.		Level
41.30	Main St. N. (Rockwood)		Level
42.19	4th Line		Level
42.30	Farm Crossing		Level, Farm
42.82	Farm Crossing		Level, Farm
43.02	3rd Line		Level
43.97	County Rd. 29		Level
45.83	Private Crossing	Closed	Level, Private
446.22	Watson Rd. N.		Level
48.80	*Guelph Station*		
49.09	Dublin St. N.	Closed	Level
49.20	Glasgow St. N.		Level
49.33	Yorkshire St.		Level
49.54	Edinburgh Rd.		Level
49.79	Alma St.		Level

[2] * Construction and maintenance crossings not included.

[3] This table is current as at time of publishing, but is a living list that will continue to evolve to meet service demands.

Mile	Crossing Name	Road Authority	Type
50.24	Silvercreek Pkwy.	Closed	Level
52.41	Farm Crossing	Planned for Closure	Level, Farm
52.95	County Rd. 32		Level
53.47	Private Crossing		Level, Private
53.74	Farm Crossing		Level, Farm
54.06	Speedvale Ave. W.		Level
54.37	Guelph Townline Rd.		Level
55.01	Farm Crossing	Planned for Closure	Level, Farm
56.41	Farm Crossing	Planned for Closure	Level, Farm
57.00	Township Rd. 72A		Level
58.39	Woolrich St. S.		Level
59.81	Bingemans Centre Dr.		Level
62.08	Lancaster St. W.		Level
62.26	Saint Leger St.		Level
62.70	*Kitchener Station*		
62.82	Duke St.		Level
63.40	Park St.		Level
Kingston Subdivision (Mile 332.40 - Mile 313.57, W-E)			
328.60	*Danforth Station*		
328.40	Farm Crossing		Level, Farm
328.00	Farm Crossing	Closed	Level, Farm
325.20	*Scarborough Station*		
323.20	*Eglinton Station*		
321.97	Scarborough Golf Club Rd.		Level
321.20	*Guildwood Station*		
320.95	Galloway Rd.		Level
320.65	Poplar Rd.		Level
320.41	Morningside Ave.		Level
319.90	Manse Rd.		Level
318.88	Beechgrove Dr.		Level
317.30	*Rouge Hill Station*		
317.22	Chesterton Shores		Level
315.95	Rodd Ave.		Level
Newmarket Subdivision (Mile 63.00 - Mile 3.00, N-S)			
62.50	*Barrie Layover Yard*		
62.03	Minet's Point Rd.	City of Barrie	Level
61.34	Little Ave.	City of Barrie	Level
59.50	*Barrie South Station*		
59.29	Mapleview Dr. E.	Township of Innisfil	Level
58.94	Farm Crossing	Closed	Level, Farm
58.47	Lockhart Rd. (11th Line)	City of Barrie	Level
58.15	Farm Crossing		Level, Farm

Mile	Crossing Name	Road Authority	Type
57.49	Victoria St. E. (10th Line)	Township of Innisfil	Level
56.59	9th Line	Township of Innisfil	Level
55.55	Innisfil Beach Rd. (8th Line)	County of Simcoe	Level
54.56	7th Line	Township of Innisfil	Level
52.82	Belle Aire Beach Rd. (5th Line)	Township of Innisfil	Level
51.89	Killarney Beach Rd. (4th Line)	Township of Innisfil	Level
50.99	3rd Line	Township of Innisfil	Level
50.12	2nd Line	Township of Innisfil	Level
49.88	Farm Crossing	Planned for Closure	Level, Farm
49.24	Shore Acres Dr. (1st Line)	Township of Innisfil	Level
49.05	Gilford Rd.	Township of Innisfil	Level
48.65	Farm Crossing		Level, Farm
47.21	13th Line	Township of Bradford - W. Gwillimbury	Level
46.29	12th Line	Township of Bradford - W. Gwillimbury	Level
45.37	Coulson's Hill Rd. (11th Line)	Township of Bradford - W. Gwillimbury	Level
44.86	Farm Crossing		Level, Farm
44.34	10th Line	Township of Bradford - W. Gwillimbury	Level
43.37	Stanlon Creek Rd. (9th Line)	Township of Bradford - W. Gwillimbury	Level
42.26	Industrial Rd.	Township of Bradford - W. Gwillimbury	Level
41.96	Private Crossing	Ministry of Environment	Level, Private
41.56	Pedestrian Crossing	GO	Level, Pedestrian
41.50	*Bradford Station*		
41.49	Pedestrian Crossing	GO	Level, Pedestrian
41.39	Given Rd.	Township of E. Gwillimbury	Level
41.25	Private Crossing	Planned for Closure	Level, Private
41.02	Private Crossing	Planned for Closure	Level, Private
40.93	Toll Rd.	Planned for Closure	Level
40.53	Kalvers St.	Closed	Level
39.66	Bathurst St.	Region of York	Level
39.33	Oriole Dr.	Township of E. Gwillimbury	Level
38.43	Bradford St.	Region of York	Level
37.71	Old Yonge St.	Region of York	Level

Mile	Crossing Name	Road Authority	Type
37.65	Chapman St.	Township of E. Gwillimbury	Level
36.38	Main St. (2nd Concession)	Region of York	Level
35.61	Green Lane Rd.	Region of York	Level
35.50	*East Gwillimbury Station*		
34.85	Newmarket Pedestrian	Town of Newmarket	Level, Pedestrian
34.20	*Newmarket Station*		
34.16	Davis Dr.	Region of York	Level
33.64	Timothy St.	Town of Newmarket	Level
33.55	Water St.	Town of Newmarket	Level
32.75	Mulock Dr.	Region of York	Level
31.28	St. John's Side Rd.	Town of Aurora	Level
30.04	Centre St.	Town of Aurora	Level
29.99	Wellington St. E.	Region of York	Level
29.90	*Aurora Station*		
29.80	Pedestrian Crossing	GO	Level, Pedestrian
29.17	Engelhard Dr.	Town of Aurora	Level
26.10	Bloomington Rd.	Township of King	Level
25.25	Farm Crossing		Level, Farm
24.60	Dufferin St.	Region of York	Level
22.73	Station Rd.	Township of King	Level
22.70	*King City Station*		
21.99	King-Vaughan Rd. (Townline Rd.)	City of Vaughan	Level
21.59	Farm Crossing		Level, Farm
21.34	Farm Crossing		Level, Farm
21.10	Farm Crossing		Level, Farm
20.66	Kirby Rd.	City of Vaughan	Level
20.43	Farm Crossing		Level, Farm
20.03	Farm Crossing		Level, Farm
19.72	Farm Crossing	Planned for Closure	Level, Farm
19.40	Teston Side Rd.	City of Vaughan	Level
18.49	McNaughton Rd.	City of Vaughan	Level
18.30	*Maple Station*		
16.70	*Rutherford Station*		
15.50	Langstaff Rd.	Region of York	Level
14.82	Rivermede Rd.	City of Vaughan	Level
12.22	Flint St.		Level
11.90	T.T.C. Bus Route (York University)	TTC	Level
10.50	Carl Hall Rd.	City of Toronto	Level
10.01	Private Crossing	Closed	Level

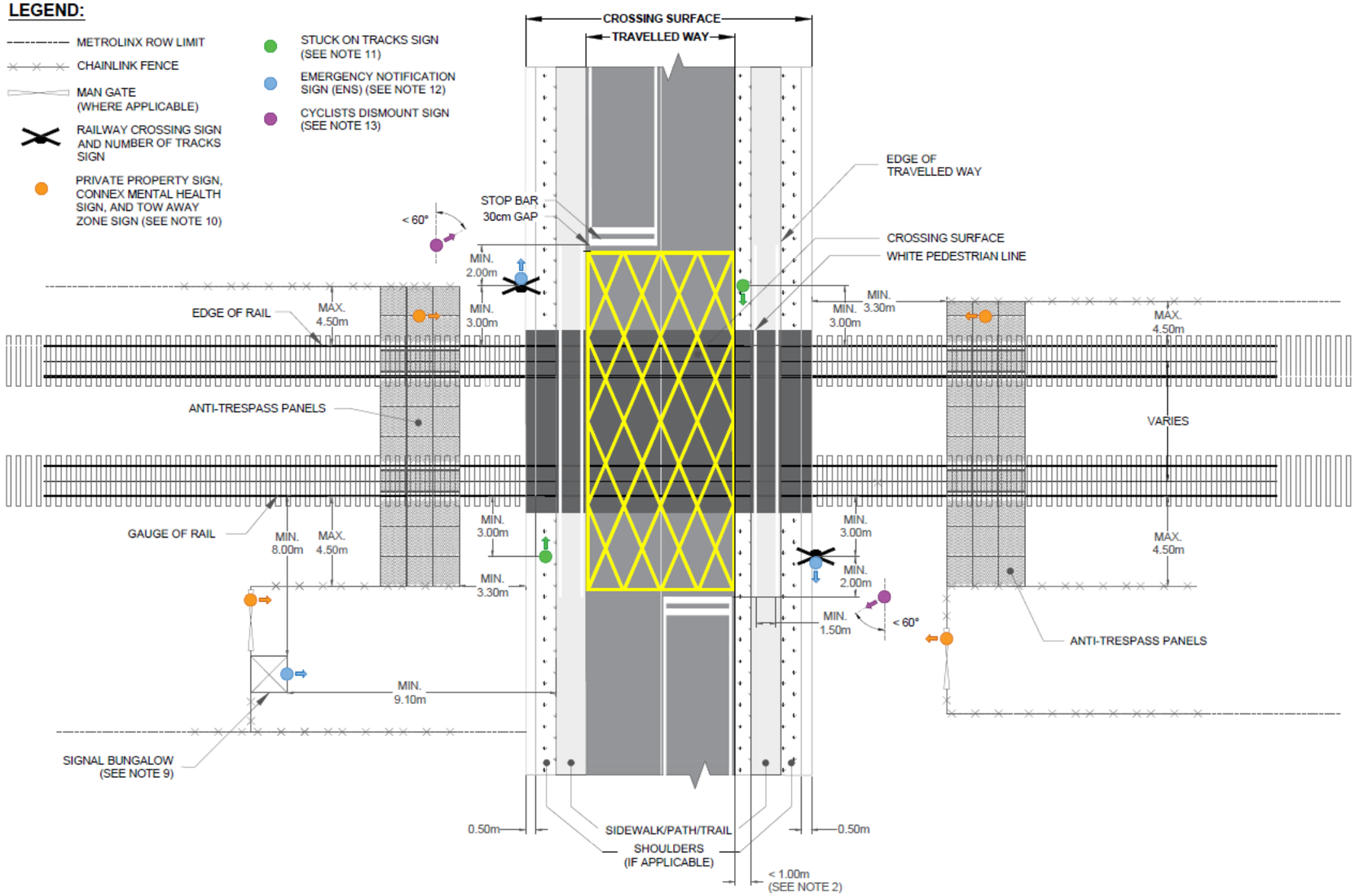
Mile	Crossing Name	Road Authority	Type
6.89	Castlefield Ave.	City of Toronto	Level
4.19	Wallace Ave.	City of Toronto	Level
Oakville Subdivision (Mile 0.96 - Mile 31.94, E-W)			
2.00	*Exhibition Station*		
6.70	*Mimico Station*		
9.70	*Long Branch Station*		
10.59	Haig Blvd.		Level
10.85	Ogen Ave.		Level
11.03	Alexandra Ave.		Level
12.02	Revus Ave.		Level
12.80	*Port Credit Station*		
13.11	Stavebank Rd.		Level
15.06	Lorne Park Rd.		Level
16.09	Clarkson Rd.		Level
16.70	*Clarkson Station*		
20.56	Chartwell Rd.		Level
21.40	*Oakville Station*		
21.97	Kerr St.		Level
23.13	Fourth Line		Level
24.70	*Bronte Station*		
26.20	Emergency Fire Crossing		Level
26.96	Burloak Dr.		Level
27.90	*Appleby Station*		
27.90	*Burlington Station*		
Uxbridge Subdivision (Mile 38.90 - Mile 61.00, E-W)			
38.90	*Lincolnville Station*		
38.93	10th Line	Town of Whitchurch Stouffville	Level
38.95	Bethesda Side Rd.	Town of Whitchurch Stouffville	Level
39.40	Farm Crossing		Level, Farm
40.30	Millard St.	Town of Whitchurch Stouffville	Level
40.60	*Stouffville Station*		
40.72	Main St. (Hwy.47)	Town of Whitchurch Stouffville	Level
41.17	Hoover Park Dr.	Town of Whitchurch Stouffville	Level
41.73	Reeves Way Blvd.	Town of Whitchurch Stouffville	Level
42.04	19th Ave.	Town of Markham	Level
42.25	Farm Crossing	Planned for Closure	Level, Farm

Mile	Crossing Name	Road Authority	Type
42.35	9th Concession Rd.	Region of York	Level
42.46	Farm Crossing	Planned for Closure	Level, Farm
42.95	Farm Crossing		Level, Farm
43.46	Elgin Mills Rd. E. (18th Ave.)	Town of Markham	Level
43.65	Farm Crossing	Planned for Closure	Level, Farm
44.40	Farm Crossing		Level, Farm
44.96	Major Mackenzie Dr. E. (17th Ave.)	Region of York	Level
45.47	Castlemore Ave.	Town of Markham	Level
45.74	Bur-Oak Rd.	Town of Markham	Level
45.80	*Mount Joy Station*		
46.31	16th Ave.	Region of York	Level
46.95	Main St. (Hwy. 48)	Town of Markham	Level
47.00	*Markham Station*		
47.17	Snider Dr.	Town of Markham	Level
48.38	McCowan Rd. (7th Line)	Region of York	Level
48.50	*Centennial Station*		
49.42	Kennedy Rd. N.	Region of York	Level
49.78	Main St. Unionville	Town of Markham	Level
49.94	Eureka St.	Town of Markham	Level
50.13	Highway 7	Region of York	Level
50.80	*Unionville Station*		
51.98	Denison St.	Town of Markham	Level
52.40	Kennedy Rd.S.	Region of York	Level
52.90	*Milliken Station*		
53.16	Passmore Ave.	City of Toronto	Level
53.61	McNicoll Ave.	City of Toronto	Level
54.41	Finch Ave.	City of Toronto	Level
54.88	Huntingwood Dr.	City of Toronto	Level
55.16	Havendale Rd.	City of Toronto	Level
55.44	Marilyn Ave.	City of Toronto	Level, Pedestrian
55.50	*Agincourt Station*		
56.72	Progress Ave.	City of Toronto	Level
59.50	*Kennedy Station*		
59.96	Corvette Ave.	City of Toronto	Level, Pedestrian
60.18	Danforth Rd.	City of Toronto	Level
Weston Subdivision (Mile 1.90 - Mile 16.80, E-W)			
15.27	Scarboro St. (North Alarton St.)	City of Mississauga	Level
14.70	*Malton Station*		
13.06	Carlingview Dr.	City of Toronto	Level
11.08	Pedestrian Crossing		Level, Private
11.00	*Etobicoke North Station*		

Mile	Crossing Name	Road Authority	Type
8.94	Church St. over Weston Tunnel	City of Toronto	Level
8.74	King St. over Weston Tunnel	City of Toronto	Level
8.40	*Weston Station*		
4.00	*Bloor Station*		
Canpa Subdivision (Mile 0.00 - Mile 2.60, E-W)			
1.56	Evans Ave.		Level
2.21	Horner Ave.		Level

Appendix B: Grade Crossing Drawings

FIGURE B-1: STANDARD LAYOUT FOR PUBLIC GRADE CROSSINGS WITH MULTIPLE TRACKS



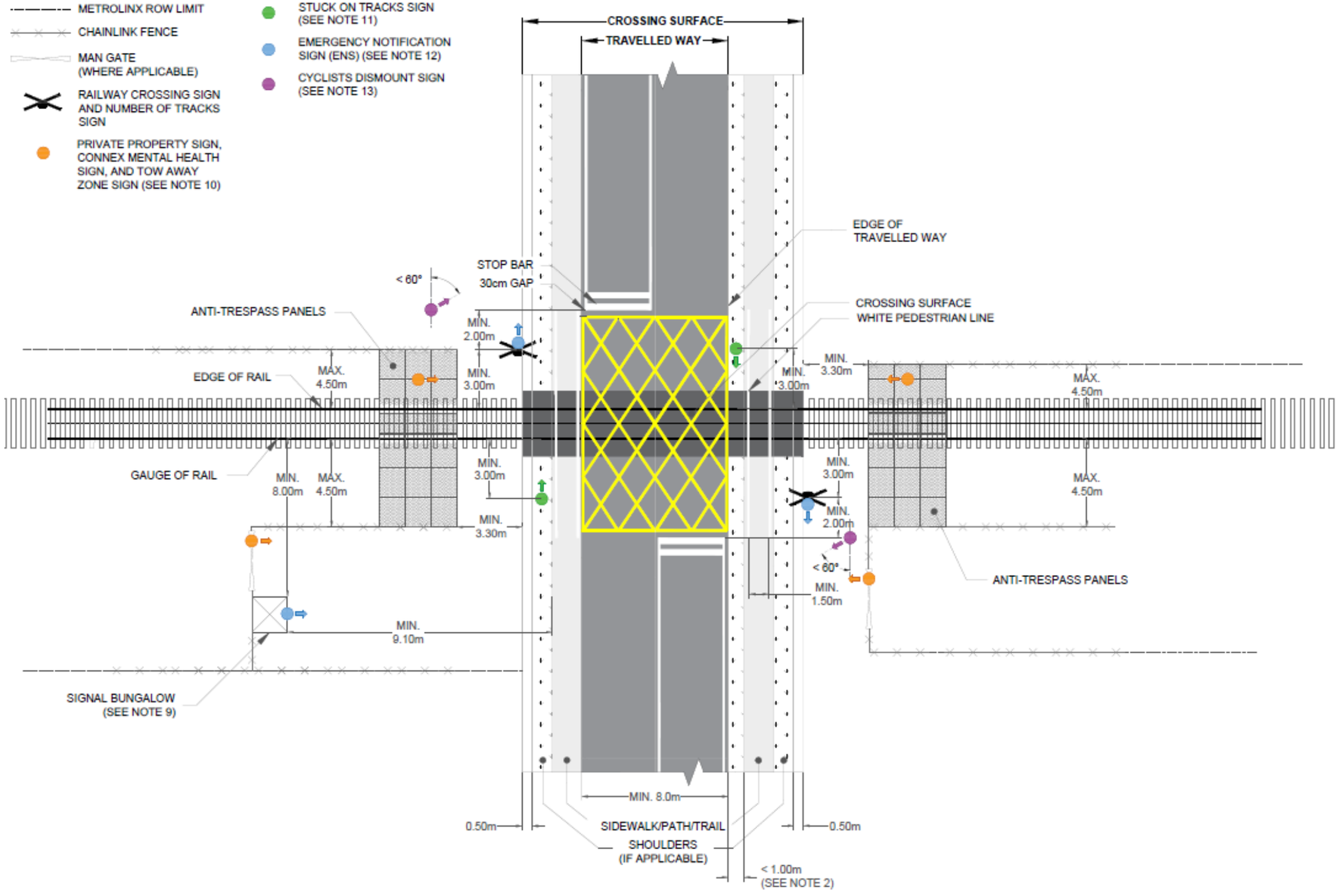
NOTES:

1. IF NO SHOULDERS ARE PRESENT, 0.5 M BUFFERS ARE TAKEN FROM THE EDGE OF THE TRAVELLED WAY OR APPLICABLE PEDESTRIAN PATHS.
2. CROSSING SURFACES MAY BE SEPARATE IF THE SPACE BETWEEN THE ROAD AND PEDESTRIAN PATH IS ≥ 1.0 M. OTHERWISE, THE CROSSING SURFACE SHALL BE CONTINUOUS.
3. THE MINIMUM GRADE CROSSING SURFACE WIDTH FOR PUBLIC ROADS FOR VEHICULAR USE AND SIDEWALKS, PATHS, OR TRAILS FOR PEDESTRIAN USE IS 8.0 M AND 1.5 M RESPECTIVELY, MEASURED AT A RIGHT ANGLE TO THE CENTRE LINE OF THE TRAVELLED WAY.
4. TWO MAN GATES FOR TRAIN CREW ACCESS ARE REQUIRED; ONE ON EACH SIDE OF THE GRADE CROSSING APPROACH. MAN GATES SHALL BE PLACED ON THE SIDE OF THE RAIL CORRIDOR WHERE ROW SPACE IS MOST ADEQUATE.
5. ANTI-TRESPASS PANEL DIMENSIONS AND LAYOUT ARE AS PER MANUFACTURER SPECIFICATIONS.
6. YELLOW CROSSHATCH MARKINGS SHALL BE PAINTED UP TO 30 CM FROM THE EDGE OF STOP BAR LINES.
7. WHITE PAVEMENT EDGE LINES SHALL BE PAINTED ON EACH EDGE OF THE ROADSIDE IF THE CROSSING ANGLE TAKEN FROM THE TANGENT OF THE CENTERLINE OF ROAD TO THE TANGENT OF THE CENTERLINE OF RAIL IS LESS THAN 30 DEGREES OR GREATER THAN 150 DEGREES.
8. WHITE PEDESTRIAN LINES SHALL BE PAINTED UP TO STOP BAR LINES WITH AT LEAST 1.5 M BETWEEN THE INSIDE EDGES OF LINES.
9. SUFFICIENT CLEARANCE AROUND SIGNAL BUNGALOWS SHALL BE PROVIDED AS PER THE GO TRANSIT SIGNAL STANDARDS, UNLESS OTHERWISE DIRECTED BY METROLINX.
10. PRIVATE PROPERTY, CONNEX MENTAL HEALTH, AND TOW AWAY ZONE SIGNS SHALL BE PLACED ON MAN-GATES AT EACH CROSSING QUADRANT ORIENTED TO FACE THE ROAD. WHERE MAN-GATES ARE NOT INSTALLED, ALL SIGNS WITH THE EXCEPTION OF TOW AWAY ZONE SIGNS SHALL BE INSTALLED ON U-POSTS ALONG THE SECOND ROW OF ANTI-TRESPASS MATS. ANTI-TRESPASS MATS SHALL BE CUT TO ACCOMMODATE U-POSTS AS NECESSARY.
11. STUCK ON TRACKS SIGNS ARE TO BE INSTALLED ON U-POSTS AND PLACED ON THE NEAREST SHOULDER TO THE ROAD APPROACH, AT LEAST 3.0 M FROM THE EDGE OF RAIL. SIGNS SHALL BE ORIENTED TO FACE ONCOMING TRAFFIC.
12. EMERGENCY NOTIFICATION SIGNS (ENS) SHALL BE PLACED BELOW THE NUMBER OF TRACKS SIGNS AND ON A SIDE OF A SIGNAL BUNGALOW ORIENTED PARALLEL TO THE ROAD, UNLESS OTHERWISE DIRECTED BY METROLINX.
13. CYCLISTS DISMOUNT SIGNS ARE TO BE INSTALLED ON U-POSTS AND SKEWED AT AN ANGLE LESS THAN 60 DEGREES, TAKEN FROM THE TANGENT OF THE CENTRELINE OF THE ROAD TO THE TANGENT OF THE CENTERLINE OF RAIL.

FIGURE B-2: STANDARD LAYOUT FOR PUBLIC GRADE CROSSINGS WITH A SINGLE TRACK

LEGEND:

- METROLINX ROW LIMIT
- CHAINLINK FENCE
- MAN GATE (WHERE APPLICABLE)
- RAILWAY CROSSING SIGN AND NUMBER OF TRACKS SIGN
- PRIVATE PROPERTY SIGN, CONNEX MENTAL HEALTH SIGN, AND TOW AWAY ZONE SIGN (SEE NOTE 10)
- STUCK ON TRACKS SIGN (SEE NOTE 11)
- EMERGENCY NOTIFICATION SIGN (ENS) (SEE NOTE 12)
- CYCLISTS DISMOUNT SIGN (SEE NOTE 13)



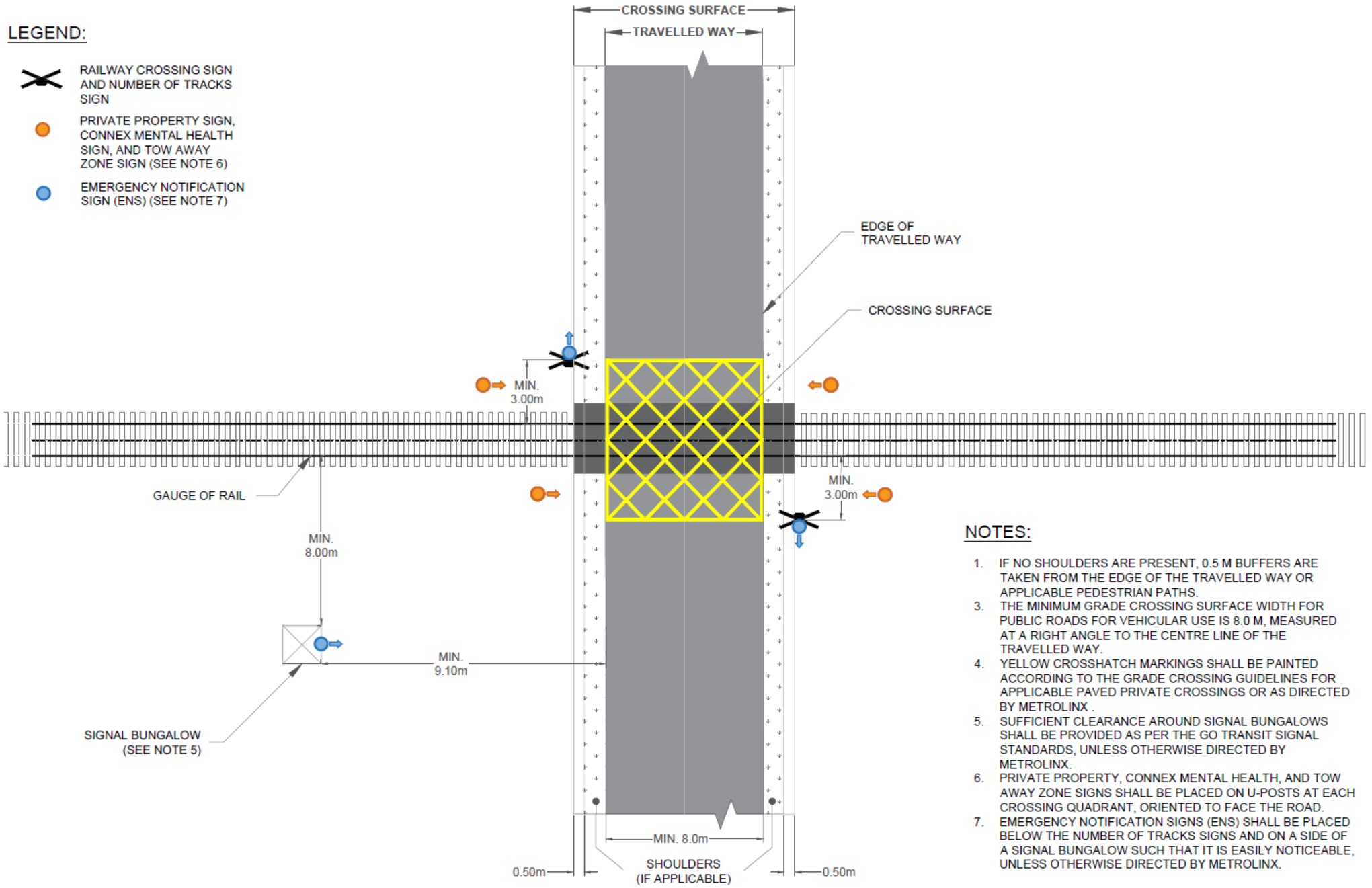
NOTES:

1. IF NO SHOULDERS ARE PRESENT, 0.5 M BUFFERS ARE TAKEN FROM THE EDGE OF THE TRAVELLED WAY OR APPLICABLE PEDESTRIAN PATHS.
2. CROSSING SURFACES MAY BE SEPARATE IF THE SPACE BETWEEN THE ROAD AND PEDESTRIAN PATH IS ≥ 1.0 M. OTHERWISE, THE CROSSING SURFACE SHALL BE CONTINUOUS.
3. THE MINIMUM GRADE CROSSING SURFACE WIDTH FOR PUBLIC ROADS FOR VEHICULAR USE AND SIDEWALKS, PATHS, OR TRAILS FOR PEDESTRIAN USE IS 8.0 M AND 1.5 M RESPECTIVELY, MEASURED AT A RIGHT ANGLE TO THE CENTRE LINE OF THE TRAVELLED WAY.
4. TWO MAN GATES FOR TRAIN CREW ACCESS ARE REQUIRED; ONE ON EACH SIDE OF THE GRADE CROSSING APPROACH. MAN GATES SHALL BE PLACED ON THE SIDE OF THE RAIL CORRIDOR WHERE ROW SPACE IS MOST ADEQUATE.
5. ANTI-TRESPASS PANEL DIMENSIONS AND LAYOUT ARE AS PER MANUFACTURER SPECIFICATIONS.
6. YELLOW CROSSHATCH MARKINGS SHALL BE PAINTED UP TO 30 CM FROM THE EDGE OF STOP BAR LINES.
7. WHITE PAVEMENT EDGE LINES SHALL BE PAINTED ON EACH EDGE OF THE ROADSIDE IF THE CROSSING ANGLE TAKEN FROM THE TANGENT OF THE CENTERLINE OF ROAD TO THE TANGENT OF THE CENTERLINE OF RAIL IS LESS THAN 30 DEGREES OR GREATER THAN 150 DEGREES.
8. WHITE PEDESTRIAN LINES SHALL BE PAINTED UP TO STOP BAR LINES WITH AT LEAST 1.5 M BETWEEN THE INSIDE EDGES OF LINES.
9. SUFFICIENT CLEARANCE AROUND SIGNAL BUNGALOWS SHALL BE PROVIDED AS PER THE GO TRANSIT SIGNAL STANDARDS, UNLESS OTHERWISE DIRECTED BY METROLINX.
10. PRIVATE PROPERTY, CONNEX MENTAL HEALTH, AND TOW AWAY ZONE SIGNS SHALL BE PLACED ON MAN-GATES AT EACH CROSSING QUADRANT ORIENTED TO FACE THE ROAD. WHERE MAN-GATES ARE NOT INSTALLED, ALL SIGNS WITH THE EXCEPTION OF TOW AWAY ZONE SIGNS SHALL BE INSTALLED ON U-POSTS ALONG THE SECOND ROW OF ANTI-TRESPASS MATS. ANTI-TRESPASS MATS SHALL BE CUT TO ACCOMMODATE U-POSTS AS NECESSARY.
11. STUCK ON TRACKS SIGNS ARE TO BE INSTALLED ON U-POSTS AND PLACED ON THE NEAREST SHOULDER TO THE ROAD APPROACH, AT LEAST 3.0 M FROM THE EDGE OF RAIL. SIGNS SHALL BE ORIENTED TO FACE ONCOMING TRAFFIC.
12. EMERGENCY NOTIFICATION SIGNS (ENS) SHALL BE PLACED BELOW THE NUMBER OF TRACKS SIGNS AND ON A SIDE OF A SIGNAL BUNGALOW ORIENTED PARALLEL TO THE ROAD, UNLESS OTHERWISE DIRECTED BY METROLINX.
13. CYCLISTS DISMOUNT SIGNS ARE TO BE INSTALLED ON U-POSTS AND SKEWED AT AN ANGLE LESS THAN 60 DEGREES, TAKEN FROM THE TANGENT OF THE CENTRELINE OF THE ROAD TO THE TANGENT OF THE CENTERLINE OF RAIL.

FIGURE B-3: STANDARD LAYOUT FOR PRIVATE GRADE CROSSINGS WITH A SINGLE TRACK

LEGEND:

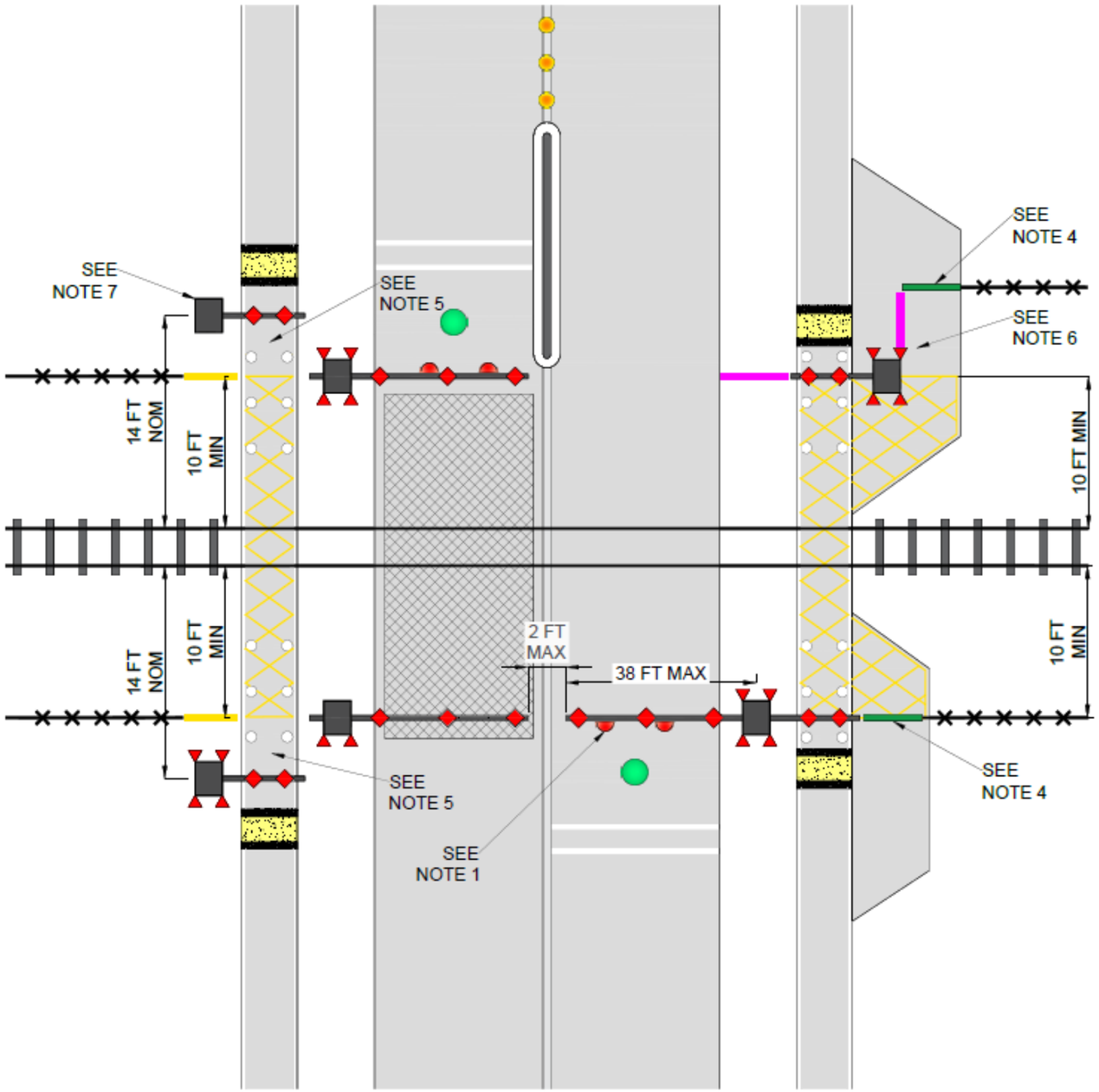
- RAILWAY CROSSING SIGN AND NUMBER OF TRACKS SIGN
- PRIVATE PROPERTY SIGN, CONNEX MENTAL HEALTH SIGN, AND TOW AWAY ZONE SIGN (SEE NOTE 6)
- EMERGENCY NOTIFICATION SIGN (ENS) (SEE NOTE 7)



NOTES:

1. IF NO SHOULDERS ARE PRESENT, 0.5 M BUFFERS ARE TAKEN FROM THE EDGE OF THE TRAVELLED WAY OR APPLICABLE PEDESTRIAN PATHS.
3. THE MINIMUM GRADE CROSSING SURFACE WIDTH FOR PUBLIC ROADS FOR VEHICULAR USE IS 8.0 M, MEASURED AT A RIGHT ANGLE TO THE CENTRE LINE OF THE TRAVELLED WAY.
4. YELLOW CROSSHATCH MARKINGS SHALL BE PAINTED ACCORDING TO THE GRADE CROSSING GUIDELINES FOR APPLICABLE PAVED PRIVATE CROSSINGS OR AS DIRECTED BY METROLINX .
5. SUFFICIENT CLEARANCE AROUND SIGNAL BUNGALOWS SHALL BE PROVIDED AS PER THE GO TRANSIT SIGNAL STANDARDS, UNLESS OTHERWISE DIRECTED BY METROLINX.
6. PRIVATE PROPERTY, CONNEX MENTAL HEALTH, AND TOW AWAY ZONE SIGNS SHALL BE PLACED ON U-POSTS AT EACH CROSSING QUADRANT, ORIENTED TO FACE THE ROAD.
7. EMERGENCY NOTIFICATION SIGNS (ENS) SHALL BE PLACED BELOW THE NUMBER OF TRACKS SIGNS AND ON A SIDE OF A SIGNAL BUNGALOW SUCH THAT IT IS EASILY NOTICEABLE, UNLESS OTHERWISE DIRECTED BY METROLINX.

FIGURE B-4: GRADE CROSSING ENHANCEMENTS GENERAL ARRANGEMENT – PERPENDICULAR



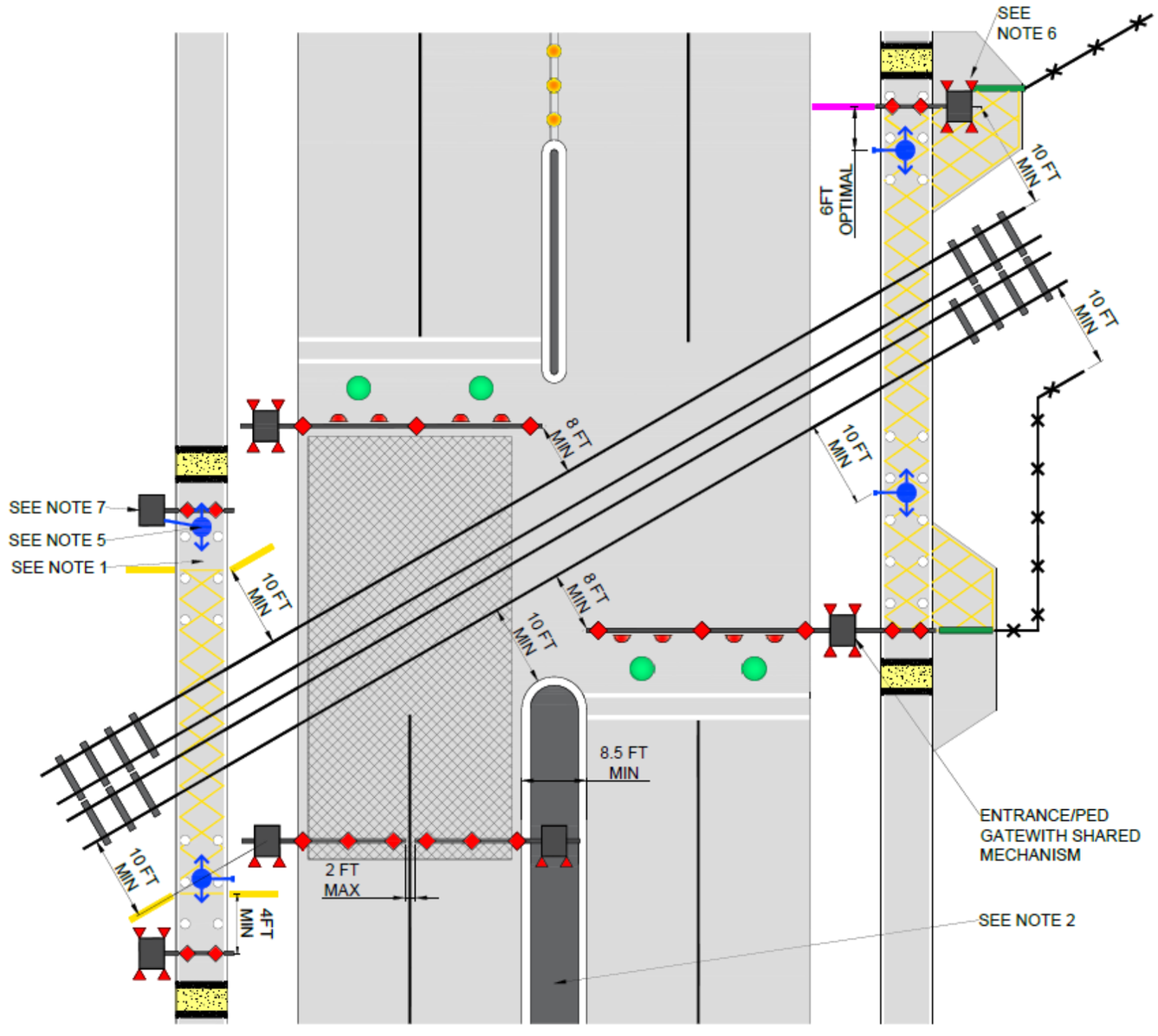
LEGENDS

- MEDIAN, RAISED CONCRETE CURB, OR PLASTIC BOLLARDS
- GATE MAST WITH FLASHERS
- GATE ARM
- TACTILE PLATE
- TRACK FENCING
- WHITE FLUSH-MOUNT LEDs (FOR SIDEWALK)
- RED FLUSH-MOUNT LEDs (FOR ROADWAY)
- VEHICLE DETECTION AREA
- EXIT SWING GATE
- HATCHING FOR PEDESTRIAN WARNING ZONE
- VEHICLE LOGGING DEVICE
- REFUGE AREA DEMARCATION RAILING
- RAILING

NOTES

1. ROADWAY LEDs ARE MOUNTED DIRECTLY BELOW THE GATE ARMS.
2. DRAWING NOT TO SCALE.
3. ELECTRIFICATION COMPATIBILITY CLEARANCES ARE NOT CONSIDERED.
4. SWING GATE TO BE ALIGNED WITH PED GATE MAST EXCEPT OFFSET BY 6FT IF REQUIRED BY SECTION 4.10.5
5. REFUGE AREA OF 4FT MINIMUM TO BE PROVIDED UNLESS EXTENDED REFUGE AREA IS REQUIRED PER SECTION 4.6.
6. HAZARDS TO PUBLIC SHALL BE ADDRESSED PER SECTION 1.6.6.
7. PEDESTRIAN GATE SHOWN WITHOUT FLASHERS PER SECTION 4.5.2.

FIGURE B-5: GRADE CROSSING ENHANCEMENTS GENERAL ARRANGEMENT – ACUTE ANGLE



LEGENDS

- MEDIAN, RAISED CONCRETE CURB, OR PLASTIC BOLLARDS
- GATE MAST WITH FLASHERS
- GATE ARM
- TACTILE PLATE
- TRACK FENCING
- WHITE FLUSH-MOUNT LEDs (FOR SIDEWALK)
- RED FLUSH-MOUNT LEDs (FOR ROADWAY)
- VEHICLE DETECTION AREA
- EXIT SWING GATE
- HATCHING FOR PEDESTRIAN WARNING ZONE
- VEHICLE LOGGING DEVICE
- DYNAMIC MULTI-TRAIN WARNING SIGN
- REFUGE AREA DEMARCATION RAILING
- RAILING

NOTES

1. REFUGE AREA OF 4FT MINIMUM TO BE PROVIDED UNLESS EXTENDED REFUGE AREA IS REQUIRED PER SECTION 4.6.
2. MEDIAN WIDTH TO BE 8.5 FT MININUM IF A GATE MAST IS TO BE INSTALLED WITHIN IT. THE ROAD WIDTH ON THIS DRAWING IS NOT ADJUSTED ACCORDINGLY.
3. DRAWING NOT TO SCALE.
4. ELECTRIFICATION COMPATIBILITY CLEARANCES ARE NOT CONSIDERED.
5. MTWS SHOWN MOUNTED ON THE PED GATE MAST PER FIGURE 5-5.
6. HAZARDS TO PUBLIC SHALL BE ADDRESSED PER SECTION 1.6.6.
7. PEDESTRIAN GATE SHOWN WITHOUT FLASHERS PER SECTION 4.5.2.