

At-Grade LRT Crossing Safety Review: 5E’s of Transportation Safety

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Introduction

Safety is a key element of Calgary Transit’s Customer Commitment, and plays a critical role in guiding the planning, design and implementation of transit service. At-grade Light Rail Transit (LRT) crossings are continuously reviewed through the 5E’s of Transportation Safety for a comprehensive approach to address pedestrian and vehicle safety. The 5E’s are:

- Engineering
- Evaluation
- Enforcement
- Education
- Engagement

Engineering

Engineering treatments are crossing protection devices used to make at-grade LRT crossings safe through physical protection and warning devices. These treatments include bells, swing gates, staggered bedsteads, automatic crossing gates and flashing lights. An inventory of protection measures, device classification, constraints and costs can be found in this section of the report.

Calgary Transit’s LRT system has 92 at-grade crossings; Table 1 provides a breakdown of crossing types.

Table 1: Number and Type of At-grade Crossings

<u>At-grade Crossing Type</u>	<u>Number of Crossings</u>
Pedestrian only crossings	32
Road only crossings	12
Mixed crossings (pedestrian and road)	48
Total:	92

The design and safety treatments of at-grade LRT crossings follow applicable industry standards and Calgary Transit’s LRT Design Guideline Manual (DGM) (Figure 2). In 2009, Calgary Transit updated the guiding principles for planning and design in the DGM for new and reconstruction of LRT crossings (previously from 2001). The updated guiding principles help manage the constraints and design of at-grade crossings. LRT extensions and construction between 2000 and 2009 followed 2001 guiding principles; however, CTrain extensions after the Blue Line West extension followed the updated 2009 guiding principles listed below:

I. Safety is paramount:

- Priority is for a safe and dependable design based on industry best practices.
- Crossing protection must allow for accessibility by all users, including people with disabilities. The Guidelines must account for persons with physical, sensory and developmental disabilities, children, seniors, customers/pedestrians carrying groceries/packages or pushing strollers, cyclists (young, old, proficient, and novice), and the like.

- Facilities must provide clear direction to users.
- The Guidelines must provide for variation from normal practice in special circumstances, with the addition of appropriate mitigating measures.
- Perceived safety issues should be reviewed and addressed where appropriate.

II. *Balance rapid transit, customer access and community connectivity:*

- Crossing protection (and the number of at-grade crossings) should allow Calgary Transit to operate the LRT at the highest possible speed based on track geometry and station spacing, and to maintain schedule reliability. This must be balanced with the need for customers to access stations efficiently and for community connectivity.
- While the goal of LRT is to provide rapid transit, The Municipal Development Plan/Calgary Transportation Plan has developed goals for intensification, connectivity and increased emphasis on active modes that will influence the design of crossing protection on some potential future rail transit lines in urban corridors (e.g. service with slower speed operation with traditional traffic control devices). Prior to the construction of such lines, the Guidelines should be reviewed to confirm applicability, or the need to develop additional or revised Guidelines to meet requirements specific to that mode of operation.

III. *Need for crossing protection:*

- Where the LRT is operated at the speed of other adjacent traffic, with an expectation that the train operator will follow standard roadway traffic signal controls (e.g., 7th Avenue or other future at-grade urban corridors), traditional traffic control devices may be used for motor vehicle and pedestrian control (traffic signals, walk/don't walk signals and audible cues).

IV. *Cost-effective approach:*

- Calgary's LRT will continue to be based on an affordable, surface running design integrated into adjacent development, rather than more expensive grade separated concepts. Use of at-grade crossings will continue to be a standard approach, with exceptions only as warranted at major roadways, other railways, major geographic barriers, etc.
- The Guidelines will be applied to new installations. Older installations will be retrofitted to new standards where prioritized based on future safety reviews.

V. *Reliability:*

- Crossing protection facilities must be proven, robust and capable of operating with a high degree of reliability under all likely conditions with low maintenance requirements.
- Facilities must be fail-safe, and reside in safe mode in the event of failure

LRT operations along 7 Avenue S in downtown are based on in-street operations. In-street operations require the LRT to follow traffic signals that also control cross street traffic and bus movements. Every at-grade crossing outside the 7 Avenue S corridor has engineering protection measures in place. At

minimum, all at-grade crossings outside of 7 Avenue are protected by flashing lights and bells. In addition, swing gates or bedsteads are installed at pedestrian crossings and automatic gate arms are installed at road and mixed crossings for vehicular traffic. These additional measures go beyond the current industry standards and have been added to the LRT Crossing Guidelines because they have been found to be effective at reducing near misses and incidents through audits conducted by the LRT Crossing Committee (see Evaluation section).

Calgary’s LRT system began operations in 1981, and the LRT Crossing Guidelines have evolved over time with industry standards, best practices and internal experience. A revised edition of the Crossing Guidelines issued in 2017 include significant safety enhancements such as installing automatic pedestrian gate arms for all new lines and extensions. The refreshed guidelines also further extended the minimum requirements to address accessibility issues (such as addition of tactile warning strips) and a minimum required crossing surface width to ensure there is appropriate room for a person using a wheelchair to safely cross the tracks.

The 2017 Crossing Guidelines also provides a decision tree matrix for updating safety measures at existing at-grade crossings in a cost-effective and prioritized manner based on the type of crossing, site conditions and risk. The decision tree can be found in Appendix 1.

Freight railways are federally regulated by Transport Canada Grade Crossing Standards; these specifications are followed where LRT at-grade crossings are in freight railway Right of Way (ROW). Pedestrian crossings that cross LRT tracks along with one or more tracks belonging to a freight railway (i.e. CP Rail) are also protected with flashing lights, bells and crossing arms for vehicles.

A complete inventory of at-grade crossing locations and protection measures can be found in Appendix 2. Table 2 summarizes the type of protection measures that Calgary Transit employs, how the protection measure supports safety, and approximate costs. The costs of each treatment are based on previous Calgary Transit at-grade crossing upgrade projects, and represent the entire costs to implement a measure (e.g. in-house design, labour, signal connections and upgrades, materials, equipment, excavation and thorough testing to ensure the treatments work under normal operating conditions and in safe mode). Costs also vary depending on site conditions (e.g. space, adjacent land uses and vehicle and pedestrian volume). Figure 1 shows some examples of the engineering protection measures used.

The LRT system also has grade-separated pedestrian crossings at specific locations; these are provided where pedestrian access across the track is restricted by physical site constraints such as station access, road classification or environmental area. It is costly and difficult to grade separate an existing crossing however opportunity exists with future extensions or new LRT lines. Pedestrian volumes, traffic volumes and transit operations are considerations when determining grade separated crossings.

Table 2: At-grade LRT Crossing Treatment Inventory

Protection Measure	Device Classification	Industry Guidelines	Calgary Transit Guidelines	Approximate Costs
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Flashing Lights	Visual warning device	Required	Required	Single track crossing: \$15,000-\$19,000 Two track crossings: \$30,000-\$35,000
Bells	Audible warning device	Required	Required	Additional bell: \$1,000-\$1,500
Swing gates or bedsteads	Physical barriers	Recommended	Required	Swing gate replacement or additional bedstead: \$1,000-\$4,000 New design and construction: \$40,000
Automatic gate arms (pedestrian crossing)	Automatic physical barrier	Recommended under site specific conditions	Existing crossing: Depends on site conditions (see Appendix 1) New crossing: Required	Four gate arms: \$400,000-\$500,000 +\$200,000 for third party coordination (ex. Heavy rail, underground utilities)
Automatic gate arms (road crossing)	Automatic physical barrier	Recommended under site specific conditions	Required	Four gate arms: \$400,000-\$500,000
Second train light	Visual warning device	Recommended under site specific conditions	Existing crossing: Depends on site conditions (see Appendix 1) New construction: Two tracks and no refuge - Required	One crossing: \$13,000

Figure 1: (left) flashing lights, bells and besteads; (middle) automatic pedestrian gate arm, flashing light and bells; (right) automatic vehicle gate arms



7 Avenue S corridor

LRT operations along 7 Avenue S corridor between 11 Street SW and 3 Street SE and 9 St SW function using in-street operations, meaning that trains are required to follow conventional traffic signals. There are no additional protection measures with the following exceptions:

- 11 Street at 7 Avenue SW is the western transition point from in-street operations to signalized territory. Automatic vehicle gate arms exist for NB and SB vehicle traffic and automatic pedestrian gate arms are located on the west pedestrian crossing.
- 3 Street at 7 Avenue SE is the eastern transition point from in-street operations to signalized territory. Swing gates are located in the SE corner at-grade crossing where the Red Line exits and enter the tunnel. As part of this report, this intersection was reviewed to ensure it met best practices for safety (Attachment 2); the review showed that:

- Pedestrians are disregarding the warning systems due to irregularities with the warning signals due to complex operations of Blue Line and Red Line entering and exiting 7 Av S corridor. The Crossing Committee is reviewing the warning system times at this intersection.
- The installation of flashing lights, bells and automatic gate arms at the Red Line pedestrian crossing are recommended to address safety and accessibility.

The recommendations made by the review will be considered by the LRT Crossing Committee and be prioritized within annual work plans by risk and budget availability.

- 9 Street between 4 Avenue and 7 Avenue S
 - 9 Street at 4 Avenue S – flashing lights, bells and bedsteads exist for pedestrians
 - 9 Street at 5 Avenue S – automatic vehicle gate arms exist to maintain vehicle level of service and address operator sight line concerns. For pedestrian safety, flashing lights, bells and bedsteads exist.
 - 9 Street at 6 Avenue S –bedsteads exist for pedestrians

- 9 Street at 7 Avenue S – flashing lights, bells and bedsteads exist for pedestrians

Evaluation

LRT Crossing Committee

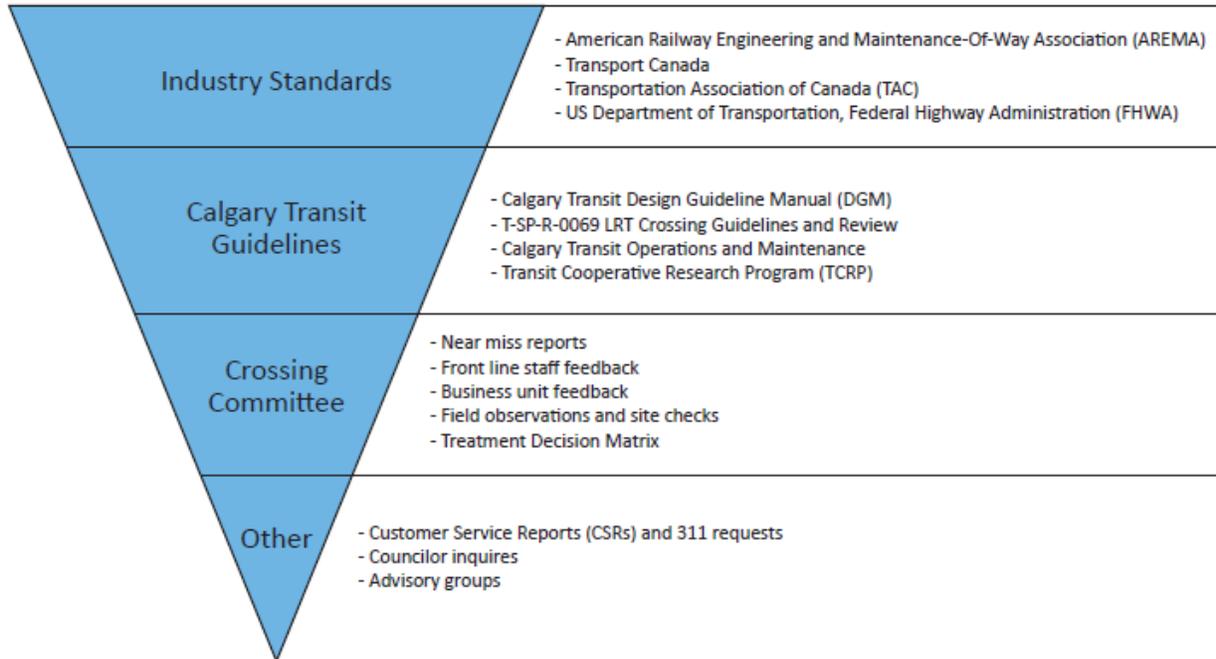
Calgary Transit’s LRT Crossing Committee is made up of internal technical experts that are responsible for conducting technical reviews of at-grade crossings to ensure crossing treatments meet the needs of the users, operations and site-specific issues. The group is made up of members from Signals and Rail Systems, Track and Way, Public Safety and Enforcement, LRT Operations, Transit Planning and Communications and Marketing. An advisory group that includes Roads Safety, Calgary Police Services and Liveable Streets are consulted to provide a broader transportation safety perspective. The LRT Crossing Committee relies on multiple data sources such as near miss reports from LRT operators and public concerns from 311 to prioritize locations for improvement. Other inputs are also included in evaluations such as feedback from Calgary Police Services, Roads and other Calgary Transit divisions such as Operations, Public Safety, and Enforcement and Infrastructure. The LRT Crossing Committee engages internal advisory groups such as the Access Design Sub Committee and Calgary Transit Customer Advisory Group to understand the user experience. Over the past few years, the LRT Crossing Committee has increased the focus of prioritizing their annual work plan based on the number of near misses reported at locations. Table 3 shows the locations with three or more near misses in a year, outside of downtown.

Table 3: Crossing locations, outside of downtown, with three or more near misses per year

2015	2016	2017	2018
Chinook Station	Chinook Station	Chinook Station	Sunnyside Station
Saddletowne Station	36 St and 12 Av NE	Saddletowne Station	Chinook Station
Sunnyside Station	Banff Trail Station	Sunnyside Station	Saddletowne Station
Whitehorn Station	Sunnyside Station	Whitehorn Station	Whitehorn Station
	Saddletowne	Banff Trail Station	58 Av SW
	Whitehorn	Heritage Station	Lions Park Station
	SAIT/ACAD/Jubilee Station	Marlborough Station	Marlborough Station
	36 St and 26 Av NE	McKnight-Westwinds Station	36 St and 20 Av NE
		Shawnessy Station	Brentwood Station
		Sirocco Station	Martindale Station

Immediate safety concerns and high priority improvements are addressed through the lifecycle and asset management budgets in the Calgary Transit Infrastructure division. The Council-approved LRT Reliability fund was previously used to address priority improvement opportunities at LRT crossings between 2013-2018. Having a dedicated source of capital funding will result in continuous and consistent implementation of further improvement opportunities to at-grade crossings prioritized based on risk.

It is important to note that the LRT Crossing Committee and at-grade crossing designs must follow applicable industry standards, Calgary Transit’s Design Guidelines and LRT Crossing Guidelines, as indicated in Figure 2. Input from other sources are considered but may not meet the standards and guidelines that are already in place to promote safety. The LRT Crossing Committee manages the feedback outside of the industry standards and LRT’s DGM. Figure 2: At-grade LRT Crossing Standards, Guidelines and other Considerations



Calgary Transit’s Rail Systems group conducts regular monthly inspections and testing of crossing safety specific infrastructure, such as train approach times, lights, bells (function and sound level), signs and gates. In a situation where crossing protection measures are damaged, malfunction or fails an inspection and cannot be immediately addressed, the crossing is closed or train operations are adjusted until the proper solution can be implemented. Post incident investigations are conducted immediately after an incident occurs, and the findings are shared with the Law department and Calgary Police Services, as requested.

Through the LRT Crossing Committee’s review of near misses, site visits and other data sources, continuous upgrades are made to improve pedestrian safety by installing the appropriate safety measures. Figure 3 shows a recent adjustment to the flashing lights at Erlton/Stampede Station and Whitehorn Station. The pedestrian sightlines to the flashing lights were previously not direct but with a slight modification, they have been shifted to be directly facing the pedestrian (cantilevered).

Figure 3: Flashing lights lowered and cantilevered out to directly face pedestrians.



The LRT Crossing Committee is also responsible for evaluating the need for automatic gate arms at existing pedestrian at-grade crossings. Automatic gate arms are not a requirement under industry standards but are recommended under specific conditions through the Transit Cooperative Research Program (TCRP) Report 69- Light Rail Service: Pedestrian and Vehicular Safety (2001). The report uses a decision tree tool for evaluating the type of treatment that should be installed at a pedestrian grade crossing based on site specific conditions such as pedestrian volumes, sight lines and track alignment. Calgary Transit has adopted the TCRP findings and developed a decision matrix applicable to Calgary's LRT system (Appendix 1).

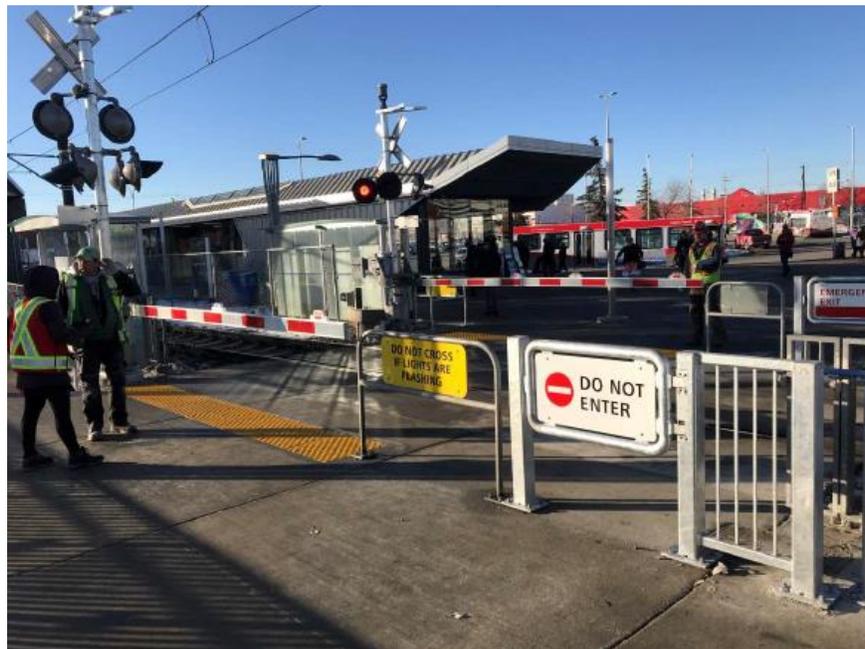
Automatic pedestrian gate arms are highly effective in providing a physical barrier when trains are approaching. However, they are expensive to retrofit into an existing system, requiring design, construction and possible land impacts to ensure sufficient pedestrian refuge areas. Automatic gate arms were recently installed at two existing at-grade locations after an extensive review from the LRT Crossing Committee: Banff Trail Station and Chinook Station. The minimum safety measures were in place at both of those stations; however, it was found that due to context specific features and significant near misses consistently occurring, enhanced safety measures were required (Table 4 and Figure 4).

All pedestrian at-grade LRT crossings on the Blue Line West were implemented with automatic gate arms as recommended by the TCRP Report 69 and lessons learned from the existing system. Green Line Stage 1 is requiring automatic pedestrian gate arms at all at-grade LRT crossings. For all new LRT lines or extensions, Calgary Transit is supportive of treatments that are consistent with the Blue Line West.

Table 4: Considerations and Impacts of Automatic Pedestrian Gate Arms at Chinook Station and Banff Trail Station

Location	Site issues	Safety Measures Before	Safety Measures After	Benefits After
Chinook Station Pedestrian Crossing	<ul style="list-style-type: none"> • 21 near miss data reports in 2017 • Fatality • High non-compliance of safety measures • High pedestrian realm (Chinook Mall) • Adjacent CP rail corridor • Transit hub of buses and LRT 	<ul style="list-style-type: none"> • Flashing lights • Bells • Bedsteads • Signage 	October 2017: <ul style="list-style-type: none"> • Flashing lights • Bells • Signage • Automatic gate arm • Tactile yellow strip 	<ul style="list-style-type: none"> • Reduced number of near misses to 4 in 2018 • Better compliance of safety measures
Banff Trail Station Pedestrian Crossing	<ul style="list-style-type: none"> • Fatality • High pedestrian realm (McMahon Stadium) • High non-compliance of safety measures during site visits • High non-compliance of safety measures during enforcement blitz • Sightlines 	<ul style="list-style-type: none"> • Flashing lights • Bells • Swing gates • Signage 	2015: <ul style="list-style-type: none"> • Flashing lights • Bells • Signage • Automatic gate arm 	<ul style="list-style-type: none"> • Better compliance of safety measures

Figure 4: Chinook Station with automatic pedestrian gate arms



Another safety measure that the LRT Crossing Committee has recently implemented is the second train warning light; this light is activated when trains in both directions are approaching the at-grade crossing. The visual display advises pedestrians not to cross when safety measures are activated as a train is approaching in the opposite direction. There are only three locations where the second train light has been implemented: Sunnyside Station south crossing (2018), Sunnyside Station north crossing (2018) and SAIT Campus crossing (1987, updated in 2017) – Figure 5.

Figure 5: Second Train Lights at SAIT Campus Crossing (left) and Sunnyside Station Crossing (right)



Best Practices Review

As part of this report, an external consultant examined the at-grade crossing protection measures employed by Calgary Transit, and benchmarked the effectiveness against comparable LRT systems in North America (Attachment 2). The scope of their review included:

- Applicable guidelines, standards and best practices;
- The rate of collisions at at-grade crossings of the LRT system;
- The adequacy of the at-grade crossing warning systems;
- Factors contributing to at-grade crossing safety issues; and
- Recommendations for improvements to address noted safety issues.

Through this examination, it was determined that Calgary Transit has implemented best practices in new designs and for making prioritized improvements to existing crossings. The effectiveness of the at-grade crossing warning systems in Calgary is similar to that of comparable LRT systems in North America. A copy of the evaluation can be found in Attachment 2; the key findings were:

- Calgary Transit is employing applicable guidelines, standards and best practices in new design and has a process for capturing improvements reflected in these guidelines, standards and best practices into its own guidelines;

- The rate of collisions at at-grade crossings of the Calgary Transit LRT system is comparable to that elsewhere in North America;
- The Calgary Transit at-grade crossing warning systems are adequate to provide for the safety of motorists, cyclists and pedestrians;
- Calgary Transit is experiencing the same factors contributing to at-grade crossing safety issues as are found elsewhere in North America; and
- Calgary Transit has implemented best practices in determining the at-grade crossings needing improvements to the warning systems.

As part of this evaluation, the external consultants conducted field assessments of a diverse set of seven at-grade crossings across the LRT network. It was determined that all locations conformed to industry standards, and some recommendations for pedestrian safety enhancements were provided for consideration. The evaluation also recommended additional general improvement opportunities for the LRT Crossing Committee to consider within its engineering toolbox; these include lowering the height of pedestrian warning signals, implementing second train warning signage at more pedestrian crossings, and further evaluating installing automatic gate arms at additional locations based on risk and site considerations. The LRT Crossing Committee is currently evaluating these improvement recommendations and will prioritize them within annual work plans based on risk and budget availability. An annual dedicated capital funding stream will be required to implement these improvement opportunities in a systematic manner, and will be requested as part of the 2020 budget adjustments.

Enforcement

Calgary Transit Peace Officers educate and enforce the municipal bylaws to ensure safe behavior and compliance at at-grade crossings on the LRT system. Crossing an at-grade LRT crossing when it is not appropriate and safe to do so (i.e. crossing LRT tracks while the control device is activated) is an offence under the following municipal bylaws:

- 26M96 Traffic Bylaw Section 6:
 - (1) A pedestrian shall not cross a street within one block in any direction of a traffic control signal or pedestrian corridor other than in a crosswalk.
 - (3) No pedestrian shall cross an LRT track except on a sidewalk or crosswalk.
 - (4) Where an LRT crossing is controlled by gates, lights, bells, pedestrian lights, or any combination thereof, a person shall not cross the LRT track while the control devices are activated indicating the crossing is not permitted.
- 4M81 Transit Bylaw Section 11:
 - (11.1) No person shall
 - (a) enter inside of the corridor created by fences or barriers located on either side of any light rail transit racks or
 - (b) where there is no corridor created by fences or concrete barriers, sit, stand, play or walking within three (3) meters of any light rail transit tracks.

Between 2015 and 2018, an average total of 890 tickets per year have been issued under the two bylaws listed above.

Enforcement blitzes are a tool used by Calgary Transit Peace Officers to educate, warn and enforce safe at-grade crossings. A combination of police and peace officers are used during a blitz to monitor an at-grade crossing to ensure safe and proper crossings and engage with users. The number of blitzes and location are recommended by the LRT Crossing Committee and based on near miss data. For 2019, approximately ten locations have been identified for an enforcement blitz. A blitz typically occurs over multiple days during high ridership time periods, with warnings and tickets issued for non-compliance. A follow up blitz is scheduled a few weeks later at the same location to examine changes in behavior.

The findings from an enforcement blitz are communicated back to the LRT Crossing Committee for further consideration.

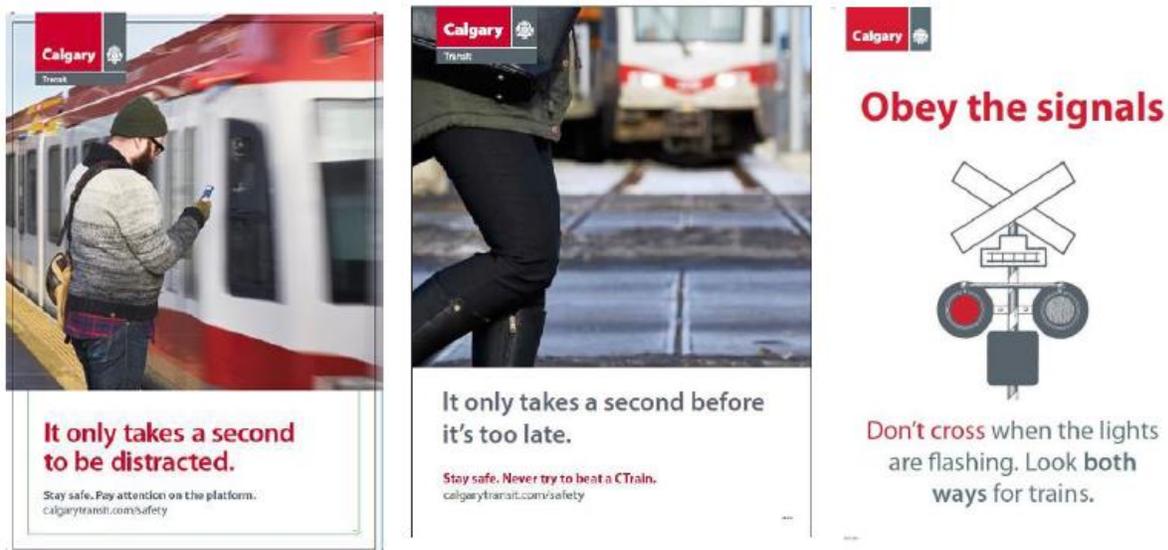
Education

External Programs

Calgary Transit continually implements prevention-oriented safety messages for transit customers to raise awareness and prevent incidents at at-grade crossings.

- Staff monitor LRT platform cameras for hazardous situations and make public safety announcements to address concerns or give general feedback.
- Calgary Transit's website (www.calgarytransit.com/ridersguide) and call centre provide information about LRT and bus safety.
- To raise awareness around distractions and crossings around the CTrain system, Calgary Transit implemented a safety campaign in 2015 called "It Only Takes a Second" and "Obey the Signals" (Figure 6)." Locations are targeted based on near miss data collected by the LRT Crossing Working Committee. The campaign is currently ongoing.
- Installing signage at key locations

Figure 6: 2018 At-grade crossing public campaign



Calgary Transit is currently refreshing the public safety campaign to ensure messaging resonates with current evolving issues. The update will be more comprehensive to include distracted walking, mental health and enforcement. It will apply the lessons learned from the previous campaigns and pedestrian behavior data to refresh its key messages, material and deployment strategy.

Calgary Transit has training programs to teach new transit users how to use the transit system including the CTrain system. The programs are designed for Grade 6+ school students, seniors and people with disabilities, although anyone is allowed to participate. The programs teach people how to use Calgary Transit services safely and independently. This includes how to cross at-grade LRT crossings and the measures in place for safety.

Internal Programs

All Calgary Transit staff involved with LRT operations are required to take LRT Rule Book Training and pass annual requalifying tests. The LRT Rulebook is Calgary Transit's guideline for operating rules and procedures for LRT which includes guidelines for operating at-grade crossings. Adherence to the rules and procedures are essential to operator and public safety.

In 2013, Calgary Transit's front-line staff for LRT operations participated in suicide awareness and prevention training. The training was a partnership between Calgary Transit and the Centre for Suicide Prevention, and included LRT Operators, LRT Operations Supervisors, Public Safety and Enforcement Peace Officers, Call Centre, LRT Track and Way, LRT Maintenance, LRT Training and Recruitment and Public Safety Dispatchers. In addition to employee support, Calgary Transit is currently reviewing its Critical Incident Support procedures to ensure resources are available for staff that have been exposed or involved in a serious incident while delivering transit service such as suicides, collisions resulting in death or serious injury or near misses.

Engagement

At-grade crossing safety has limited engagement opportunities due to the technical requirements for how crossing safety treatments are determined and implemented. Crossing safety must follow industry standards and Calgary Transit's LRT DGM. All crossings must also have a similar look and feel to ensure consistent transit customer behavior. Input into the process and the treatment type from other sources and stakeholders are considered through the LRT Crossing Committee but must adhere to industry standards and Calgary Transit's DGM for safety.

For this report, stakeholder engagement was limited to internal city stakeholders and City/CT advisory groups. The LRT Crossing Committee engages with the same stakeholders in their workplans to help implement and prioritize safety improvements.

Internal Stakeholder list

- Calgary Transit
- Green Line
- Transportation Infrastructure

- Transportation Planning
- Roads
- Calgary Police Services
- Calgary Neighbourhoods

City Advisory Groups

- Calgary Transit Customer Advisory Group
- Access Design Sub Committee of Advisory Committee on Accessibility

The various internal stakeholders were identified based on their involvement with at-grade crossings. The department representatives are involved with the planning, implementation, operating, evaluating, enforcement and/or education about at-grade LRT crossings.

The City Advisory Groups were identified based on the groups' representation. Calgary Transit's Customer Advisory Group provides insight and advice to improve the transit customer experience and Calgary Transit's relationship with customers. They will be providing feedback on public safety promotion material, transit rider training programs and the customer experience at at-grade LRT crossings.

The Access Design Sub Committee reviews and makes recommendations on issues that relate to accessibility for people with disabilities throughout the city. At-grade crossings and accessibility are a challenging issue that warrants further review outside of this report. Calgary Transit follows the City of Calgary's 2016 Access Design Standards however, the standards do not address in detail accessibility at at-grade LRT crossings. Some measures do target certain accessibility concerns such as bells for the vision impaired and flashing lights for the hearing impaired but further improvements can still be evaluated. The standards in the Access Design Stations that addresses at-grade crossings are:

- (275) A barrier-free path of travel (1,500mm) wide is required throughout the station site.
- (276) Rail crossings shall be smooth and level across the tracks and provide visual and auditory cues.
- (277) A cane detectable tactile warning strip shall be provided at entrance locations to the LRT pedestrian crossing. The tactile warning strip shall cover the width of the crossing entrance.

Prior to the establishment of the Access Design Standards, Calgary Transit, through the LRT Crossing Committee, have made improvements to address accessibility concerns such as implementing tactile warning strips at track crossings to warn people with a visual impairment that they are about to cross LRT Tracks and creating smooth and level crossings for wheelchair users. The Blue Line West opened in 2012 and has tactile warning strips at all at-grade crossings, and they are being implemented at other existing at-grade crossings during refurbishment programs (Figure 7). Accessibility concerns at at-grade crossings are multi-faceted and need to be fully understood before a solution can be proposed. Comprehensive research, evaluation and testing of evolving standards and practices needs to be conducted before major design changes can be applied to Calgary Transit's LRT system.

The scope of a more detailed accessibility and safety review is being explored by the LRT Crossing Committee as a follow up to this report to ensure that at-grade crossings and future crossings meet evolving accessibility standards, guidelines and best practices.

Figure 7: Tactile warning strip at Chinook Station



Appendix 1: At-Grade Crossing Safety Measures – Decision Matrix (July 2017)

This Chart for use in Semi-exclusive (Type b) LRT Right of Way

CROSSING CATEGORY (Sections 3.3.1 and 4.2.1) →		PEDESTRIAN CROSSING ADJACENT TO A ROAD CROSSING	PEDESTRIAN CROSSING ASSOCIATED WITH STATION ACCESS (AND NOT ADJACENT TO A ROAD)	PEDESTRIAN CROSSING ON ITS OWN
Minimum requirements		<ul style="list-style-type: none"> Standard signage Tactile warning strips Barriers with "Z" gates or swing gates* Flashing lights/bell Access width 1.8m Crossing surface width 2.8m 90 degree crossing† 	<ul style="list-style-type: none"> Standard signage Tactile warning strips Barriers with "Z" gates or swing gates* Flashing lights/bell Access width 1.8m Crossing surface width 2.8m 90 degree crossing† 	<ul style="list-style-type: none"> Standard signage Tactile warning strips Barriers with "Z" gates or swing gates* Flashing lights/bell Access width 1.8m Crossing surface width 2.8m 90 degree crossing†
Crosses more than one track - sufficient refuge area between tracks		<ul style="list-style-type: none"> Add designated refuge area with signage, tactile warning strips, barriers with "Z" gates or swing gates* between tracks 	<ul style="list-style-type: none"> Add designated refuge area with signage, tactile warning strips, barriers with "Z" gates or swing gates* between tracks 	<ul style="list-style-type: none"> Add designated refuge area with signage, tactile warning strips, barriers with "Z" gates or swing gates* between tracks
Crosses more than one track – insufficient refuge area between tracks		<ul style="list-style-type: none"> Add automatic gates unless roadway gates also cover pedestrian crossing 	<ul style="list-style-type: none"> Add automatic gates unless station platforms located such that all trains stop before occupying crossing 	<ul style="list-style-type: none"> Add automatic gates
Crossing includes freight railway track(s)		<ul style="list-style-type: none"> Add automatic gates unless roadway gates also cover pedestrian crossing 	<ul style="list-style-type: none"> Add automatic gates 	<ul style="list-style-type: none"> Add automatic gates
Crosses road in addition to track(s)	Limited or normal pedestrian activity#	<ul style="list-style-type: none"> Add median island(s) between road and track with tactile warning strips Add pavement (crosswalk) markings Add ped heds Add permanent barriers to prevent jay-walking 	<ul style="list-style-type: none"> Add median island(s) between road and track with tactile warning strips Add pavement (crosswalk) markings Add ped heds Add permanent barriers to prevent jay-walking 	<ul style="list-style-type: none"> Add median island(s) between road and track with tactile warning strips Add pavement (crosswalk) markings Add ped heds Add permanent barriers to prevent jay-walking
	High pedestrian activity	<ul style="list-style-type: none"> Increase size of median island(s) Increase width of pedestrian route 	<ul style="list-style-type: none"> Increase size of median island(s) Increase width of pedestrian route 	<ul style="list-style-type: none"> Increase size of median island(s) Increase width of pedestrian route
	Pedestrian surges	<ul style="list-style-type: none"> Increase size of median island(s) further Increase width of pedestrian route further 	<ul style="list-style-type: none"> Increase size of median island(s) further Increase width of pedestrian route further 	<ul style="list-style-type: none"> Increase size of median island(s) further Increase width of pedestrian route further
Does not cross road	Limited or normal pedestrian activity#	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A
	High pedestrian activity	<ul style="list-style-type: none"> Increase width of pedestrian route 	<ul style="list-style-type: none"> Increase width of pedestrian route 	<ul style="list-style-type: none"> Increase width of pedestrian route
	Pedestrian surges	<ul style="list-style-type: none"> Increase width of pedestrian route further 	<ul style="list-style-type: none"> Increase width of pedestrian route further 	<ul style="list-style-type: none"> Increase width of pedestrian route further
Severe sightline restrictions		<ul style="list-style-type: none"> Add automatic gates 	<ul style="list-style-type: none"> Add automatic gates 	<ul style="list-style-type: none"> Add automatic gates

Appendix 2: Inventory of at-grade crossing locations and safety measures

#	Line	Location	Crossing Type	Territory	Flashing lights (Wig-wags)	Bells	Second Train Light	Pedestrian			Road Automatic Gate Arms
								Bedsteads	Swing Gates	Automatic Gate Arms	
1	Red Line S	3 St SE	PED-X	LRT ROW	Yes	Yes			Yes		
2	Red Line S	Erlton Stampede Station	PED-X	LRT ROW	Yes	Yes		Yes			
3	Red Line S	25 Av SE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
4	Red Line S	36 Av SE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
5	Red Line S	39 Av SE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
6	Red Line S	50 Av SE	MIXED	CP ROW	Yes	Yes		Yes			Yes
7	Red Line S	58 Av SE	MIXED	CP ROW	Yes	Yes		Yes			Yes
8	Red Line S	61 Av SE	MIXED	CP ROW	Yes	Yes		Yes			Yes
9	Red Line S	Chinook Station	PED-X	LRT ROW	Yes	Yes				Yes	
10	Red Line S	Heritage Dr SE	MIXED	CP ROW	Yes	Yes		Yes			Yes
11	Red Line S	Heritage Station	PED-X	LRT ROW	Yes	Yes		Yes			
12	Red Line S	Southland Station	PED-X	LRT ROW	Yes	Yes		Yes			
13	Red Line S	Anderson Station	PED-X	CP ROW	Yes	Yes				Yes	
14	Red Line S	Anderson Station Wy SE	ROAD	CP ROW	Yes	Yes					Yes
15	Red Line S	Fish Creek Lacombe Station	PED-X	LRT ROW	Yes	Yes		Yes			
16	Red Line S	James McKeivitt Rd SW	ROAD	CP ROW	Yes	Yes					Yes
17	Red Line S	Shawnessy Station	PED-X	LRT ROW	Yes	Yes			Yes	Yes	
18	Red Line S	162 Av SW	MIXED	CP ROW	Yes	Yes		Yes			Yes
19	Red Line S	Somerset Station North	PED-X	CP ROW	Yes	Yes				Yes	
20	Red Line S	Somerset Station South - East	PED-X	CP ROW	Yes	Yes				Yes	
21	Red Line S	Somerset Station South - West	PED-X	LRT ROW	Yes	Yes				Yes	
22	Red Line S	Shawville Gate	MIXED	CP ROW	Yes	Yes		Yes			Yes
23	Blue Line NE	7 Av/4 St SE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
24	Blue Line NE	6 Av SE	MIXED	LRT ROW	Yes	Yes		Yes			Yes

25	Blue Line NE	Deerfoot Tr SE	ROAD	LRT ROW	Yes	Yes					Yes
26	Blue Line NE	28 St. SE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
27	Blue Line NE	4 Av NE	ROAD	LRT ROW	Yes	Yes					Yes
28	Blue Line NE	5 Av NE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
29	Blue Line NE	8 Av NE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
30	Blue Line NE	12 Av NE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
31	Blue Line NE	16 Av NE	ROAD	LRT ROW	Yes	Yes					Yes
32	Blue Line NE	16 Av NE	ROAD	LRT ROW	Yes	Yes					Yes
33	Blue Line NE	20 Av NE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
34	Blue Line NE	26 Av NE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
35	Blue Line NE	32 Av NE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
36	Blue Line NE	Whitehorn Station	PED-X	LRT ROW	Yes	Yes		Yes			
37	Blue Line NE	Whitehorn Drive	ROAD	LRT ROW	Yes	Yes					Yes
38	Blue Line NE	39 Av NE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
39	Blue Line NE	44 Av NE	MIXED	LRT ROW	Yes	Yes		Yes			Yes
40	Blue Line NE	McKnight Westwind Station	PED-X	LRT ROW	Yes	Yes			Yes		
41	Blue Line NE	Martindale Bv NE (south leg)	MIXED	LRT ROW	Yes	Yes			Yes		Yes
42	Blue Line NE	Martindale Bv NE (north leg)	MIXED	LRT ROW	Yes	Yes				Yes	Yes
43	Blue Line NE	Saddletowne Circle NE (south leg)	MIXED	LRT ROW	Yes	Yes			Yes		Yes
44	Blue Line NE	Saddletowne Station South	PED-X	LRT ROW	Yes	Yes			Yes		
45	Blue Line NE	Saddletowne Station North	PED-X	LRT ROW	Yes	Yes			Yes		
46	Blue Line NE	Saddletowne Circle NE (north leg)	MIXED	LRT ROW	Yes	Yes		Yes			Yes
47	Red Line NW	9 St at 7 Av SW	PED-X	In-Street Operations	Yes	Yes		Yes			
48	Red Line NW	9 St at 6 Av SW	MIXED	In-Street Operations	No	No		Yes			
49	Red Line NW	9 St at 5 Av SW	MIXED	In-Street Operations	Yes	Yes		Yes			Yes
50	Red Line NW	9 St at 4 Av SW	MIXED	In-Street Operations	Yes	Yes		Yes			
51	Red Line NW	2 Av NW	MIXED	LRT ROW	Yes	Yes		Yes			Yes
52	Red Line NW	Sunnyside Station South	PED-X	LRT ROW	Yes	Yes	Yes		Yes		

53	Red Line NW	Sunnyside Station North	PED-X	LRT ROW	Yes	Yes	Yes		Yes		
54	Red Line NW	4 Av NW	MIXED	LRT ROW	Yes	Yes		Yes			Yes
55	Red Line NW	SAIT Campus	PED-X	LRT ROW	Yes	Yes	Yes	Yes			
56	Red Line NW	SAIT/ACA/Jubilee Station	PED-X	LRT ROW	Yes	Yes			Yes		
57	Red Line NW	Jubilee Cr NW	MIXED	LRT ROW	Yes	Yes		Yes			Yes
58	Red Line NW	14 St NW (east leg)	MIXED	LRT ROW	Yes	Yes		Yes			Yes
59	Red Line NW	14 St NW (west leg)	MIXED	LRT ROW	Yes	Yes		Yes			Yes
60	Red Line NW	Lions Park Station East	PED-X	LRT ROW	Yes	Yes		Yes			
61	Red Line NW	Lions Park Station West	PED-X	LRT ROW	Yes	Yes			Yes		
62	Red Line NW	14 Av NW	MIXED	LRT ROW	Yes	Yes		Yes			Yes
63	Red Line NW	Banff Trail Station	PED-X	LRT ROW	Yes	Yes				Yes	
64	Blue Line W	11 St SW	MIXED	LRT ROW	Yes	Yes				Yes	Yes
65	Blue Line W	26 St SW	ROAD	LRT ROW	Yes	No					Yes
66	Blue Line W	Shaganappi Station	PED-X	LRT ROW	Yes	Yes				Yes	
67	Blue Line W	47 St SW	ROAD	LRT ROW	Yes	No					Yes
68	Blue Line W	45 St SW Station (47 St SW east)	PED-X	LRT ROW	Yes	Yes				Yes	
69	Blue Line W	47 ST SW (west)	PED-X	LRT ROW	Yes	Yes				Yes	
70	Blue Line W	Sarcee Tr SW	ROAD	LRT ROW	Yes	No					Yes
71	Blue Line W	Sarcee Tr Greenway (Pathway)	PED-X	LRT ROW	Yes	Yes				Yes	
72	Blue Line W	Sirocco Station (Costello Bv SW east)	PED-X	LRT ROW	Yes	Yes				Yes	
73	Blue Line W	Costello Bv SW	ROAD	LRT ROW	Yes	No					Yes
74	Blue Line W	Costello Bv SW (west)	PED-X	LRT ROW	Yes	Yes				Yes	
75	Blue Line W	Christie Park Ga SW (east)	PED-X	LRT ROW	Yes	Yes				Yes	
76	Blue Line W	Christie Park Ga SW	ROAD	LRT ROW	Yes	No					Yes
77	Blue Line W	Christie Park Ga SW (west)	PED-X	LRT ROW	Yes	Yes				Yes	
78	7 Avenue S	3 St SE	MIXED	In-Street Operations	Yes	Yes					
79	7 Avenue S	3 St SE	PED-X	In-Street Operations	Yes	Yes			Yes		
80	7 Avenue S	Macleod Tr SE	MIXED	In-Street Operations	No	No					
81	7 Avenue S	1 St SE	MIXED	In-Street Operations	No	No					

82	7 Avenue S	Centre St S	MIXED	In-Street Operations	No	No					
83	7 Avenue S	1 St SW	MIXED	In-Street Operations	No	No					
84	7 Avenue S	2 St SW	MIXED	In-Street Operations	No	No					
85	7 Avenue S	3 St SW	MIXED	In-Street Operations	No	No					
86	7 Avenue S	4 St SW	MIXED	In-Street Operations	No	No					
87	7 Avenue S	5 St SW	MIXED	In-Street Operations	No	No					
88	7 Avenue S	6 St SW	MIXED	In-Street Operations	No	No					
89	7 Avenue S	7 St SW	MIXED	In-Street Operations	No	No					
90	7 Avenue S	8 St SW	MIXED	In-Street Operations	No	No					
91	7 Avenue S	9 St SW	MIXED	In-Street Operations	No	No					
92	7 Avenue S	10 St SW	MIXED	In-Street Operations	No	No					