OC Transpo Transitway Station Design Safety Study

Independent Safety Study

Final Safety Study

September 2021

OC TRANSPO TRANSITWAY STATION DESIGN SAFETY STUDY

INDEPENDENT ROAD SAFETY STUDY

Prepared for:

Ottawa Carleton Regional Trans.
1500 St. Laurent Boulevard
Ottawa, ON K1G 0Z8

Prepared By:

1223 Michael Street North, Suite 100
Gloucester, Ontario
K1J 7T2

Final Safety Study

September 2021

477433

Table of Contents

Appendices

1.0 INTRODUCTION

Following the collision at Westboro Station on January 11, 2019, senior management directed that an independent safety study of Transitway Stations be carried out. The focus of the study is on the physical station and potential bus interactions, and the posted speed limit within the station area. Five different stations were selected to undertake a road safety audit of all the different generations of Transitway stations. This includes the oldest sections of Transitway to the newest facilities that were built as part of the O-Train Line 1 construction.

A Double Decker Bus Feasibility Study was completed in 2007, prior to the purchase of the City's first double decker bus fleet. The study assessed the feasibility of using these buses on the existing transit network, including along the Transitway. A primary focus was on vertical clearances of overhead infrastructure.

2.0 OBJECTIVES

In accordance with the Project Charter (version 5 dated January 22, 2020), the objectives for the project and the road safety audit are discussed below.

2.1 Project Objectives

The project has the following objectives:

- Ensure Transitway Stations continue to have a safe design, given the current makeup of OC Transpo's bus fleet
- Determine if any design changes are required that would improve the overall safety and operations of Transitway Stations as they relate to potential bus-station interactions
- Determine the need for shorter-term station solutions, versus future design considerations, if any
- Provide recommendations where appropriate to amend or add to the Transitway and Station Design Guidelines as outcomes of the road safety audit
- Provide a comparison of recommendations to improve design and safety experience at the Transitway Stations against the same factors at the Winnipeg and Calgary Transitway Stations
- Provide recommendations on the posted regulatory and advisory speed limits along the transitway and within Transitway Station areas

2.2 Road Safety Audit Objectives

A road safety audit is a process for systematically checking the safety of road transportation projects, based on sound road safety engineering principles, and undertaken from the road users' perspectives. A road safety audit provides an independent assessment of the "anticipated" safety performance of a road transportation project at predetermined intervals by road safety specialists. It is duly noted that the project design team remains ultimately responsible for the design. A road safety audit is defined as follows:

> *"A road safety audit is a formal and independent safety performance review of a road transportation project by an experienced team of safety specialists, addressing the safety of all road users."*

The primary objective for this in-service road safety review was to identify any elements which may have a negative impact on the safety performance of the facility, and to suggest corrective measures for consideration by the OC Transpo Project Team. The mitigation measures suggested in this report are not the only measures, and as such, reflect the nature of a solution, which may or may not be adopted by the design team. In other words, it is the responsibility of the OC Transpo Team to respond to the audit findings in a way that the Team deems appropriate. Hence, the selection of specific solutions for the identified safety issues resides with the OC Transpo Project Team, and not with the road safety auditors.

3.0 ROAD SAFETY AUDIT (RSA) PROCESS

The road safety audit was carried out following the procedures described in the following safety audit guidelines:

- *The Canadian Road Safety Audit Guide*, Transportation Association of Canada, 2001.
- The Canadian Guide to In-Service Road Safety Reviews, Transportation Association of Canada, 2004.
- *Applied Human Factors in Road Safety Guide*, Transportation Association of Canada, 2013.

The road safety audit included the following steps:

- **Start-up Meeting:** Discussions between OC Transpo and members of the RSA team took place on February 18, 2020. Minutes of the meeting are in Appendix A
- **Site Visit:** Members of the RSA team undertook a daytime site visits on February 18, 19, 20 & 21, 2020.and nighttime site visits on February 18, 19 & 20, & 21, 2020.
- **Post-Audit Meeting:** The RSA Team presented an overview of their findings with respect to potential safety issues on February 21, 2020. Minutes of the meeting are in Appendix B
- **Audit Report:** The audit team has prepared this report to document the key findings associated with this RSA.
- **Response Report:** A formal written response to the Road Safety Audit Report should be completed to document the actions to be taken by the OC Transpo Project Team to address the safety issues identified by the RSA Team. The response report would then become part of the overall project documentation. A decision to reject an audit finding or mitigation measure should be always accompanied by justification and/or rationale in the response report. Where a finding is accepted, the OC Transpo Project Team should also document the specific solution/action to be taken to correct the identified safety issue(s), especially if the solution/action is different from the auditor's suggestion.

  The OC Transpo Project Team is under no obligation to accept any or all of the audit findings and/or its suggestions. Also, it is not the role of the auditor to agree to or approve of the OC Transpo Project Team's responses to the audit. Rather, the audit provides the opportunity to highlight potential safety issues and have these issues formally considered by the OC Transpo Project Team, in conjunction with all other project considerations.

4.0 AUDIT TEAM

An independent team of road safety auditors, comprising the following specialists, undertook the road safety audit:

- John Morrall, PhD., P.Eng., Lead Road Safety Auditor (Canadian Highways Institute Ltd.)
- Tim Murphy, AScT, MBA, Eng.L., P.L.(Eng.), RSP, Road Safety Auditor (Parsons)

5.0 DOCUMENTS REVIEWED

The following document were received or obtained by the Audit Team for review:

- *Transitway and Station Design Guidelines, OC Transpo, Ottawa, June 2013*
- *TAC GDG Chapter 7 Roadside Safety*
- *ASSHTO Urban Roadside Design Guide*
- *Incidents Involving in and around the following stations: Pleasant Park, Hurdman, Westboro, Fallowfield and Longfields, Spreadsheet prepared for the RSA Team, February 2020*
- *Drivers Workstation: E500 for male and female, undated*
- *Longfields Station Plan, undated*
- *Hurdman Station plan*
- *Report of Double Decker Bus Compatibility*
- *Aerial images of all Stations*

6.0 FINDINGS AND MITIGATION SUGGESTIONS

This section discusses the observed potential road safety issues identified during site visits to the five selected transitway stations and the suggested mitigations to address these issues.

6.1 Pleasant Park Station

The RSA team undertook a site visit of the Pleasant Park Station on February 18, 2020 during hours of day light and darkness. The station transitway was inspected from a moving vehicle on the approaches and through the station, and on foot within the station. Several potential road safety issues were observed and are discussed below.

Issue 1: No speed transition zones

In the northbound direction there is no speed transition zone for the change in the posted speed from 80 km/h to 50 km/h on the approach to the station. The 50 km/h speed zone starts at the beginning of the median barrier at the northbound entrance to the station. Transit vehicles could be legally travelling at 80 km/h at the beginning the median barrier and the entrance into the station. This is an issue as some vehicles may slow to 50 km/h prior to the start of the 50 km/h zone, while other vehicles may slow to 50 km/h only upon reaching the 50 km/h speed zone. This could result in a speed differential of vehicles entering the station which could contribute to rear end type crashes and vehicles travelling at too high of an operating speed within the entrance to the station.

Also, in the southbound direction there is no speed transition zone for the change in the posted speed from 50 km/h to 80 km/h upon exiting the station.

Suggestions:

Install appropriate speed zoning in terms of sign spacing. Sign spacing should be 100-150m to allow bus drives to slow at an appropriate deceleration rate for passenger comfort and safety.

Issue 2: Advisory speed signing for the reverse curve is in one direction only

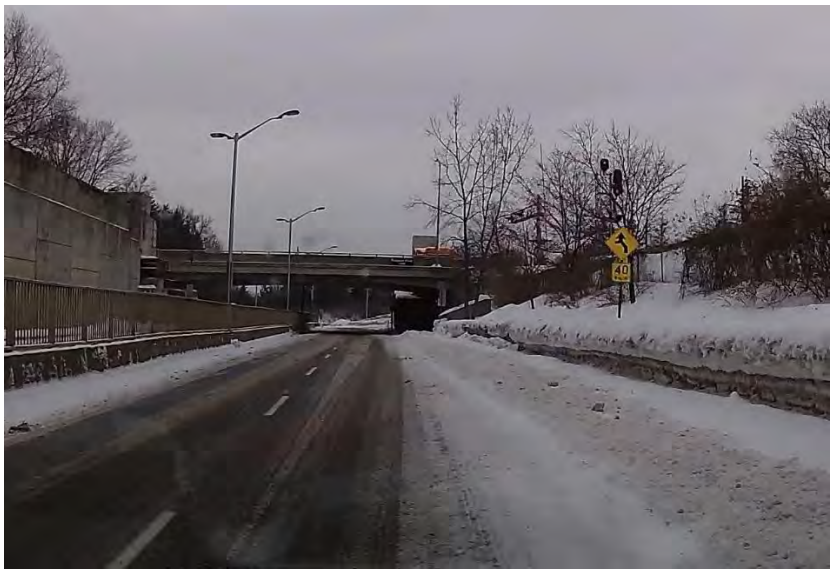
A curve warning sing with an advisory speed tab of slow to 40 km/h is only in the northbound direction. There is no curve warning advisory speed posted for the southbound direction.

Suggestions:

Install an advisory speed sign Tab of 40 km/h with the curve sign in the southbound direction.

Issue 3: Northbound reverse curve warning sign is located south of the station

The northbound reverse curve warning sign, for the reverse horizontal curve north of the station, is located within the south entrance to the station. At this location, there is a high driver workload, the transit driver is focusing on activity and vehicle movements within the transit station and needs the curve warning information after the station.



Similarly, the southbound reverse curve warning sign of the reverse curve for these curves is located at north entrance to the Riverside Station.

Suggestions:

Relocate the reverse curve sign north (downstream) of the Pleasant Park Station for northbound operations and for Southbound operations locate the reverse curve sign south of the Riverside Station

Issue 4: No energy attenuation at the median barrier ends

There is no energy attenuation at the median barrier ends at the entrances into the station. This is especially an issue at the northbound entrance into the station as the speed change from 80 km/h to 50 km/h for northbound vehicles occurs at this point. A transit vehicle may be travelling at 80 km/h at the start of the barrier.

Suggestions:

Install an appropriate TL-3 crash cushion attenuator in place of the sloped end. A picture of the TL-3 crash cushion attenuator is shown below.

Issue 5: Service vehicle access curb letdown located at the nearside of station

The curb letdown or vehicular access for service vehicles to access the platform at the station is located at the approach side or nearside of the station. The location of this access provides a potential opportunity for an errant vehicle to easily mount the curb and intrude onto the platform at the station.

Suggestions:

Replace the letdown curb on the approach end of the station platform with a 150mm high barrier curb. The letdown curb on the departure end of the station platform can remain.

Note potential design guideline implication – locate curb letdown far side of station and curb height should be higher at BRT Stations, namely a raised platform 200mm (8") to 250mm (10") (reference to APTA BRT Stations and Stops Recommended Practice).

Issue 6: No protection for transit patrons on platform from an errant vehicle

Other than the raised curb along the edge of the transitway, there is no barrier to mitigate an errant vehicle accessing the passenger platform area. This is an issue as an errant vehicle travelling at high speed and encountering the curb at an obtuse angle could potentially mount the curb and enter onto the station platform area.

Suggestions:

An 810mm high TL-3 concrete barrier with an appropriate length of need and taper is suggested to shield waiting transit customers from an errant bus mounting the curb on the approach end of the station platform.

Note potential design guideline implications.

Issue 7: Concrete abutment end located in clear zone

The concrete abutment wall is located within the minimum dimension for a clear zone for an urban roadway. An errant transit vehicle leaving the transitway could run head-on into the barrier.

Suggestions:

Remove the concrete abutment or shield it with an appropriate length of need and taper of a TL-3 concrete barrier.

6.2 Westboro Station

The RSA team undertook a site visit of the Westboro Station on February 19, 2020 during hours of day light and darkness. The station transitway was inspected from a moving vehicle on the approaches and through the station, and on foot within the station. The RSA team inspected the station from both an OC Transpo staff vehicle and a double decker bus. Several potential road safety issues were observed and are discussed below.

Issue 8: Jagged rock face and wall surface protrusions

Along both the westbound and eastbound approaches to the station, the side walls of the cut section have jagged rock face or wall surface protrusions. This is a potential issue as should a transit vehicle veer outside of the transitway running surface, these protrusions could grab the side of the vehicle resulting in a severe collision with the wall.

Suggestions:

Install an appropriate length of need and taper of an anchored TL-3 F-Shape concrete barrier or a Cast-In-Place TL-4 F-shape concrete barrier. The barrier should be installed 1m offset from the edge line.

Note: An unanchored concrete barrier could shift or deflect by a maximum 1.8 metres if hit by a heavy vehicle, but the barrier shift caused by a bus would be less. Any barrier used on the Transitway must have a FHWA acceptance letter specifying the Test Level (TL).

Issue 9: Light areas and shadows due to sun angle

Along both the westbound and eastbound approaches to the station there can be light areas and shadows due to the angle of the sun and objects along the top of the cut section. This is a potential issue for patches of icing and inconsistent road surface fiction during temperatures near freezing the point.

Suggestions:

Low sun angles cannot be easily mitigated. Driver training, reduced speed and a higher level of winter maintenance are suggested for the short term. In the longer-term better drainage and a flashing beacon activated by a road surface sensor monitoring conditions such as ice and temperature are suggested.

Issue 10: Water and ice on transitway surface cause glare

Patches of water and ice on the transitway can cause glare when the sun is positioned in the sky in line with the transitway.

Suggestions:

During the site visit it was noticed that snow, which had accumulated on the curved roof resulted in snow and water from melting snow falling on the roadway. Eavestrough along the canopy edge is suggested to drain water away from falling on the Transitway.

Issue 11: Limited intersection sight distance at T-intersection

The local access road to the transitway just west of the station has limited sight distance to the east at the T-intersection. This can be an issue for vehicles entering onto the transitway for selecting a safe opportunity to enter onto the transitway within the traffic stream. Some transit vehicles were observed to be parked on the hatched area along the north side of the transitway, further reducing intersection sight distance to the east.

Suggestions:

Install a flashing beacon activated by buses at the stop bar to warn westbound buses of the potential turning movement conflict would help reduce the potential for collisions. Install "No Stopping" signs along the north side of the transitway for the extent of the hatched area.

Issue 12: Retro-reflectivity of traffic signs rated as fair

During the night site visit at the station, the retro-reflectivity of the traffic signs was observed to be only fair. The signs were visible but not from longer distances. This is an issue as when the signs ability to reflect light is diminished the message conveyed by the traffic signs may not be seen and understood at an appropriate distance for the driver to react in time for the during nighttime conditions.

Suggestions:

The RSA Team suggests that OC Transpo consider a formalized sign asset management program, to ensure traffic signs are replaced before they reach the end of their effective life. The reflective sheeting on the face of traffic signs usually has an effective life of about seven years.

Issue 13: No protection for transit patrons on platform from an errant vehicle

Other than the raised curb along the edge of the transitway, there is no barrier to mitigate an errant vehicle accessing the passenger platform area. This is an issue as an errant vehicle travelling at high speed and encountering the curb at an obtuse angle could potentially mount the curb and enter onto the station platform area.

Suggestions:

An 810mm high TL-3 concrete barrier with an appropriate length of need and taper is suggested to shield waiting transit customers from an errant bus mounting the curb on the approach end of the station platform.

Note potential design guideline implications.

Issue 14: Curb height at station only 75 to 100 mm or 3 ½ to 4 inches

The barrier curb for both the westbound and eastbound directions within the station is only 3 ½ to 4 inches in height. This curb is typically designed and constructed to be 6 inches in height, but it appears that transitway road maintenance activities have resulted in the pavement surface being raised in elevation and shortening the height of the curb within the station. This is an issue as the purpose of the barrier curb is to deflect vehicles travelling at low speeds (up to 40 km/h) that collide with the curb at shallow angles from intruding onto the platform. When a vehicle strikes a curb, the resulting trajectory of that vehicle depends on several variables:

- the size and suspension characteristics of the vehicle
- its impact speed and angle
- the height and shape of the curb itself.

Therefore, the reduced height of the curb may inhibit the ability of the curb to deflect vehicles.

Suggestions:

Rebuild the low curb with a 150mm high barrier curb in keeping with the current transitway design guidelines.

In future, do not allow curb heights to be reduced by road maintenance activities, from the height specified in the approved design, unless it has been explicitly reviewed and approved by a civil engineer.

Note potential design guideline implication – Curb height should be higher at BRT Stations, namely a raised platform 200mm (8") to 250mm (10") (reference to APTA BRT Stations and Stops Recommended Practice).

Issue 15: Service vehicle access letdown at near side of station

The curb letdown or vehicular access for service vehicles to access the platform at the station is located at the approach side or nearside of the station. The location of this access provides a potential opportunity for an errant vehicle to mount the curb and intrude onto the platform at the station.

Suggestions:

Replace the letdown curb on the approach end of the station platform with a 150mm high barrier curb. The letdown curb on the departure end of the station platform can remain.

Note potential design guideline implications.

Issue 16: Overhead canopy located within the desired Clear Zone

An overhead canopy protruding out from the frontage of the station in both the westbound and eastbound directions is located within the desirable Clear Zone of the transitway. The Clear Zone is a fixed-object-free area available to permit recovery by an errant vehicle. Where curb is used, the lateral offset to the hazard is measured from the face of the curb. Generally, in urban areas, a minimum of 0.5 metres offset is provided from the face of curb to fixed objects. However, in urban environments, past studies have shown that approximately 80 percent of roadside collisions involve objects with a lateral offset from the curb face equal to or less than 1.2 metres and approximately 90 percent of urban roadside collisions have lateral offsets less than or equal to 1.8 metres. The auditors note that US studies (FHWA) have shown that 20 percent of errant vehicles exceed clear zone distances. Therefore, a lateral offset of 1.2 metres to 1.8 metres from the curb face to fixed objects is desirable. The existing offset between the curb face and the canopy at this station was difficult to measure during the onsite audit, but the offset appears to be about 0.5 to 0.7 metres.

When a vehicle collides with a fixed object, the crash response safety systems of the vehicle, such as the bumper and vehicle frame crumpling to absorb energy, may possibly deflect the vehicle and / or reduce the severity of the crash for the vehicle occupants. However, these vehicle safety systems may not be engaged in crashes where the fixed object contacts the vehicle at a height higher than the vehicle's bumper.

Suggestions:

Either reduce operating speed of buses to 20 km/h within the limits of the station to mitigate severity of possible collision with canopy or alternatively remove the canopy.

Possible steps for removing the canopy are also suggested:

- Extend the temporary concrete barrier (six components) with an appropriate taper (while gravity unanchored concrete barriers are TL-3 rated, temporary concrete barrier systems can have a dynamic deflection of 1.8m. Consider anchoring the barriers with 25mm rebar, this reduces deflection to 75mm up to 900mm). The existing barrier system should be anchored as well, and the extension tied to the existing temporary barrier system along the curb.
- With the barrier in place remove the canopy and install eaves troughing on the station roof.
- Before beginning any work reduce approach speeds to 30 km/h or stopping buses at the approach end of the platform and moving ahead slowly.

Note potential design guideline implications regarding clear zone considerations.

Issue 17: Curved shape of overhead canopy and station roof dropping snow and water onto transitway lane

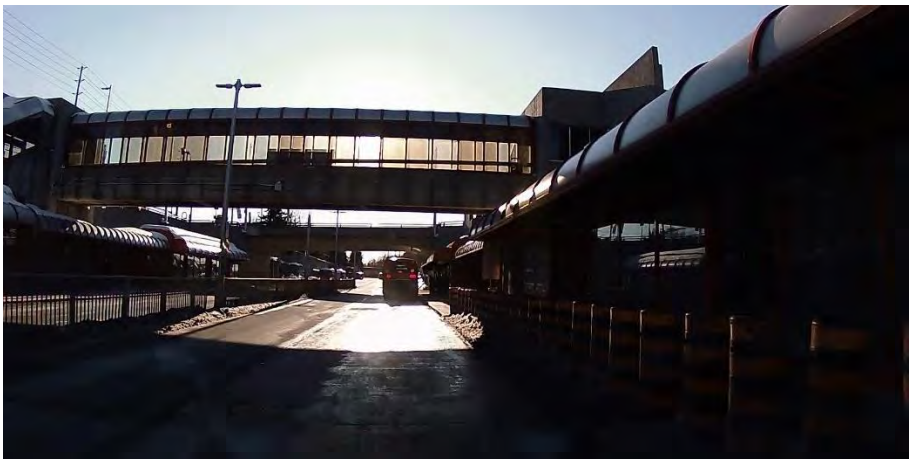
The convex shape of the roof and canopy at the station deposits snow and water onto the sidewalk and transitway surface at the station. This is a potential issue for icing during certain times of the year which could impact surface friction on the transitway and slipping/falling hazard on the sidewalk.

Suggestions:

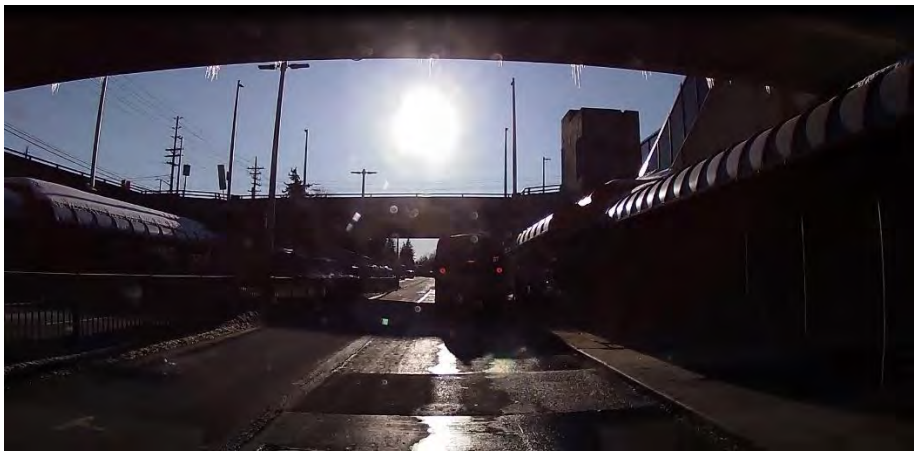
Remove canopy as it cannot be made frangible or shielded. Alternatively install an eavestrough to capture water dripping on the transitway.

Issue: 18 Position of pedestrian bridge creating shadow area on transitway in advance of station

During sunny days a shadow from the pedestrian bridge is cast onto the transitway at the east end of the station on the westbound approach.



On these days when the sun is positioned in the southern sky directly in line with the Transitway. Drivers may experience bright glare from the sun straight ahead, then a very brief few seconds of darkness immediately followed by a bright sun directly in their cone of vision again. For drivers, this circumstance would test two visual factors in the driving task, adaption, and glare sensitivity. Adaption is the ability to change in sensitivity to different levels of light, as adjusting to changes in light upon entering the shadow area. Glare sensitivity is the ability to resist and recover from the effects of glare, as experiencing a reduction in visual performance due to the sun's glare upon exiting the shadow area.



Suggestions:

Consider a sunscreen to block out the sunlight on the transitway.

Issue: 19 Median barrier is not designed for deflecting an errant vehicle

Unlike the median barriers at other station along the transitway, the median barrier at the Westboro Station is not designed to be a vehicle barrier. The purpose of the barrier is to discourage transit patrons from crossing the Transitway. This barrier would not deflect an errant vehicle from crossing over into the oncoming lanes.

Suggestions:

Replace the median fencing with a TL-3 F-Shape 810mm concrete barrier and TL-3 crash cushion end treatments.

Issue 20: Edge of platform is not conspicuous for transit vehicle operators or mobility challenged pedestrians

The edge of the station platform is delineated with a rustic-brown concrete colouring along the edge of the barrier curb. The contrast between the concrete sidewalk colouring and the edge delineation is not very conspicuous. This edge of the platform may not be discernable for people with vision impairments and / or the drivers approaching the station.

Suggestions:

Install a high tonal tactile strip along the edge of the platform, in accordance with Accessibility for Ontarian with Disability Act (AODA) Guidelines. Noting that the colour is not specified in AODA, the standard high contrast colour for tactile strips in most jurisdictions in North America is yellow.

Issue 21: Merge warning signs for lane merges on exiting the Westboro station

The westbound merge warning sign, for the lane merge on existing the Westboro Station, is located just east of the station. This is a high driver workload location; the transit driver is focusing on activity and vehicle movements within the transit station and does not need the merge warning information until after the station.

In the eastbound direction, there is no merge warning sign to warn drivers of the need to merge as the right lane ends and tapers into the left lane.

Suggestions:

In the westbound direction install the lane ends sign past the departure end of the platform. Similarly, in the eastbound direction install a lane ends sign past the departure end of the platform.

Issue 22: Gore area ineffective for prohibiting parking on the transitway

A gore area along the north side of the transitway just west of the station was recently installed as a measure to prohibit parking along this section of the transitway. Parked transit vehicles along this section of the transitway were limiting sight distance at the T-intersection just to the west. During the site audits at this and other station along this transitway, buses were observed parking in the gore area on a few occasions. This measure has not been effective for prohibiting parking.

Suggestions:

In the immediate term install no stopping signs. In the longer term if bus drivers continue to park in the hatched area install drivable delineators 500mm offset from the outside of the edge line to prevent drivers from entering the hatched area.

6.3 Fallowfield Station

The RSA team undertook a site visit of the Fallowfield Station on February 20, 2020 during hours of day light and darkness. The station transitway was inspected from a moving vehicle on the approaches and through the station, and on foot within the station. Several potential road safety issues were observed and are discussed below.

Issue 23: No energy attenuation at median ends

There is no energy attenuation at the median barrier ends at the entrances into the station. An errant vehicle could potentially rollover or be launched from a collision with the bull-nose end of the barrier.

Suggestions:

Replace the sloped ends with an appropriate TL-3 crash cushion.

Issue 24: No redundant entry prohibition signs for motorist egress from VIA Rail station

There are turn prohibition signs on the approaches to the crossing of the VIA RAIL Station access and the transitway to advise motorists crossing the transitway not to enter onto the transitway. However, at times this intersection is very busy with many crossing pedestrians as well as vehicles accessing the VIA Rail Station and transit vehicles at the intersection which could distract a driver's attention. Should a driver travelling to and from the rail station not see these turn prohibition signs when approaching the intersection, they may mistakenly turn onto the transitway. As shown in a picture below, a passenger car as was observed on the transitway during the onsite audit. There are no signs at the intersection to advise the driver not to enter onto the transitway.

Suggestions:

Install Entry Prohibited (RB-23) signs with a Tab "Except Buses" at the throat of the transitway. Double signing is suggested.

Issue 25: STOP sign intrusion into transitway lane

The STOP sign located in the southwest quadrant of the intersection at the station has been placed with the sign intruding onto the transitway. Buses proceeding away from the station could collide with the sign and the sign does show evidence of being struck. Consequently, some transit vehicles were observed to veer left into the adjacent when leaving the station of avoid hitting the sign. This could contribute to side-swipe collisions at the intersection.

Suggestions:

Relocate stop sign 500mm from the face of curb.

Issue 26: Conspicuity of tactile surface

The tactile surface for the entrance to the crosswalk is not conspicuous in comparison to the concrete sidewalk. Most people with a visual impairment have some sensory abilities but may not be able to discern between objects unless they have high contrast. Many people start to suffer vision loss after the age of 65 years. For these people, there may be a limited perception of the path ahead and obstacles. Such people would need to rely entirely on non-visual indicators to find this textured plate.

Suggestions:

Install Accessibility for Ontarian with Disability Act (AODA) approved high tonal tactile surface. Although the colour of the tactile surface is not specified in AODA, the common high contract colour standard for most jurisdictions in North America is yellow.

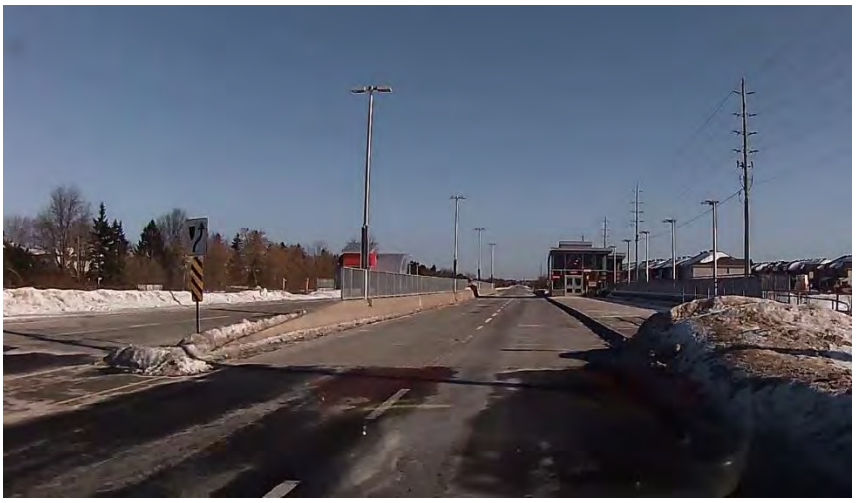
Note potential design guideline implications.

6.4 Longfields Station

The RSA team undertook a site visit of the Longfields Station on February 20, 2020 during hours of day light and darkness. The station transitway was inspected from a moving vehicle on the approaches and through the station, and on foot within the station. Several potential road safety issues were observed and are discussed below.

Issue 27: No energy attenuation at median barrier ends

There is no energy attenuation at the median barrier ends at the entrances into the station. An errant vehicle could potentially rollover or be launched from a collision with the bull-nose end of the barrier.



Suggestions:

Replace the sloped ends with appropriate TL-3 crash cushions.

Issue 28: Faded red edge on platform with no tactile quality

The edge of the station platform is delineated with a rustic-brown concrete colouring along the edge of the barrier curb. The contrast between the concrete sidewalk colouring and the edge delineation is not very conspicuous. This edge of the platform may not be discernable for people with vision impairments and / or the drivers approaching the station.

Suggestions:

Install AODA approved high tonal contrast tactile surface. The suggested high contrast colour is yellow.

Issue 29: Concrete barrier – Blunt end with no energy attenuation

A concrete no-post barrier with a hazard marker has been installed on the road surface of the transitway along the right edge of the right travel lane directly beside the station building. A barrier has been installed in both the southbound and northbound directions. There is damage to the outside of the southbound station building which appears to be caused by a vehicle collision. This appears to be the rationale for the concrete barriers, to protect the station buildings from vehicle collisions. The station buildings are offset about 0.5 metres from the curb face of the transitway. The barriers are fix-objects and a potential hazard to vehicles on the transitway. There is no energy attenuation to lessen the impact of a collision with the barriers. The barriers also narrow the travel lane to 3.0 metres. Vehicles passing the barriers would need shy distance to comfortably avoid colliding with the barrier and this, coupled with the narrowness of the lane forces drivers to intrude into the adjacent lane in order to pass by the barrier.

Suggestions:

Remove the concrete barriers with a blunt end. Install drivable delineators along the base of the building on a 200 mm white line to keep buses away the station and allow the bus to remain in the departure lane. Alternatively, remove the concrete barriers and install a low concrete curb against the base of the station. In either case remove the concrete barrier with the blunt end as it is a hazard.

Note potential design guideline implications for clear zone considerations and station offsets from the transitway.

Issue 30: Concrete barrier – Forces abrupt bus maneuvers

Transit vehicles leaving the station were observed to make abrupt turning maneuvers into the adjacent lane to avoid colliding with the concrete barrier. This presents several safety issues:

- Transit vehicles leaving the station in the right lane could potentially side swipe a transit vehicle travelling through the station in the left lane
- Transit vehicles leaving the station and immediately entering the left lane would potentially be travelling at a slower speed than an approaching transit vehicle travelling through the station in the left lane and this speed differential could contribute to a rear-end type collision
- The purpose of the right lane leaving the station is to allow transit vehicles to accelerate from a stopped position to the posted speed of the transitway and then merge safely into any traffic in the left lane.

Suggestions:

Remove the concrete barriers with a blunt end. Install drivable delineators along the base of the building On a 200 mm white line to keep buses away the station and allow the bus to remain in the departure lane. Alternatively install a low concrete curb against the base of the station.

Issue 31: Concrete barrier – Rear swept path of double decker (rear out swing) intrudes onto platform

The rear swept path of transit vehicles leaving the station with an abrupt turning maneuver can intrude onto the passenger platform. This is especially a concern for double decker bus which have a long overhang behind the rear axle.

Suggestions:

Remove the concrete barriers with a blunt end from the travel lane. Or install a TL-3 F-Shape concrete barrier along the edge of the platform with a pedestrian railing 1000mm high of appropriate length of need and taper to shield passengers on the platform from the swept path of the articulated bus.

6.5 Hurdman Station

The RSA team undertook a site visit of the Hurdman Station on February 21, 2020 during hours of day light and darkness. An additional site visit was undertaken on May 21, 2020 during daylight hours. The station transitway was inspected from a moving vehicle on the approaches and through the station, and on foot within the station. Several potential road safety issues were observed and are discussed below.

Issue 32: Main Active Transportation Crossing – Unclear guidance for users

The main active transportation crossing does not provide clear guidance for users on how it should be used.

The crossing features stop signs and Ontario Traffic Manual (OTM) Book 18 mixed crossride markings. This tells users that the crossing is intended to be shared by pedestrians and cyclists, and that cyclists are not required to dismount.

Markings from a previous configuration were black-masked, contrary to City of Ottawa standard practices. The black paint has since worn off, causing the older crosswalk markings to show through. The most recent markings have also worn/faded, making them similar in appearance to the old markings. This has rendered the resulting visible markings non-standard, which could contribute to user confusion.

There are a number of approaches to this crossing, whose configuration gives users mixed messages.

To the southeast, an asphalt MUP transitions to concrete before meeting the crossing. While not regulatory, in Ottawa this is commonly used as a visual queue for cyclists that they should dismount and walk.

To the south, several sidewalks converge into a single concrete sidewalk. The sidewalks are too narrow to be used as shared facilities.

The south and southeast approaches converge into mixing zone with a paver surface, with no guidance to users on the intended use.

The north side of the crossing meets the station plaza. The paver surface and directional tactile pavers imply to users that it's intended as a pedestrian area, but again no clear guidance is given to users.

To the northeast, a MUP connects to the plaza without any signage or guidance for users.

Suggestions:

It should be confirmed whether a mixed crossride is appropriate and desirable for this location. OTM Book 18 notes that mixed crossrides are "for low volume crossings, particularly at unsignalized locations where practitioners do not anticipate queuing of pedestrians or cyclists". This does not appear to be a low volume crossing, and queuing of users would be anticipated after trains disembark creating a surge of users.

If a mixed crossride is deemed to not be appropriate, the crossing could be converted to a traditional crosswalk. Alternatively, it could be converted to a separate or combined crossride. These are suitable for higher volume crossings but would require physical modifications to widen the depressed curbs and reconfigure the approaches.

Regardless of the crossing type selected, the pavement markings should be made clear to users. Markings that are still in effect should be refreshed, and markings that are no longer in effect should be removed by abrasive blasting.

The intended use of the approaches should also be made clear to users. If a mixed crossride is deemed to be suitable, "cyclist yield to pedestrians" signs should be installed on the MUP approaches. This would give positive guidance to users that cycling is permitted and reinforce that cyclists must yield to pedestrians in mixing zones.

If it's decided to convert the crossing to a traditional crosswalk, "dismount and walk" signs should be installed on the MUP approaches. If it's decided to convert the crossing to a separate or combined crossride, the approaches should be modified to separate users. Markings, signage, and tactile delineation would be required to clearly indicate the separation to users.

Issue 33: Main Crosswalk – STOP sign for pedestrians mounted too high

For a STOP sign that appears to be oriented to cyclists, the mounting height of the sign is very high.

Suggestions:

If the stop sign is to be retained (refer to issue 32), the sign should be mounted at a height of 2m from the sidewalk to the base of the sign to improve the conspicuity for cyclists.

Issue 34: East Crosswalk – Luminaires not over crosswalk

There are no streetlights located immediately at the crosswalk. Therefore, illumination levels will be brighter on the road surface located away from the crosswalk and darker at the crosswalk. This may result in pedestrians in the crosswalk being less likely to be seen at night.

Suggestions:

The RSA Team suggests a luminaire or alternatively consider a Rapid Rectangular Flashing Beacons (RRFB). The auditors note there is a commercial product that combines a luminaire that comes on when the RRFB is activated.

Issue 35: East Crosswalk – Pavement markings faded

The crosswalk pavement markings and stop bars are barely visible. The poor condition of the pavement markings detracts from conspicuity of the crosswalk and could contribute to poor compliance of motorists to stop at the crosswalk.

Suggestions:

Refresh the crosswalk pavement markings. Consider Thermoplastic as this appears to be a high use area.

Issue 36: Passenger Pick-up and Drop-off

The information or guide sign to direct motorists to the passenger pick-up and drop-off area does not comply with the colour scheme, symbol usage, letter font and letter size for guide signs in Ontario. Consequently, this sign may not be immediately recognized by motorists as an information sign for the attention of motorists and a cause of confusion or missed information.

Suggestions:

This is a guide sign and should comply with the Manual of Uniform Traffic Control Devices for Canada in terms of size, colour and shape for guide signs.

Issue 37 Transit patrons walking in transit vehicle path to avoid crowded platform

During the afternoon peak hour, the passenger platform to access bus routes leaving the station is very crowed. Some transit patrons were observed walking in the bus travel lanes to avoid the crowded platform. The walking path of these pedestrians conflicts with the path of transit vehicles and could result in potential collisions between pedestrians and transit vehicles.

Suggestions:

Install a pedestrian railing 1000mm high and signs indicating do not walk on roadway.

7.0 BENCHMARK COMPARISON OF BRT DESIGN GUIDELINE FOR SELECTED IDENTIFIED ISSUES

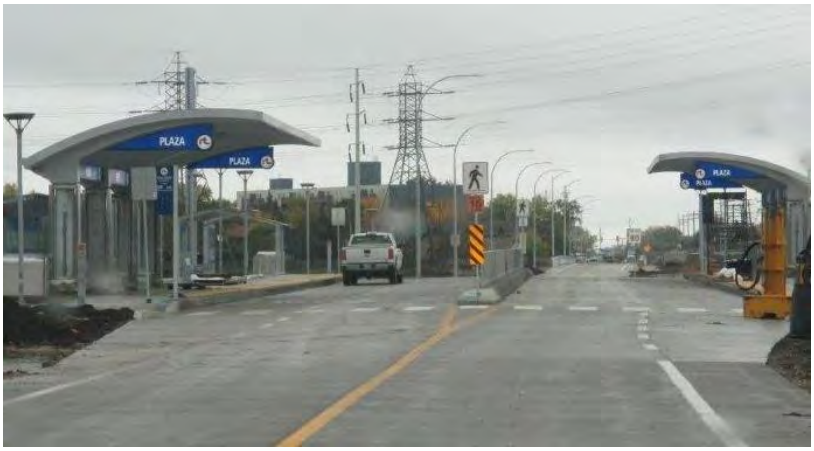
This subsection compares identified road safety issues of the OC Transpo transitway that have design guideline implications with the BRT design guidelines of the Cities of Winnipeg and Calgary. The road safety issues pertain to clear zones, platform heights, location of service vehicle accesses at stations, approach speeds to station and the colour of tactile surfaces to aid mobility for the visually impaired.

Clear Zone Considerations

BRT Stations along the Winnipeg transitway have a back wall which located outside the desirable clear zone setback of 1.8 metres. The station roof is cantilevered out beyond the curb line and overhead of the transitway but is higher than the transit design vehicle. The Winnipeg BRT and Calgary BRT do not have double decker buses.

Suggestion: Future updates to the OC Transpo Transitway Station Design Guidelines should consider locating the fixed object structural elements of stations outside of the desirable clear zone.

The auditors recommend that OC Transpo, for future Transitway Station designs, consider "Bus Rapid Transit Stations and Stops" RECOMMENDED PRACTICE, American Public Transportation Association, Report APTA BTS-BRT-RP-002-10, Approved October 2010



Winnipeg BRT Station with Clear Zone Setback

Platform height

The platform height for the Winnipeg BRT Stations is 250mm high with a barrier curb. The platform height for the Calgary BRT Stations is 260mm high with a barrier curb. The rationale for the higher platforms is to make passenger loading/unloading easier with a level floor between the station and the transit vehicle. However, the higher platform is more likely to deflect an errant bus than the 150mm barrier curbs in Ottawa (measured to be as low as 75mm at the Westboro Station).

Suggestion: Future updates to the OC Transpo Transitway Station Design Guidelines should consider a higher platform height to gain a level floor between the station platform and transit vehicle, and to enhance the effectiveness of the barrier curb to deflect errant vehicles.

Location of service vehicle entrance to station platform

Both Winnipeg and Calgary locate service vehicle pullouts after station platforms. The service vehicles do not access directly onto the platforms.

Suggestion: Future updates to the OC Transpo Transitway Station Design Guidelines should consider locating service vehicle accesses at the far side of stations.

Approach speed to stations

Winnipeg has a lower approach speed of 30 km/h for entering and travelling through the stations. Calgary has an approach speed of 50 km/h for entering and travelling through the stations as it operates on a public roadway.

Suggestion: Future updates to the OC Transpo Transitway Station Design Guidelines should consider a 30 km/h posted speed at the transitway stations to lessen the severity of possible future crashes.

Winnipeg BRT Station with 30 km/h approach speed

Colour of Tactile Surfaces for the Visually Impaired

Both Winnipeg and Calgary use yellow tactile safety strip along the platform edge at stations

Suggestion: Future updates to the OC Transpo Transitway Station Design Guidelines should consider harmonizing standards for tactile surfaces with other more broadly applied design guidelines for the mobility challenged.

8.0 BRT DESIGN GUIDELINE COMPARISON HIGHLIGHTS

This subsection highlights the key design criteria used in the BRT design guidelines of transit systems for the City of Winnipeg and the City of Calgary.

8.1 Winnipeg BRT Transitway Design Guidelines Highlights

Geometric and pavement design from the following manuals

- Busway Planning and Design Manual; Winnipeg
- BRT recommended practice APTA
- TAC GDG
- AASHTO A policy on geometric design of highways and streets
- Transit Capacity and LOS Manual 3rd edition TRB

Design Vehicles

- 12m diesel bus with bike rack, mirrors, and roof mounted AC
- 12m E-bus with bike rack, mirrors, and roof mounted AC
- 19m diesel articulated with bike rack, mirrors, and roof mounted AC

Design and Posted Speed

- Mainline 90 km/h (posted at 70 km/h and one section at 80 km/h
- Stations 60 km/h (posted at 30 km/h)

Stopping Sight Distance

- TAC Std for 90 km/h-236m
- Passenger comfort -for 60 km/h-84m

Cross Slope

- e max 3% on mainline
- e stations -2%

Cross-sections urban sections

- Transitway lane width 3.5m
- Shy 1.0m
- Barrier width 525mm
- Station loading lane width 3.15m
- Station bypass lane width 3.5m

Cross-sections rural sections

- Transitway lane width 4.1m
- Shoulder width 0.5m

Barrier Systems

- Midwest W-Beam with TL-3 SKT (extruder head) end treatment
- W-beam FOB flush with FOC (mountable)
- Transition to CIP using a strong post Thrie-Beam
- CRB F-safety shape and ½ F-Shape CIP (TL-4) 813mm
- Bridge roadside barriers single slope 1070mm CIP TL-5

Stations

- High level platform curbs 250mm (barrier curb)
- Barrier/fencing in median (to prevent passengers from walking across operational area)
- Crosswalks located 5m downstream from bus stop pole
- Platform tangent
- Minimum platform width between shelter and curb 3.0m
- Tactile yellow safety strip
- Crossfall to prevent water pooling on platform and transitway in station area
- MUPs are connected to all stations (called Active Transportation (AT) in Winnipeg)
- Cross ride at stations not permitted (signed with RB-79 & RB-79T on MUP approaching Xwalk)
- Stations have all the expected amenities (heat, light, benches, multiple doors, canopy, bike lockers, bike racks, trash bins, newspaper boxes, signs and wayfinding, warning system for bus arrival: chime and light post,
- Most stations have kiss-n-ride (PPUDO) & park-n-ride
- Landscaping and public art

8.2 Calgary BRT Transitway Design Guidelines Highlights

At the outset it is noted Calgary has three BRT lines. The SE BRT (Purple Line) is a median operation BRT line for the most part along 17th Ave SE. There is a separate transitway section over the Bow River with flashing beacon when activated to warn drivers of road surface conditions and to slow down

Geometric and pavement design from the following manuals

- BRT recommended practice APTA
- TAC GDG

Design Vehicles

- 12m diesel bus with bike rack, mirrors, and roof mounted AC
- 19m diesel articulated with bike rack, mirrors, and roof mounted AC

Design and Posted Speed

- Transitway Mainline 70 km/h (posted at 70 km/h) when fully operational

- At opening as the SW transitway was still a work zone so operating speeds were lowed at stations to 20 km/h
- Two of the three stations are at signalized intersections so operating speeds are controlled by signals and station proximity to intersections

Cross-sections

- Transitway lane width 3.5m
- Shy 1.0m
- Minimum shy 0.6m at a pinch point on the SW BRT

Barrier Systems

- W-Beam with TL-3 end treatment
- Box beam sections
- Transition to CIP using a strong post Thrie-Beam
- CRB F-safety shape and ½ F-Shape CIP (TL-4) 813mm
- Bridge roadside barriers single slope 1070mm CIP TL-5
- Median and roadside barriers on 14th Street are single slope 1070mm TL-5

Stations

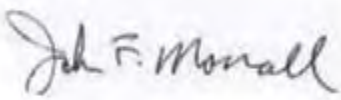
- High level platform curbs 260mm (barrier curb)
- Crosswalks located downstream from bus stop pole
- Platforms on tangent
- Tactile yellow safety strip on station platforms
- Crossfall to prevent water pooling on platform and transitway in station area
- MUPs are connected to all stations
- Cross ride at stations not permitted (signed with RB-79 & RB-79T on MUP approaching Xwalk)
- Stations have all the expected amenities (heat, light, benches, multiple doors, canopy, bike racks, trash bins, newspaper boxes, signs and wayfinding, warning system for bus arrival: LED CMS.
- Terminal station has kiss-n-ride (& park-n-ride
- Stations do not have curb letdowns
- Pull outs 2.4m wide are provided past the departure end of the platform at some stations for service vehicles

9.0 STATEMENT OF LIMITATIONS

The findings and opinions contained in this document are based on an examination of available and relevant plans and documents, as well as the specified road and its surroundings. The findings reflect the Road Safety Audit Team's best professional judgment in light of the information available to them at the time of the preparation of the safety audit.

This safety audit was conducted using generally accepted road safety engineering principles, covers only physical features that may affect road users' safety, and has sought to identify potential road safety hazards. However, guarantees cannot be made or implied that all safety deficiencies or crash causes have been identified. Further, if all the issues raised in this report were to be rectified or amended, this would not confirm that the highway is 'safe'; rather, the consideration of the identified issues may result in changes to the design which could prove beneficial to the safety performance of the facility.

The document was prepared for OC Transpo and The City of Ottawa and no third party should solely rely on the information therein in any particular circumstances without seeking professional advice. The road safety audit team and/or their respective organizations accept no responsibility for damages, if any, incurred to any person or property acting or failing to act as a result of the material in this document.



Lead Road Safety Auditor
John Morrall, Ph.D., P.Eng
President
Canadian Highways Institute Ltd

Road Safety Auditor
Tim Murphy, MBA, PMP, RSP
Senior Project Manager, Connected Communities
Parsons Inc

Appendix A: Start Up Meeting Minutes

OC Transpo
Transitway Station Design Safety Study

KICK-OFF MEETING NOTES (DRAFT)

Attendees:

OC Transpo
Alex Stecky-Efantis, Alex.stecky-efantis@ottawa.ca
Derek Washnuk, Derek.Washnuk@ottawa.ca

TAC Committee
Brett Verberne, Brett.Verberne@ottawa.ca
Nicholas Doolan, Nicholas.Doolan@ottawa.ca
Krista Tanaka, Krista.Tanaka@ottawa.ca
Sandra Majkic, Sandra.Majkic@ottawa.ca
Anna Valliant, Anna.Valliant@ottawa.ca

Parsons
Gary Holowach, Gary.Holowach@parsons.com
Ron Clarke, Ronald.Clarke@parsons.com
Tim Murphy, Tim.Murphy@parsons.com

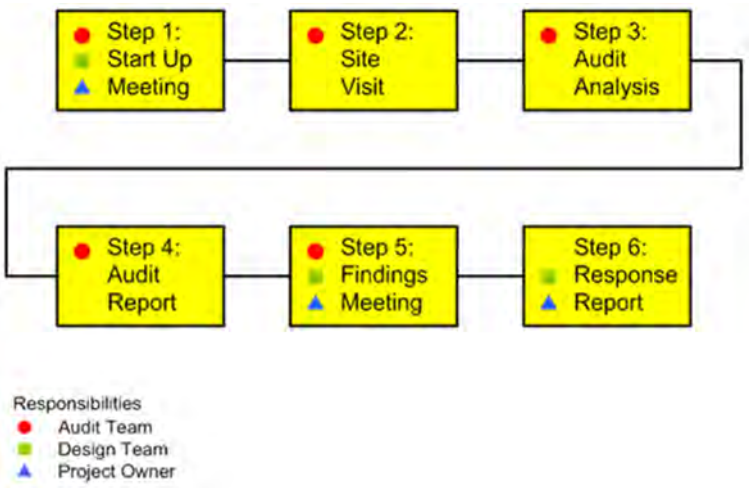
Canadian Highways Institute
John Morrall, jmorrall@shaw.ca

File Number: 477433

Location: OC Transpo
1500 St Laurent Blvd
Room 1406

Date: February 18, 2020
9:00am

ITEM	TOPICS	ACTION
1.	Overview of the Project Parsons provided a brief overview of the objectives for this Safety Study (as outlined in Parson proposal dated December 20, 2019) and as follows • Ensure Transitway stations continue to have a safe design, given the current makeup of OC Transpo's bus fleet • Determine if any design changes are required that would improve the overall safety and operations of Transitway stations as they relate to potential bus-station interactions • Determine the need for shorter-term station solutions, versus future design considerations, if any • Provide recommendations where appropriate to amend or add to the Transitway and Station Design Guidelines as outcomes of the road safety audit • Provide a comparison of recommendations to improve design and safety experience at the Transitway Stations against the same factors at the Winnipeg and Mississauga Transitway Stations • Provide recommendations on the posted regulatory and advisory speed limits along the transitway and within Transitway Station areas John Morrall provided the following about Road Safety Audits • Is not a way of assessing or rating a project as good or poor	Info

ITEM	TOPICS	ACTION
	• Is not a means of ranking or justifying one project against others in a works program • Is not a way of rating one option against another • Is not a check of compliance with standards • Is not a substitute for design checks • Is not a crash investigation • Is not a redesign of a project • Is not something to be applied only to high-cost projects or only to projects involving safety problems • Is not the name used to describe informal checks, inspections or consultation	
2.	Study Process This Study follows the Road Safety Audit Process, as outlined in *The Canadian Road Safety Audit Guide.*  Step 1 - Start Up Meeting (discussion of today) Step 2 - Site Visits (to occur this week and generally involve both AM and PM Peak periods, along with night-time observations at each of the stations and transitway approaches) Step 3 - Audit Analysis (March 2020) Step 4 - Audit Report (Draft) (March 2020) Step 5 - Findings Meeting (April 2020 Step 6 - Response Report (Dependent upon internal review by OC Transpo / City)	Info
3.	Schedule for the week	

ITEM	TOPICS	ACTION
	• Tuesday February 18 – Project Kick-off meeting with Client early in the morning, site visit in late morning and evening to Pleasant Park Transitway station • Wednesday February 19 – Westboro Transitway station site visit, morning/daytime and evening • Thursday February 20 – Morning, daytime and evening site visits to two stations, Fallowfield and Longfields Transitway stations • Friday February 21 – Site visit to Hurdman Transitway station early morning, client briefing meeting on observed issues in early afternoon, site visit in evening Alex provided an overview of each Transitway station (using the city's GeoOttawa mapping) and general observations were provided for discussion purposes	Info
4.	Status of Available Information Information provided by OC Transpo to date has been all station related. Parsons requested additional data concerning the transitway approaches to the Stations. Parsons requested that OC Transpo, provide crash records and any Incident Reports on-file (over the last last 5 years) and raw GPS data, including Dashcam Footage (which will assist in establishing Bus speeds / potential conflicts on the transitway approach/departure and within the platforms areas). Skid Resistance investigations were requested, OC to determine who/where this information resides	OC Transpo
5.	New Business No new business at this time.	Info
6.	Meeting adjourned at 11:00 am	

Errors and omissions in these notes must be provided to Gary Holowach by February 28th, 2020 otherwise the meeting notes will be assumed as an accurate reflection of the discussions at the meeting.

Copies: All present

Cathy Kourouma, Kathy.Kourouma@ottawa.ca

Appendix B: Post-Audit Presentation

PARSONS

OC TRANSPO TRANSITWAY

POTENTIAL ROAD SAFETY ISSUES - DRAFT BRIEFING PRESENTATION

John Morrall and Tim Murphy
February 21, 2020

DRAFT AGENDA

Objectives

Audit Process

Potential Safety Issues

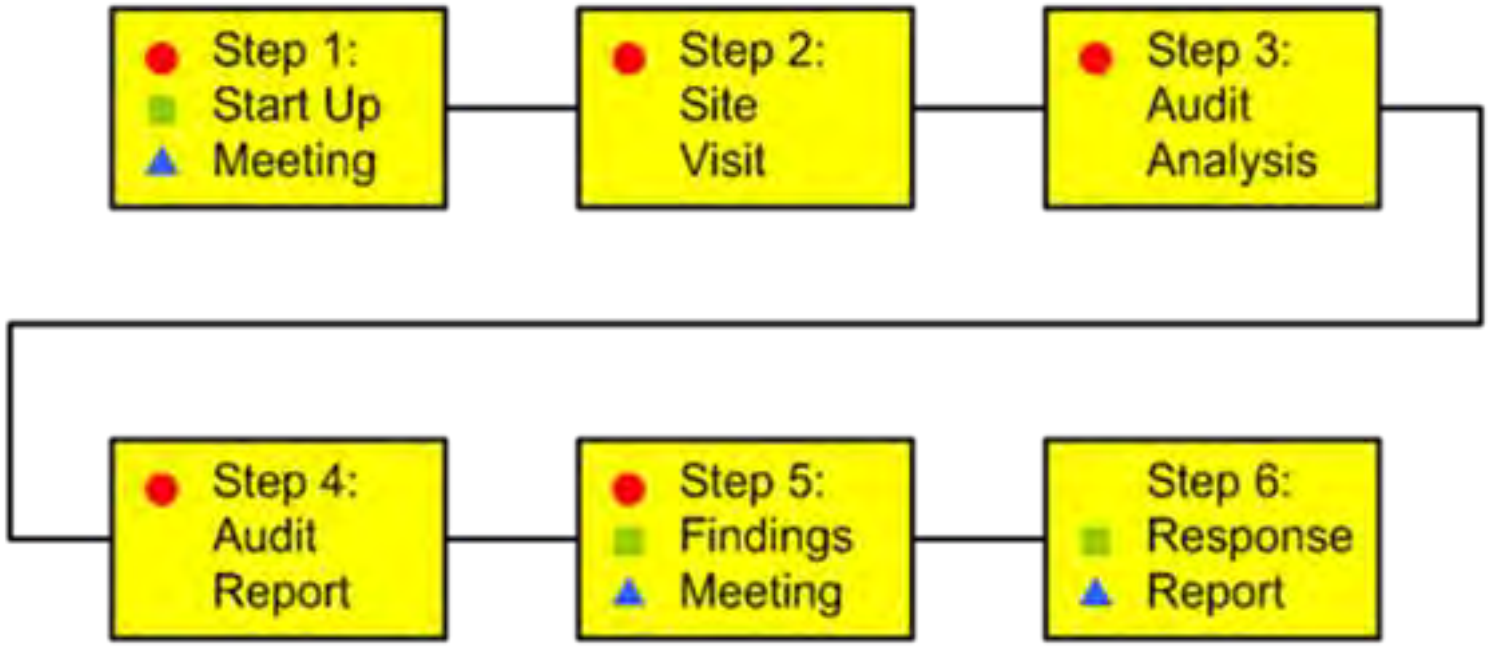
- Pleasant Park Station
- Westboro Station
- Fallowfield Station
- Longfield Station
- Hurdman Station

Questions & Discussion

TRANSITWAY ROAD SAFETY AUDIT OBJECTIVES

- Ensure Transitway stations continue to have a safe design, given the current makeup of OC Transpo's bus fleet;
- Determine if any design changes are required that would improve the overall safety of Transitway stations as they relate to potential bus-station interactions;
- Determine the need for shorter-term station solutions, versus future design considerations, if any; and,
- Provide recommendations on the posted speed limit within Transitway station areas.

ROAD SAFETY AUDIT PROCESS



Responsibilities
- Audit Team
- Design Team
- Project Owner

This presentation provides a briefing on the observations in Step 2

PLEASANT PARK STATION – POTENTIAL ROAD SAFETY ISSUES

- Railway Crossing
  - Bus Stop Operations and rail track intrusions
  - Eastbound and westbound pedestrian control at tracks
- Pedestrian crossing activity during local transit and transitway transferring
- Speed Warning signing in inadequate along the transitway
- Reverse curves north of station – advisory speed signing in one direction only (northbound)
- Northbound reverse curve warning sign is located south of station
- No energy attenuation at median barrier ends
- Service vehicle curb letdown located on receiving end of station
- No protection for transit patrons on platform from an errant vehicle
- Concrete Abutment blunt end in clear zone
- Illumination poor on cross road especially for crossing pedestrians

RAILWAY CROSSING

PEDESTRIAN CROSSING ACTIVITY

REVERSE CURVE WARNING SIGN ON TRANSITWAY

REVERSE CURVES – ADVISORY SPEED SIGNING

NO ENERGY ATTENUATION AT MEDIAN BARRIER

SERVICE VEHICLE CURB LETDOWN LOCATION

NO PROTECTION FOR TRANSIT PATRONS ON PLATFORM

CONCRETE ABUTMENT BLUNT END IN CLEAR ZONE

PEDESTRIANS AT TEMPORARY CROSSING

WESTBORO STATION – POTENTIAL ROAD SAFETY ISSUES ON TRANSITWAY APPROACHES

- Rock cuts and wall surface protrusions
- Light and Shadows due to sun angle
- Water and Ice can cause glare
- Intersection Sight Distance at T-intersection
- Traffic signs retro-reflectivity only fair
- No protection for transit patrons on platform from an errant vehicle

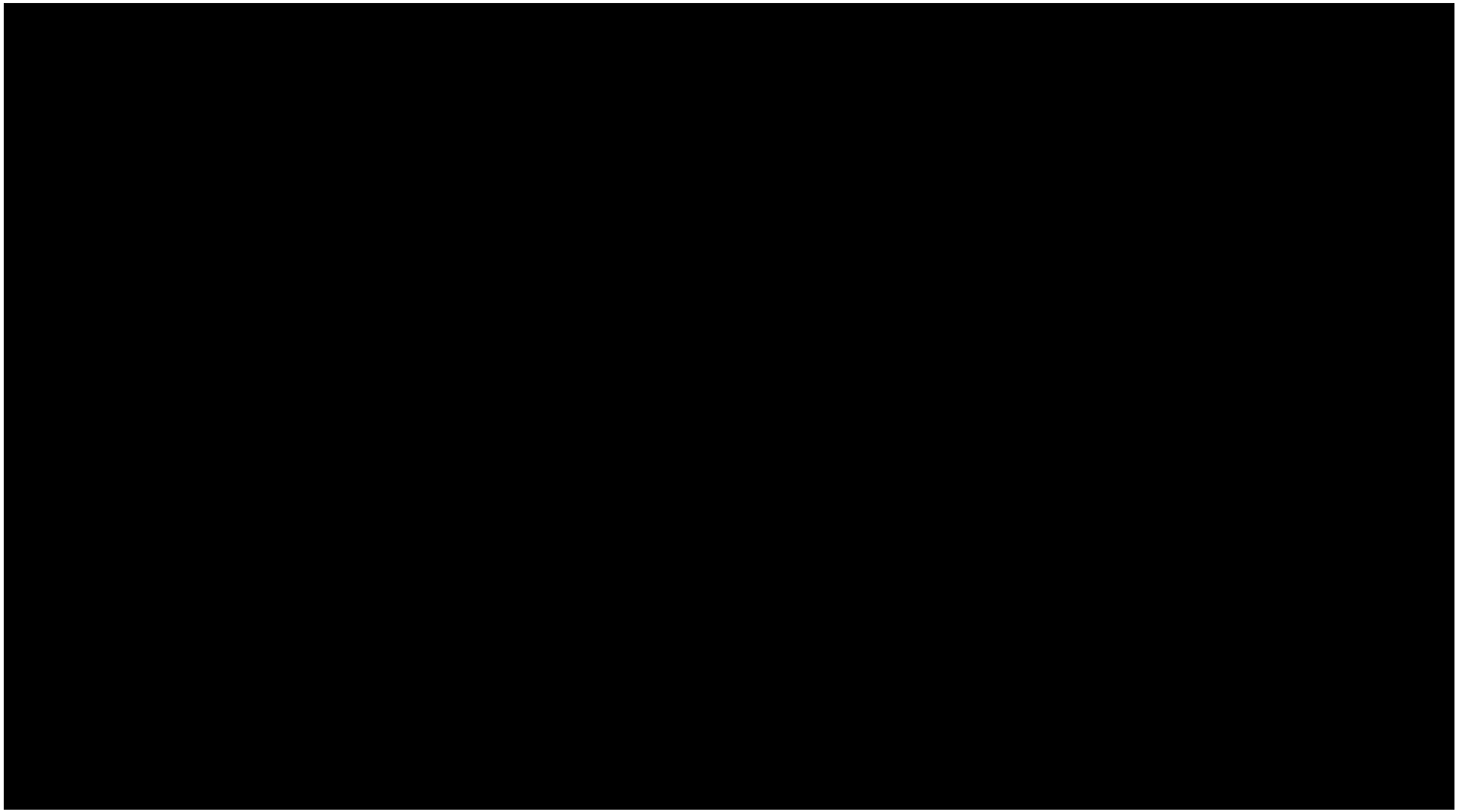
ROCK CUTS AND WALL SURFACE PROTRUSIONS

LIGHT AND SHADOWS DUE TO SUN ANGLE

WATER AND ICE ON TRANSITWAY CAUSING GLARE

INTERSECTION SIGHT DISTANCE

TRAFFIC SIGN RETRO-REFLECTIVITY



NO PROTECTION FOR TRANSIT PATRONS ON PLATFORM

WESTBORO STATION – POTENTIAL ROAD SAFETY ISSUES

- Curb height at station only 75 to 100 mm or 3 ½ to 4 inches
- Service vehicle letdown at receiving end of station
- Overhead canopy located within Clear Zone
- Curved shape of overhead canopy dropping snow and water onto transitway lane
- Position of pedestrian bridge creating shadow area on transitway in advance of station
- Median barrier not designed for deflecting an errant vehicle
- Edge of platform is not conspicuous for transit vehicle operators or mobility challenged pedestrians
- Departure end merge is inadequate
- Gore area ineffective for prohibiting parking on the transitway

CURB HEIGHT AT STATION

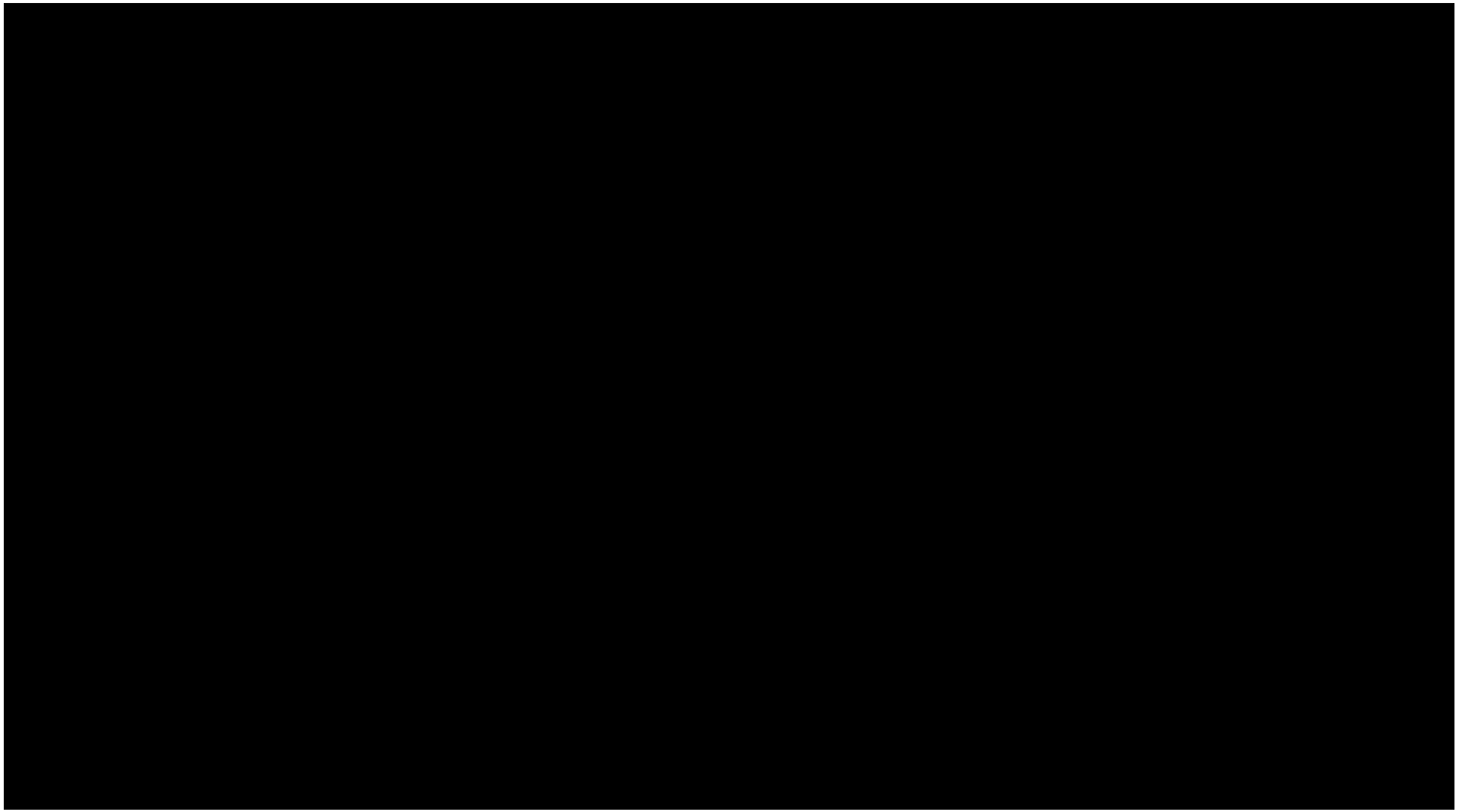
SERVICE VEHICLE LETDOWN LOCATION

OVERHEAD CANOPY LOCATED WITHIN CLEAR ZONE

CURVED SHAPE OF CANOPY

PEDESTRIAN BRIDGE CREATING SHADOW ON TRANSITWAY

GLARE ON WESTBOUND APPROACH TO WESTBORO STATION



MEDIAN BARRIER DESIGN

CONSPICUITY OF PLATFORM EDGE

DEPARTURE MERGE

LOCATION OF MERGE WARNING SIGN

GORE AREA

FALLOWFIELD STATION – POTENTIAL ROAD SAFETY ISSUES

- No energy attenuation at median ends
- No redundant entry prohibition signs for motorist egress from VIA Rail station
- STOP sign intrusion into transitway lane
- Conspicuity of tactile surface

NO ENERGY ATTENUATION AT MEDIAN BARRIER

UNAUTHORIZED VEHICLE PROHIBITION SIGNING

STOP SIGN INTRUSION ONTO TRANSITWAY LANE

TACTILE SURFACE AT CURB RAMP FOR CROSSWALK

LONGFIELDS STATION – POTENTIAL ROAD SAFETY ISSUES

- **No energy attenuation at median barrier ends**
- **Faded red edge on platform with no tactile quality**
- **Concrete barrier**
  - Blunt end with no energy attenuation
  - Forces abrupt bus maneuvers
  - Rear swept path of double decker (rear out swing) intrudes onto platform
- **Missing No Entry sign**

CONCRETE BARRIER PLACEMENT

TRAVEL LANE WIDTH NARROWING DUE TO BARRIER

ABRUPT BUS MANEUVER DUE TO BARRIER

ABRUPT BUS MANEUVER DUE TO BARRIER

ABRUPT BUS MANEUVER DUE TO BARRIER

FADED SIGNS


$125.00
FINE
AMENDE


DANGER
Keep off
roadway
$125.00
FINE
AMENDE

MISSING NO ENTRY SIGN

HURDMAN STATION – POTENTIAL ROAD SAFETY ISSUES

- **Main Crosswalk**
  - Pavement markings faded and confusing
  - No cyclist mandatory permissive sign to stop and dismount
  - STOP sign for pedestrians mounted too high
- **Courtesy Crosswalk**
  - Luminaires not over crosswalk
  - Pavement markings faded
  - Road signs do not appear to follow rules of the road
  - Centreline marked with a single yellow line, roadside sign “do not pass”
- **Passenger Pick-up and Drop-off (PPUDO)**
  - Sign size and font size are too small
  - Guide sign standards could be applied to conveying this information
- **Wayfinding ground lines ends at first call box on platform**

MAIN CROSSWALK

COURTESY CROSSWALK – FADED ROAD MARKINGS

CONFLICTING ROAD MARKINGS AND ROADSIDE SIGNING

LUMINAIRES NOT LOCATED AT CROSSING

WAYFINDING GROUND LINES

PPUDO GUIDE SIGN

QUESTIONS AND DISCUSSION

Appendix C: Test Levels Terminology

2.2.1.2 Description of Tests

These procedures establish a two digit naming system consistent with NCHRP Report 350 (129) for full-scale crash tests. The first digit is used to identify the test level followed by the second digit that identifies the specific test in the series for each type of feature.

TABLE 2-2A. Recommended Test Matrices for Longitudinal Barriers

Test Level	Barrier Section[c]	Test No.	Vehic.	Impact Speed,[a] mph (km/h)	Impact Angle,[a] θ, deg.	Im-pact Point	Acceptable IS Range,[a] kip-ft (kJ)	Evaluation Criteria[b]
1	Length-of-Need	1-10 1-11	1100C 2270P	31 (50.0) 31 (50.0)	25 25	(c) (c)	≥13 (17.4) ≥27 (36.0)	A,D,F,H,I A,D,F,H,I
	Transition	1-20[d] 1-21	1100C 2270P	31 (50.0) 31 (50.0)	25 25	(c) (c)	≥13 (17.4) ≥27 (36.0)	A,D,F,H,I A,D,F,H,I
2	Length-of-Need	2-10 2-11	1100C 2270P	44 (70.0) 44 (70.0)	25 25	(c) (c)	≥25 (34.2) ≥52 (70.5)	A,D,F,H,I A,D,F,H,I
	Transition	2-20[d] 2-21	1100C 2270P	44 (70.0) 44 (70.0)	25 25	(c) (c)	≥25 (34.2) ≥52 (70.5)	A,D,F,H,I A,D,F,H,I
3	Length-of-Need	3-10 3-11	1100C 2270P	62 (100.0) 62 (100.0)	25 25	(c) (c)	≥51 (69.7) ≥106 (144)	A,D,F,H,I A,D,F,H,I
	Transition	3-20[d] 3-21	1100C 2270P	62 (100.0) 62 (100.0)	25 25	(c) (c)	≥51 (69.7) ≥106 (144)	A,D,F,H,I A,D,F,H,I
4	Length-of-Need	4-10 4-11 4-12	1100C 2270P 10000S	62 (100.0) 62 (100.0) 56 (90.0)	25 25 15	(c) (c) (c)	≥51 (69.7) ≥106 (144) ≥142 (193)	A,D,F,H,I A,D,F,H,I A,D,G
	Transition	4-20[d] 4-21 4-22	1100C 2270P 10000S	62 (100.0) 62 (100.0) 56 (90.0)	25 25 15	(c) (c) (c)	≥51 (69.7) ≥106 (144) ≥142 (193)	A,D,F,H,I A,D,F,H,I A,D,G
5	Length-of-Need	5-10 5-11 5-12	1100C 2270P 36000V	62 (100.0) 62 (100.0) 50 (80.0)	25 25 15	(c) (c) (c)	≥51 (69.7) ≥106 (144) ≥404 (548)	A,D,F,H,I A,D,F,H,I A,D,G
	Transition	5-20[d] 5-21 5-22	1100C 2270P 36000V	62 (100.0) 62 (100.0) 50 (80.0)	25 25 15	(c) (c) (c)	≥51 (69.7) ≥106 (144) ≥404 (548)	A,D,F,H,I A,D,F,H,I A,D,G
6	Length-of-Need	6-10 6-11 6-12	1100C 2270P 36000T	62 (100.0) 62 (100.0) 50 (80.0)	25 25 15	(c) (c) (c)	≥51 (69.7) ≥106 (144) ≥404 (548)	A,D,F,H,I A,D,F,H,I A,D,G
	Transition	6-20[d] 6-21 6-22	1100C 2270P 36000T	62 (100.0) 62 (100.0) 50 (80.0)	25 25 15	(c) (c) (c)	≥51 (69.7) ≥106 (144) ≥404 (548)	A,D,F,H,I A,D,F,H,I A,D,G

a See Section 2.1.2 for tolerances on impact conditions.
b See Table 5-1.
c See Figure 2-1 and Section 2.3.2 for impact point.
d Test is optional.