Region of Waterloo
Stage 1 Light Rail Transit Project

Design and Construction Performance Output Specifications
Article 14
LRT Stops and Stop Equipment

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ARTICLE 14 LRT STOPS AND STOP EQUIPMENT

14.1 Regional Transportation Master Plan Background Information

(a) The Waterloo Rapid Transit Project is being planned, designed and implemented to meet the following goals and objectives, which were developed and adopted as part of the Regional Transportation Master Plan (RTMP) *"Moving Forward 2031":*

(i) Enhance the Region's character and Place-Making: Enhance the character of Cambridge, Kitchener and Waterloo, integrating a strong sense of identity into the Rapid Transit (RT) corridor and stops that will attract residents, businesses and visitors alike;

(ii) Support new development that is compact and transit-supportive: support communities that contain a full range of development densities and land uses, including those that are compact, mixed-use and pedestrian friendly;

(iii) Be compatible with adjacent communities and neighbourhoods: transform some communities and neighbourhoods, while protecting the stability of others and recognizing the need to enhance connectivity;

(iv) Integrate Sustainable Design: enhance the RT system with infrastructure, designs, materials and technologies that encourage sustainability;

(v) Serve as an investment in the Region's future: ensure the Region's economic competitiveness by investing in more sustainable modes of transportation, centred around an efficient RT system;

(vi) Preserve and enhance natural and physical environments: minimize impacts to the natural environment to the greatest extent possible and protect outlying areas from urban encroachment by developing a RT system;

(vii) Increase transit accessibility and mobility: ensure that all residents – including those with low incomes, physical challenges, the elderly and others who cannot or do not own a vehicle – are provided safe, affordable and accessible RT service;

(viii) Provide convenient and accessible Rapid Transit (RT) Stops: develop transit stops as the hub of activity along the corridor, incorporating safety, comfort, aesthetics and convenience for system users;

(ix) Provide safe and efficient infrastructure: construct innovative, but proven, infrastructure to facilitate safe and efficient movement of RT; and,

(x) Collaborate with the community to manage project issues: proactively work with the community to minimize negative effects on residents and businesses during construction and operations.

14.2 Design Guidelines

(a) This Section presents the guidelines and criteria that are needed by Project Co to carry out the preliminary and final design of the many components and elements of Light Rail Transit (LRT) Stops. The LRT Stops will be at-grade LRT vehicle loading/unloading areas composed of *open air shelters at street level* and platforms.

(b) LRT stops are an integral part of the LRT system. As such, they must facilitate the barrier-free movement of passengers within the LRT realm in the most convenient and cost-effective manner.

(c) Provide a comfortable ambient environment, adequate lighting, personal comfort, aesthetic quality, supplementary services, weather protection, and security. As the time spent by patrons in aggregate is substantial, the environment for patrons waiting for a LRT train must not only be safe and secure, but should also be enjoyable, comfortable and informative.

(d) Minimize crowding, travel impedance, conflicts, disorientation, level changes, and physical barriers. Maximize safety, reliability, efficiencies of fare collection, and the ability to accommodate emergencies.

(e) LRT Stops and access to stops, intermodal and exchange facilities in the scope of work shall incorporate the safety principles of Crime Prevention through Environmental Design (CPTED).

(f) The Project will be urban or suburban in nature, constructed at-grade beside or within the medians of arterial roadways and adjacent to established residential, commercial and institutional communities. Stops will be neighbourhood friendly with special attention placed on their careful integration into adjacent communities.

(g) For the details of the Stop electrical, mechanical and communication components the Consultant should refer to the appropriate Sections in the RFP. Design guidelines, criteria and standards for specific components such as signage and graphics are indicated in Signage and Graphics section.

(h) All disciplines are required to closely coordinate their design activities with each other to ensure that the many different LRT Stop elements are properly interfaced.

(i) The general configuration of the stations should be standardized wherever possible. However, to help establish a neighborhood identity for each LRT Stop or block of LRT Stops, a certain level of design freedom is allowed on the following LRT Stop elements: canopies, guardrails, floor finishes, public artwork, LRT Stop areas, plaza areas and other related items. Signage and maps shall be consistent, system-wide. Any deviation from standardization should be avoided except when approved by the AHJ or its representative. Refer to Section 14-10 for a specific requirements for stop locations.

(j) Allow for future operating changes with minimal reconstruction. The design should be flexible to suit a wide variation in site conditions and to provide for future LRT extensions as well as additions/connections to accommodate future redevelopment of adjacent lands and structures. The design life of LRT Stops is expected to be 30 years.

14.3 Design Requirements

(a) Platforms: Platform is that portion of the LRT Stop directly adjacent to the tracks where trains stop to load and unload passengers. There are two basic types of platform configuration:

(i) Centre Platform located between each set of tracks, and,

(ii) Side Platform loading with the platforms located either on the outside of each set of tracks or one platform located on the outside of one set of tracks.

(b) Architecture

(i) The architectural concept of LRT Stops shall reflect the attributes of simplicity, economy, functionality, aesthetics, marketability, serviceability and safety as well as blend in with the local styles of the adjacent community.

(ii) Create a civic architecture that is permanent, has a characteristic thread and contributes to its context – one that is not entirely derivative of the transit system, but of the neighborhoods and community of which it is a part.

(iii) Provide patron seating at shelters and other protected locations on the platform and protect transit passengers from adverse weather conditions (rain, wind and sun) and vehicular traffic.

(iv) Make transit safe, secure, friendly, fun and accessible to all, including users with disabilities.

(v) Develop systems that use durable, low maintenance materials and minimize life cycle costs.

(vi) Provide patron seating at shelters and other protected locations on the platform

(vii) Refer to drawings in Appendixes L.1-L.4 for Functional Plans, Directive and Descriptive Drawings and Conceptual Design of the LRT Stops. Refer also to the design of aBRT Stops included in Appendix L.4 to ensure that the aBRT and LRT read as one system. The Stop Public Information Centre presentation boards are also available at: http://rapidtransit.regionofwaterloo.ca/en/multimedialibrary/resources/E-13-061__PUBLIC_CONSULTATION_CENTRES_FOR_ION_STOP_DESIGN_CONCEPTS.pdf. These boards provide the most recent concepts of the LRT and aBRT Stops and are supplementary to Appendix L.3 and L.4.

(c) Interchange Function

(i) Provide a safe, efficient, barrier free accessible and convenient LRT Stop configuration that facilitates the movement of passengers within the LRT Stop and from one transit mode to another.

(ii) Provide clear and easily understood transit related information that can be referenced quickly in order to minimize disorientation.

(iii) Provide transit related information signage not only within the platforms realm but also in the vicinity of LRT Stops.

(d) Accessibility

(i) The application of design guidelines and criteria, standards and practices must accommodate the needs of persons with physical, sensory, and mental disabilities.

(ii) LRT Stops, and their approaches, must facilitate the barrier-free movement of passengers to and from the LRV and other transportation modes in the most convenient and cost effective manner possible.

(iii) Project Co should be proactive in the application of barrier-free standards to address the accessibility concerns of persons with physical, sensory and mental disabilities and not wait for changes to the Building Codes.

(iv) LRT Stops are to comply with all aspects of accessibility requirements for the disabled, including:

A. Provision of ramps or sloped walkways as required;

B. Provision of adequately sized openings in areas such as platform shelters for wheelchair access and egress;

C. Provision of handrails as required, of proper design, diameter and height requirements;

D. Provision of features necessary for use by the sight and hearing impaired.

(e) Fare Payment

(i) Platforms to be a fare paid zone. Proof of payment is required prior to entering the LRT Trains.

(f) Passenger Safety and Security

(i) The design of all LRT Stop-related public areas (platforms, entrances and passageways, sidewalks, parking areas) will be subject to CPTED review by the City. Preferably, the designer is to provide evidence of having completed a CPTED course and to certify that all CPTED principles are incorporated in the design.

(ii) Refer to Section 14.12 Security Considerations for the design guidelines related to LRT passenger safety and security.

(g) Community Relationship

(i) Protect, maintain and enhance existing neighbourhood and community qualities that are valued.

(ii) Promote development that conforms to local plans.

(iii) Initiate and coordinate programs with the community that limit local traffic impacts and minimize disruption during and after the implementation phase.

(iv) Utilize local jurisdictional processes and agencies throughout project design and implementation.

(v) The facilities must be able to serve the needs of patrons efficiently, economically, safely, conveniently, and comfortably. These LRT Stops shall also provide for the traditional requirements of public transit systems: identity in neighborhoods or downtown areas as a location for public transit, shelter from severe weather, and cover and/or screening from average weather conditions.

(vi) In designing the facilities, the anticipated growth and long-term life of the system shall be considered. Function and life cycle consideration are important, as are aesthetics and the overall quality and character of the facilities. LRT Stop design shall be compatible in design with the immediate vicinity and reflective of the Region of Waterloo context.

(vii) Standard graphic information systems are especially important. Consistency reduces inventories for replacement parts and equipment for maintenance and costs.

(viii) In all segments, it is essential that great care be taken in developing the final design with the Region, the affected communities and neighborhoods, adjacent property owners or developers, public agencies, or community groups having jurisdiction over, or significant interest in, the human environment and design of facilities at LRT Stops and along routes. Respect of and integration and cohesion with the development plans and master plans of local communities and neighborhoods is essential to blending the transit system into the

urban fabric and regional context of Waterloo, and in assuring Region and community needs are met.

(ix) Platform furnishings shall not have containment space which provides concealment.

(x) Project Co shall design and construct temporary barriers, fencing, signage and other temporary works intended to protect and guide the public during construction to also be used as an opportunity for communications and local business support. Graphic materials to be provided by the Region.

14.4 Regulations, Codes and Standards and Guidelines

(a) Code Compliance

(i) LRT Stops are *open air shelters at street level* (as defined in the OBC Section 3.13.1.2. DEFINITIONS) and do not fall under the definition of 3.13 *rapid transit stations* in Section 3.13 of the Ontario Building Code. LRT Stops shall conform to the requirements of the codes (including ordinances and Zoning By-Laws), regulations (including general rules and safety orders), and standards listed herein.

(ii) Where the requirements stipulated in this document or any referenced source conflict, the more restrictive requirement shall govern.

(iii) Project Co shall meet the Fire and Life Safety Objectives defined by the Ontario Building Code (OBC) 2006 Edition, Part 2, OBJECTIVES and provide Acceptable Solutions as defined by the OBC.

(iv) The LRT Stops has two types of platforms: centre platforms that are confined by tracks on both sides and side platforms that are confined on one side by the tracks and that, on the other side, may or may not be confined by private property or a vehicular lane.

(b) Development Permit

(i) Development Permit requirements are to be confirmed by Project Co.

(ii) Unless stated otherwise, LRT Stops and their related ancillary facilities must be designed to meet all requirements of all applicable Federal, Provincial, and Municipal codes and regulations.

(iii) Applicable codes and standards include the most recent (as of date of issuance of RFP) edition of the following documents:

(c) The primary applicable Codes and Standards are:

(i) Ontario Building Code (OBC)

(ii) National Building Code (NBC)

(iii) National Energy Code (NEC)

(iv) Applicable Plumbing Code

(v) Applicable Mechanical Code

(vi) Applicable Electrical Code

(vii) Applicable Fire Code

(viii) Note: Code Variances:

A. While LRT Stops fall under the definition of buildings in the Ontario Building Code, some of their operational characteristics do not coincide with normal building functions. Where no provisions are made in the Codes for particular features of design, or where Code provisions are not applicable, Project Co is required to propose an Acceptable Solution and submit a Code Variance to the AHJ for approval.

B. There may be instances where the Project Co is of the opinion that a Code requirement should be relaxed or a variance is justified. If this occurs, the Registered Professional should identify any conflicts between applicable Codes and raise the issue to the AHJ for resolution or propose an Acceptable Solution and submit a Code Variance to the AHJ for approval.

C. If AHJ is not regulated, the Fire Life Safety Consultant shall the AHJ.

(ix) NFPA 14 - Standard for the Installation of Standpipe, Private Hydrants, and Hose Systems

(x) NFPA 101 - Safety from Fire in Buildings and Structures

(xi) NFPA 130, Fixed Guideway Transit and Passenger Rail Systems

(xii) NFPA, Life and Safety Code

(xiii) Quality Standards for Architectural Woodwork (AWMAC)

(xiv) Applicable Accessibility Standards

(xv) ANSI A 117.1

(xvi) Occupational Safety and Health Standards (OSHA) (29FR Part 1910)

(xvii) Canadian Painting Contractors Specification Manual

(xviii) Applicable CSA and ASTM standards

(d) Reference Guidelines

(i) Accessibility and Design Guidelines for the Visually Impaired

(ii) Accessibility for Ontarians with Disabilities Act, 2005 (AODA)

(iii) CPTED - Crime Prevention Through Environmental Design

(iv) Area Municipal Urban Design Manuals and Guidelines

(v) The Region of Waterloo Central Transit Corridor Community Building Strategy

14.5 Reference Drawings

(a) Appendix L.1 Site Plan and Scope Split

(b) Appendix L.2 LRT Stops Specific Functional Plans

(c) Appendix L.3 Conceptual LRT Stop Design Drawings

(d) Appendix L.4 Conceptual aBRT Stop Design Drawings

14.6 General LRT Stop Requirements

(a) Weather Protection

(i) Generally, there shall be canopies over portions of each platform including the ticket vending area. The canopies shall be supported by columns:

A. Centered on the platform width for central platforms

B. Positioned along the outside edge of the side platform (side opposite to loading & unloading side)

C. They shall be designed to allow snow and ice to melt without dropping on the patrons. The canopies will be of uniform design and size and shall allow for ease of expansion. The canopies shall be composed of durable components, economical to repair or replace.

(b) Passenger Shelters

(i) Passenger shelters should be designed to achieve the following objectives:

A. Provide passengers with comfort and protection from adverse weather conditions, rain, wind and sun.

B. Provide identity for the LRT Stop as well as the surrounding area.

C. Provide a feeling of security and means of surveillance.

D. Provide adequate lighting.

E. Provide protection for the fare equipment.

F. Utilize materials and construction practices that minimize maintenance requirements.

G. Utilize materials and construction practices that minimize life cycle costs.

H. Standardize materials and construction practices.

(c) Windscreens

(i) Where passenger shelters include windscreens, they shall be designed to achieve the following objectives:

A. Provide patrons with comfort as protection from adverse weather conditions, rain and wind.

B. Provide a feeling of security and means of surveillance.

C. Use materials compatible with minimizing maintenance and life cycle costs.

D. Standardize materials and construction practices.

(d) Patron Amenities

(i) Seating - benches capable of seating 3-4 persons each shall be provided at minimum 3 or more location on the platform (depending on the ridership data for each stop). One bench shall be located near each public entry point to the platform. Benches should be arranged so that they do not interfere with patron circulation or emergency exiting. Seating shall not encroach on queuing and exit way paths.

(ii) Benches and/or seating units shall be of designs that will prevent individuals from lying down, sleeping or sitting on top of the back rest. Seating design shall comply with Accessibility Guidelines and some portion of the platform seating should be designed with backs and full-length armrests to facilitate use by persons with disabilities.

(iii) Bicycle Racks - space for bicycle racks may be provided at LRT Stops, outside of platform areas.

(iv) Trash Receptacles - shall be provided at all LRT Stops by Project Co and integrated into the overall design. The trash receptacles should be designed to provide compartments for non- recyclable garbage as well as recyclables..

(v) Communications – See Section 14.8 (b) for a description of the communications system.

(vi) 120VAC receptacles will be provided for use by vendors & maintenance within the platform areas. Receptacles to be incorporated into the canopy support columns or other stop furnishing/elements and be spaced maximally at 10m apart.

(e) Signage

(i) The basic objectives of the system signage is to guide persons to and through the system in the most efficient, safe, and user friendly manner using simple, strong, and precise style, organized in systematic and sensible layouts. Sign communication shall be further enhanced by proper placement of signs and careful determination of sign dimensions and quantities.

(ii) Signs shall be standard throughout the LRT system. Each LRT Stop shall have a system map and system schedule displayed in a map case. Project Co shall consider implementing advanced electronic technologies such as interactive LED information display panels. The map case shall be of sufficient size to accommodate power and communications conduit coming into the case through the base or legs. If the LRT Stop features kiosks or other display systems they should also be of sufficient size to accommodate power and electrical conduit entering through the base or legs.

(iii) All signage shall conform to Accessibility Guidelines.

(f) Advertising

(i) The LRT Stop shelter and other elements may need to accommodate advertising. The application may vary by neighbourhood and local by-laws. Advertising displays shall conform to a system-wide standard of frames and finishes subject to local jurisdictions.

(g) Maintenance Space and Procedures

(i) All LRT Stop maintenance will be performed by Project Co. Major pieces of maintenance and repair equipment will be moved to the LRT Stop from a central facility where equipment, supplies, and materials are stored.

(i) Public Art

(i) Public Art may be incorporated into the LRT Stops. This could include landscape features, glass panels or additions to the shelter wall. Project Co. will be directed by the Region on all issues surrounding Public Art and the municipal or stakeholder engagement it may require.

(ii) Standard flush hose bibs shall be provided to allow for full coverage of the platform including shelters. Heat trace and insulate piping to ensure year-round functionality.

14.7 Site Access & Egress

(a) Pedestrian

(i) Good pedestrian circulation to, from, and across platforms is essential for the smooth and safe operation of LRT stops. Circulation patterns should be as simple, obvious, and comfortable as possible. Some of the points that warrant careful review for applicability and consideration in achieving good pedestrian orientation and circulation follow:

A. Avoid unnecessary turns and dead ends.

B. Pedestrian access and circulation shall provide direct, convenient, safe and delineated approaches to/from platforms and bus loading areas

C. Avoid cross-circulation at fare collection and decision points. Generally provide right-hand circulation as people naturally tend to keep to the right.

D. Provide well lit pedestrian walkways.

E. Provide adequate assembly space on platforms.

F. Provide a minimum 1500mm clear space between the edge of the platform and obstructions such as stairs, railings, columns, equipment and furniture.

G. Provide adequate space for passenger queues at fare collection areas that do not block through passenger traffic, interfere with equipment maintenance functions or overflow onto roadways.

H. Locate passageways, shelters, stairways, etc., to encourage balanced train loading and unloading. Passengers tend to board at such connection points on the platform.

I. Grade changes are to be minimized and, where necessary, shall conform to slope criteria for disabled access. Provide sloped walkways and ramps as required

J. Surge and queuing spaces shall be provided ahead of every barrier and change in circulation, direction or mode.

K. Provide adequate sight distance and visibility along pedestrian routes.

L. Discourage pedestrian crossing of LRT tracks.

M. Entranceways must be laid out to avoid queuing.

N. Passenger circulation routes should be direct. Disorientating dead-ends and unnecessary turns, blind corners, unnecessary barriers, bottlenecks and areas of congestion should be avoided.

(ii) There are three distinct user groups that must be considered in the design of the pedestrian circulation patterns:

A. Regular patrons move quickly with a minimum of guidance.

B. Infrequent users move easily but with heavy reliance on signage for guidance.

C. Persons with disabilities move more slowly with guidance required depending on the frequency of use and degree of disability.

(b) Barrier Free Requirements

(i) For most barrier-free provisions applicable to stops Project Co should refer to the Accessibility for Ontarians with Disabilities Act, 2005 (AODA), the Ontario Building Code (3.8 Barrier-Free Design) and 16.5.8, Access & Egress. Project Co must provide additional requirements such as:

A. Well lit, barrier-free walks and pathways

B. At least one barrier-free entrance at every stop

C. Consistent LRT Stop layout to permit patron familiarity

D. Ramps in accordance with Code Accessibility requirements

(ii) In addition to the foregoing, the following features will be provided on the platform:

A. On demand audio train arrival announcements

B. Designated wheel chair stalls are required in platform shelters

C. Accessible platform / shelter seating

(c) Bicycle Racks

(i) Bicycle racks shall be provided, as directed by the Region. Racks shall conform to the requirements listed below:

A. Located so as to be readily visible

B. Located to cause minimum interference with other LRT Stop activities

C. Provide a secure stanchion that allows bicycles to be locked

(ii) Wherever possible, bicycle racks shall be installed parallel to the track and between it and any directly adjacent area of pedestrian access in order to encourage patrons to walk to either side of the bicycle racks to reach the designated track crossings at the platform ends.

(d) Bicycle Access

(i) Those passengers arriving by bicycle shall be accommodated in a safe, comfortable and convenient manner. See Bicycle Parking Guidelines for the amount of bicycle parking and design considerations.

(e) Horizontal Circulation

(i) Minimum passageway width between handrails is 1169 mm.

(ii) The maximum means of egress capacity of platforms, sloped walkways and ramps shall be computed at 0.0819 p/mm-min. (persons per millimeter per minute).

(iii) The maximum means of egress travel speed along platforms, sloped walkways and ramps shall be computed at 38 m/min. (meters per minute).

(f) Vertical Circulation

(i) Vertical circulation requirements vary based on LRT Stop type, access requirements and grades established as part of the overall site plan. Access to LRT Stops and ancillary facilities is required to be barrier-free through the use of both ramps and sloped walkways and stairs.

(ii) The location of ramps, sloped walkways (with slopes up to 5%) and stair entrances are a function of surface street geometry, land use requirements, ownership, access traffic needs and LRT Stop external and internal integration requirements.

(iii) All vertical circulation elements shall be designed in accordance with Accessibility requirements. Ramps shall be provided for any rider needing or wishing to use them at all changes of grade. Grades within the LRT Stop and pedestrian area of the park-and-ride lot should not exceed 5%. Ideal grades for the facility are 1.5 to 3%.

(iv) While constructed maximum grade requirements are established within the Accessibility guidelines, design grades shall be reduced to allow for construction tolerances.

(v) All stairs are required to meet minimum Code requirements for accessibility:

A. Tread depth shall be 280mm to 305mm. The sum of tread depth and riser height shall be 430mm to 457mm. Treads shall have rounded nosings and must be slip resistant utilizing finishes that provide the same degree of friction as a medium broom finish. Where elevation change is less than 330mm, a sloped walkway (with slope up to 5%) should be used.

B. Treads shall have a slip resistant strip of contrasting color 50mm wide, parallel to and not more than 25mm from the nose of each step. Proposed products used to meet this requirement shall be approved by the Region.

C. Minimum width between handrails shall be 1372 mm. Maximum width without an intermediate handrail is 2235 mm.

D. Maximum height between landings should be 3658 mm. Minimum landing depth shall be at least equal to effective stair width.

E. Continuous handrails shall be provided on each side, 920 mm high, measured vertically from tread nose and extending at that height 300 mm beyond the riser at the top of the stair and one tread length plus 300 mm at the bottom of the stair. Handrails may extend up to 100 mm into required stair width and should be 38 mm in diameter.

F. Capacity and travel speeds for stairs shall be computed as follows:

1. Capacity: 0.0555p/mm-min.

2. Travel speed: 15m/min.

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G. Open risers are not permitted.

H. A 100 mm wide sweep or cleaning trough on both sides of interior stairways is considered to be a desirable feature for ease of cleaning.

I. The design of exterior stairway landing levels should include a grated drainable catchment basin to trap grit, water and snow.

(vi) Railings and guardrails should be 316 grade stainless steel.

A. Handrails shall be 38 mm in diameter.

B. Vertical railing supports are to be welded flush to preinstalled embedded anchor plates.

(vii) Whenever not possible to provide a sloped walkway with gradient up to 1:20, ramps shall be provided to the platforms as required for topographic changes. Ramps: Any part of an accessible route with a slope greater than 1 in 20 (5%) shall be considered a ramp and shall comply with minimum Code requirements for accessibility.

A. The least possible slope shall be used for any ramp. The maximum slope shall be 1 in 14. The maximum rise for any run shall be 610mm.

B. To allow for construction tolerances, the maximum gradient design is 7%.

C. To allow for construction tolerances, the maximum cross slope shall not exceed 1.5%.

D. Minimum clear width of a ramp between handrails is 1524mm.

E. Ramps shall have level landings, 1524mm long for rest and safety at no more than 9144mm intervals and whenever turns are unavoidable. A 1524mm x 1524mm landing is desirable at the top of a ramp with 1829mm of straight clearance at the bottom.

F. Handrails shall be provided on both sides and shall be continuous.

G. Capacity and travel speeds for stairs shall be computed as follows:

1. Capacity: 0.0819p/mm-min.

2. Travel speed: 38m/min.

H. Ramp access is required at end of platform for public access.

14.8 Platforms & Shelters Design Requirements

(a) Design Objectives

(i) Design objectives are identified as a means to achieve the basic goals of LRT Stop design and site planning as follows:

A. Arrange platform zones such that they provide safety and convenience for patrons and employees.

B. Use materials and construction practices that minimize maintenance requirements.

C. Use materials and construction practices that minimize life cycle costs.

D. Standardize materials and construction practices.

(ii) This section presents the guidelines for the main structural components of a LRT Stop, which is comprised of the platform, its roof, passenger shelters and the various ancillary spaces that are required to provide a functional LRT Stop.

(iii) The platform is the key main component of a LRT Stop. Restrictions to the location of platforms are governed by the LRT Stop location.

(iv) Platforms can contain a variety of elements such as passenger shelters, fare collection area and equipment, information signage and graphics, patron amenities etc.

(b) The following Communications and other system equipment shall be provided for each LRT Stop platform:

(i) One Passenger Assistance Intercom, placed under a canopy or in the shelter, with two clearly marked buttons, Emergency and Customer Service, to be connected to an Intercom Management System located at the OMSF.

(ii) Closed Circuit Television Cameras (CCTV): one CCTV to be dedicated to the TVM area, and one dedicated to the Passenger Assistance Intercom area to record actions of the call once the intercom is activated. Additional CCTV cameras to provide visual coverage of the entire platform.

(iii) At least one centrally located Variable Message Signs (VMS) per platform used to display next train information and any other special messages issued by Central Control. Provisions for adding a second VMS to be made.

(iv) One Public Address (PA) system, allowing announcements to be made from the platform, via microphone, or to be made from the Control Centre. The speakers for the PA system can be integrated into the VMS display or be separate and strategically placed at the platform.

(v) At least two Ticket Vending Machine (TVM) for each LRT Stop (Two TVMs for a shared centre platform, and one TVM for each side platform).

(vi) At least two Platform Fare Transaction Processors (PFTP) per platform located at the platform entrances.

(c) Platform Configuration

(i) Refer to Alignment Drawings for locations and platform type. Platform is that portion of the LRT Stop directly adjacent to the tracks where trains stop to load and unload passengers. There are two basic types of platform configuration:

A. centre platform with the platform located between each set of tracks, and

B. side platform, with the platforms located on the outside of each set of tracks

(ii) The platform size (excluding sloped walkways, ramps and stairs) is as follows:

A. Centre Platform: 4.5 metre wide x 65 metre long

B. Side Platform: 3.5 metre wide x 65 metre long.

C. Refer to LRT Stop Specific Functional Plans – Appendix L.2 for a non-standards platform size.

(iii) Platforms will be low-level centre platform type. All platforms shall be designed to conform with AODA including detectable warning strips on platform edges. Disabled persons will be able to board the LRV at indicated locations. Boarding locations to be indicated by a contrasting colour platform finish.

(iv) The nominal horizontal gap between the platform edge and the edge of vehicle floor shall be 50 mm. The platform edge is located 1400 mm from track centre-line, with a tolerance of + 12.7mm and - 0.0mm.

(v) The platform height at the edge of platform face shall be 329mm above the top-of-rail profile.

(vi) The platform edge shall provide a 600mm detectable warning paver assembly, using approved truncated dome pavers, running the length of the platform edge.

(vii) Avoid steep platforms. Cross slopes shall not exceed 1.5% with a minimum of 1% and the maximum longitudinal slope shall be less than 5%.

(viii) Provide clear emergency exiting from platforms.

(ix) Concentrate fixed objects such as furniture, signage, shelters etc. within a furniture zone while maintaining adequate distance between elements for circulation. Keep as much of the platform clear of fixed elements as possible.

(x) When appropriate, use furnishings to protect patrons by placing elements between patron areas and transit or non-transit roadways.

(xi) Exits shall provide safe exiting from trains and platforms under normal operational and emergency conditions. Platforms and exits shall allow passengers to completely clear the platform prior to the arrival of the next train.

(xii) If secondary access or exit points are provided, they should be clearly visible, inviting and safe.

(xiii) Barriers should be designed to discourage, not prevent, patrons from crossing the tracks and should not trap anyone between the barrier, LRV or vehicular traffic.

(xiv) Clear and unobstructed pedestrian access across platforms should be provided wherever modal interchange occurs.

(d) Side Platforms

(i) Side platforms with direct access at grade should function as an extension of the sidewalk zones, reinforcing the existing pattern of circulation and activity and the urban design framework.

(ii) Side platforms should include raising the adjacent sidewalks to allow an approach to the platform without stairs or ramps.

(iii) Side platforms located in the roadway shall have a glass screen running along the vehicular lane side of the platform to provide protection from slush and water and provide a physical barrier between platform patrons and moving vehicles.

(e) Central Platforms

(i) Central platforms to have access off the pedestrian cross walks as indicated in Appendix L.2. Refer to Appendix L.1 and L.2 for exceptions.

(f) Platform Width

(i) A tactile warning zone 600mm wide is to be provided at the platform edge.

(ii) A minimum 1500mm of clear space should be provided between the edge of the platform and obstructions such as equipment, railings and structural columns.

(iii) For centre loading configuration shelters, equipment and amenities are to be placed in the centre portion of the platform.

(iv) For side loading configurations shelters, equipment and amenities are to be placed adjacent to the back wall.

(v) There shall be a minimum of two travel lanes along the entire length of the platform between the platform edge and a wall, balustrade, railing, or other vertical elements.

(g) Clearances from Platform

(i) Horizontal

A. The clearance distance from centre-line of track to the finished edge of platform is 1400 +/- 5 mm.

(ii) Vertical Clearances above Platform Surface

A. Any LRT Stop element that could be targeted for theft or vandalism (e.g., light fixtures, speakers, cameras, etc.) shall be located a minimum of 2200mm above traveled pathways. The potential to use benches, trash receptacles, etc., to access these elements should also be considered in locating these elements. In addition, horizontal elements (e.g., canopy framework, sign units, etc.) that could lend themselves to climbing shall also be located 2400 mm above the platform floor.

(iii) Vertical elements should be designed to deter climbing.

(iv) Cantilevered vertical elements shall provide clearance for service and snow clearing vehicles.

(h) Catenary Clearance

(i) The minimum vertical clearance distance is governed by the overhead catenary clearance requirements.

(ii) Platform canopies and roofs must not extend over the tracks

(iii) Platform canopies, roofs, and any fixed obstruction must be designed with an offset of 1.75 m measured from the center line of track which includes a running clearance of 150 mm from the dynamic envelope of the LRT vehicle.

(iv) An allowance for construction tolerances for the Platform canopies, roofs, and any fixed obstruction or platform elements needs to be added to the 1.75 m distance from the centreline of track.

(i) Platform Surface and Edge Treatment

(i) The surface of all platforms shall be non-skid and of durable, weather resistant materials. The tactile tile near the platform edge shall be yellow, high-strength concrete tiles or

suitable materials. This strip shall meet Accessibility requirements, currently 600mm wide from the car clearance envelope. The warning strip shall not impede the passage of a wheelchair but shall be sufficiently rough or different to be felt by sight-impaired patrons.

(j) Platform Drainage

(i) The platform finish surface should be:

A. Crowned at the centre on central platforms, sloping at a minimum of 1.0% grade to the outer edges allowing water to run off onto the track-way.

B. For side platforms sloping at a minimum of 1.0% grade to the outer edges allowing water to run off onto the track-way.

(k) Rail Vehicle Clearance and Description

(i) Confirm and coordinate Light Rail Vehicle clearances and dimensions with selected ION LRV.

(l) Pedestrian Patterns

(i) The criteria listed in this section are minimum guidelines relevant to pedestrian circulation and they should not supplant the logic of a better functional solution, should it develop.

(ii) Three distinct groups must be considered in the design of pedestrian circulation:

A. Regular users move quickly with a minimum of guidance

B. Infrequent users move easily with great reliance on signs for guidance

C. Disabled users move slowly with the guidance required depending on the frequency of use and the degree of the disability

(iii) The following general principles shall be employed to accommodate these varying demands:

A. LRT Stops should be designed to directly and safely accommodate anticipated pedestrian movements. The direction of circulation elements shall be as obvious as possible to aid recognition.

B. Queuing space is desirable ahead of every barrier, and in front of ticket vending machine (TVM) installations.

C. No obstructions shall be permitted within the main pedestrian flow. This area shall be defined as an approximate 1500 mm clear strip along the track side of the platform (measured from the platform's edge).

D. Shelter areas shall have sufficient transparency to give adequate visual surveillance of these spaces for user safety and to discourage vandalism.

E. Pedestrian access from bus must be clear and as simple as possible with no visible barriers.

(iv) Special attention must be given to the overall platform finishes to minimize the risk of injury to the public and to avoid excessive maintenance. To meet this stipulation the following features are required:

A. The finished floor must be specified to have a non-slip surface.

B. Floor colour and texture must be different from the flooring in the areas approaching the platform.

C. A tactile warning strip providing a minimum width of 600mm and comprised of truncated dome detectable warning surface is to be placed along the trackside edge of the platform.

D. For additional visibility at the platform edge lighting fixtures should be installed at the underside of the roof structure casting continuous lighting on the platform edge, warning strip. The use of tube-type lighting is not permitted.

E. Platforms may be of precast construction or cast in-place and sloped to provide natural drainage towards the track.

F. Yellow strobe lights, controlled from a common switch located in the platform equipment shelter, shall be provided at each end of the LRT Stop to warn approaching trains of platform snow-clearing operations.

(v) 300 mm wide continuous tactile wayfinding strip finished with contrasting paving and 2000 mm wide tactile area indicating LRT door locations shall be provided on all platforms.

14.9 Design Elements of Continuity and Variability

(a) Project Co. must create various elements of LRT Stop classified as either:

(i) Constant elements for all LRT Stops (elements of continuity)

(ii) Unique elements for each LRT Stop (elements of variability)

(b) Constant elements shall be standardized throughout the LRT system in order to utilize a scale of economy, functional and operational consistency and maintenance as well as reflect system branding.

(c) Unique elements shall be designed in order to provide an individual expression and identity to Special LRT Stops or to LRT Stops in certain area or City which have a different platform access, ridership or layout. . Refer to Appendix L.3 Conceptual LRT Stop Design Drawings and Exhibit 14.9-1 LRT Stop Elements.

Exhibit 14.9-1
LRT Stop Elements

LRT Stop Element	System-wide Constant Elements	Elements Unique to each LRT Stop
Platform approach paving:		
Material & finishes		X
Length		X

Exhibit 14.9-1
LRT Stop Elements

LRT Stop Element	System-wide Constant Elements	Elements Unique to each LRT Stop
System and equipment:	X	
Ticket Vending Machines	X	
Ticket Validating Machines	X	
Communication equipment	X	
Emergency and Safety equipment	X	
Security equipment	X	
Information Devices:		
System & identification signage	X	
System & vicinity maps	X	
Platform edge	X	
Handrails & guardrails (material & finishes)	X	
Leaning rails:		
Material & finishes	X	
Quantity, length and locations		X*
Lighting:		
Lighting within LRT Platform	X	
Architectural Accent Light in vicinity of LRT Platform		X
LED Lights	X	
LED Light signalling LRT vehicle proximity	X	

Exhibit 14.9-1
LRT Stop Elements

LRT Stop Element	System-wide Constant Elements	Elements Unique to each LRT Stop
"Solid" shelter element:		
Form & size		X
Length & extent		X*
Structural Elements		X
Finishes (flooring, walls, ceiling, materials)		X
"Transparent" Glass shelter element (screen and canopy)		
Form & size	X	
Length & extent		X*
Structural Elements	X	
Finishes (flooring, walls, ceiling, materials)	X	
Windscreens		
Form	X	
Material & finish	X	
Length & extent		X
Height	X	
Trash Receptacles		
Materials & finishes	X	
Quantity & placement		X
Bicycle racks		

Exhibit 14.9-1
LRT Stop Elements

LRT Stop Element	System-wide Constant Elements	Elements Unique to each LRT Stop
Materials & finishes	X	
Quantity & placement		X
Benches		
Materials & finishes	X	
Quantity & placement		X

*- function of ridership

14.10 Specific LRT Stop requirements (by location)

The specific LRT Stops may be influenced by surrounding development, architectural vernacular, existing landscape or other design features that the Project Co. may utilize to refine the design concepts of the LRT Stops. To help establish a neighbourhood identity for each LRT Stop or block of LRT Stops, a level of design freedom is allowed on the following LRT Stop elements: canopy elements, public art, potential plaza areas, landscaping, and other related items. Project Co will be required to host consultations with the Region, and other relevant stakeholders as identified by the Region, on these elements and the overall final LRT Stop designs. Note that all communications with the public shall be directed by the Region and coordinated by Project Co with the Region.

The Region, in coordination with the Cities of Cambridge, Kitchener, and Waterloo, has also completed a Community Building Strategy for the Region's Central Transit Corridor (CTC). This strategy, which identifies key directions for building communities and moving people within, to, and from the CTC, should inform Project Co. designers with regards to the long term vision for the Region's development around rapid transit. Project Co. should refer to "The Region of Waterloo Central Transit Corridor Community Building Strategy" (available at www.centraltransitcorridor.ca) for a discussion on the corridor's existing urban context and long term objectives.

Individual Stop Design requirements and consideration include (but are not limited to):

(a) "Special" LRT Stops:

(i) Conestoga Mall

A. Urban context considerations: Major destination. LRT stop adjacent to arterial road and Mall vehicular entrance, bus transit loop, parking lot and commercial uses. Stop is somewhat remote from Mall entrance.

B. Stop design requirements:

1. Pedestrian and Visual connection to Mall entrance

2. Integration with Bus Transit facility

3. Design Integration of Sub-station and LRT/Bus driver Facility

4. Pedestrian oriented plaza surrounding station and accommodating grade change to parking lot and Bus Facility

(ii) Research and Technology Park

A. Urban context considerations: Currently suburban context but LRT stop adjacent in area of potential future development.

B. Stop design requirements:

1. Consider future pedestrian connections to adjacent developments and future bus loop

2. Provide connection to Laurel trail

3. Consider grade change and access to north of station including site lines

(iii) University of Waterloo

A. Urban context considerations: Major destination. LRT stop adjacent in area of potential future development of the Campus. Refer to Campus Master Plan.

B. Stop design requirements:

1. Consider future pedestrian connections to adjacent developments and future bus transit way

2. Integrate site access with Laurel way, bicycle parking and intersection configuration

3. Consider grade change and access to north of station including steps and ramp access

4. Consider pedestrian access from both sides of platform

5. Re-configuare storm water management pond and existing pedestrian paths adjacent to Stop

(iv) Waterloo Town Square

A. Urban context considerations: Urban. Stop located on historic centre of Waterloo.

B. Stop Design requirements:

1. Integration with sidewalk and consideration of pedestrian flow around Stop required

2. Consider pedestrian access and location of cross walks overall lighting of sidewalks to provide enhanced pedestrian environment

3. This stop will require consultation with City of Waterloo regarding specific landscape features and Public Art.

(v) Transit Hub

A. Urban context considerations: Major transfer location. Stop located adjacent to future multi-modal transit hub at key intersection. Challenging site condition due to grade separation of commuter rail and LRT and roadway.

B. Stop Design requirements:

1. Integration with sidewalk and consideration of pedestrian flow around Stop required.

2. Consider future Transit Hub development including bus and commuter rail.

3. Consider landscape features to provide an improved pedestrian environment

4. Consider overall lighting of sidewalk below grade separation to provide enhanced pedestrian environment

(vi) Fairview Park Mall

A. Urban context considerations: Major destination and transfer location. Stop located adjacent to large retail mall surrounding by parking lots, arterial road and mall vehicular entrance, bus transit loop, parking lot and commercial uses. Stop is remote from Mall entrance.

B. Stop Design requirements;

1. Integrate with aBRT bus loop

2. Consider pedestrian connections to Mall and improved crosswalks

3. Consider grade change along bus road

(b) Other LRT stops

(i) Northfield Drive

A. Urban context considerations: Suburban location. Stop located adjacent to future commercial/office development. Challenging site conditions for pedestrians due to adjacent road, turning LRT alignment, CNR tracks and wide arterial road.

B. Stop Design requirements:

1. Integration with sidewalk/crosswalk and consideration of pedestrian flow around Stop required

2. Consider landscape features to provide an improved pedestrian environment

3. Consider location of cross walks overall lighting of sidewalks to provide enhanced pedestrian environment

4. Consider new development adjacent to Stop

(ii) Seagram Drive

A. Urban context considerations: Suburban location near campus. Stop located adjacent to future development. Major pedestrian access to Waterloo Park and Wilfred Laurier University.

B. Stop Design requirements:

1. Integration with sidewalk and consideration of pedestrian flow around Stop required

2. Consider pedestrian access and location of cross walks overall lighting of sidewalks to provide enhanced pedestrian environment

(iii) Willis Way

A. Urban context considerations: Key Urban location and destination. Stop located adjacent to key public plaza.

B. Stop Design requirements:

1. Integrate Stop with access to existing plaza and adjacent streetscape

2. This stop will require consultation with City of Waterloo regarding specific design features and Public Art

3. Consider significant pedestrian flow onto the plaza and impact of events

4. Consider landscape feature, decorative fencing and paving pattern to direct pedestrian flow over LRT rail and CNR rail.

5. Provide enhanced landscape along alignment and station

6. Provide a station that has minimal visual impact or physical barrier to town plaza

(iv) Allen Street

A. Urban context considerations: Urban environment. Stop located near centre of Waterloo in urbanized area.

(v) Grand River Hospital

A. Urban context considerations: Urban. Stop located at entrance to Grand River Hospital.

B. Stop Design requirements:

1. Integration with sidewalks, crosswalks and consideration of pedestrian flow around Stop required due to roadways.

2. Provide additional wind screening/guards to prevent splashing onto platform from roadway.

3. Consider enhanced patron amenities such as additional benches

(vi) Young Street

A. Urban context considerations: Developing urban environment. Civic centre, heart of downtown Kitchener.

B. Stop Design requirements:

1. Integration with sidewalks, crosswalks and consideration of pedestrian flow around Stop required.

(vii) Gaukel Street

A. Urban context considerations: Urban environment. Civic centre, downtown Kitchener.

B. Stop Design requirements:

1. Integration with sidewalks, crosswalks and consideration of pedestrian flow to Stop required.

(viii) Frederick Street

A. Urban context considerations: Urban environment. Civic centre, downtown Kitchener.

B. Stop Design requirements:

Integration with sidewalks, crosswalks and consideration of pedestrian flow to Stop required.

(ix) Benton Street

A. Urban context considerations: Urban environment. Next to downtown Kitchener.

B. Stop Design requirements:

1. Integration with sidewalks, crosswalks and consideration of pedestrian flow to Stop required.

(x) Cedar Street

A. Urban context considerations: Future urban environment. Edge ("South") of downtown Kitchener. Close to Kitchener Market and emerging multi-cultural area with significant residential development anticipated.

B. Stop Design requirements:

1. Integration with sidewalks, crosswalks and consideration of pedestrian flow to Stop required.

(xi) Borden Avenue

A. Urban context considerations: Future semi-urban environment. Edge ("South") of downtown Kitchener. Transitioning light industrial area near established older residential area.

B. Stop Design requirements:

1. Integration with sidewalks, crosswalks and consideration of pedestrian flow to Stop required.

(xii) Mill Street

A. Urban context considerations: sub-urban environment. Older residential area, with nearby light industrial uses in transition. Stop is remote from main sidewalks and road way.

B. Stop Design requirements:

1. Integration with sidewalks, crosswalks and consideration of pedestrian flow to Stop required.

2. Consider pedestrian access and location of cross walks with overall lighting of sidewalks to provide enhanced pedestrian environment

3. Consider site lines and CEPTED due to location of Stop.

(xiii) Block Line Road

A. Urban context considerations: sub-urban environment. Older residential area with new development on adjacent site contemplated. Significant grade change over site. New road and bridge connection under construction perpendicular to site. Potential transfer location.

B. Stop Design requirements:

1. Integration with sidewalks, crosswalks and consideration of pedestrian flow to Stop required.

2. Consideration of grade change and impacts on site development. Development site has significant topographical challenges.

14.11 Security Considerations

(a) General

(i) Create shelters that provide weather protection, but allow easy surveillance.

(ii) Avoid square columns or columns wider than 400mm to minimize potential hiding places.

(iii) Create shelters with predominantly glass roofs, which make shelters appear as "lanterns" at night and do not cast long shadows. Provide a minimum eave height of 2400mm to allow easy viewing into the shelter.

(iv) Use graffiti resistant, easily replaceable and cost-effective materials and coatings.

(v) LRT Stops shelter structures should have sufficient transparency to provide visibility to platform from adjacent streets for adequate visual surveillance of the LRT Stop area to enhance patron safety and discourage vandalism.

(vi) The patron should have the ability to:

A. See and be aware of the surrounding environment through unobstructed sightlines, adequate lighting and the avoidance or minimization of confined or hidden areas;

B. Scan a space visually before entering it;.

C. Be seen by others, so that the feeling of isolation is reduced;

D. Communicate, find help or escape when in danger, through improved signage and facility designs.

(vii) Security features such as hands-free intercom and CCTV surveillance cameras will be an inherent feature of the LRT Stop design.

(viii) Recesses and alcoves which cannot be seen from the main space, as well as obstructions on the platforms which are at eye-level, should be avoided.

(b) Miscellaneous

(i) Provide maximum visibility into and out of all transit facilities from as many sides as possible.

(ii) Illuminate LRT Stops and major facilities at night with as much indirect lighting as possible.

(iii) Design major facilities as distinctive landmarks.

(iv) Terminal LRT Stops should be designed with the facilities for LRT drivers.

(v) Use glass instead of plexiglass as the latter yellows and scratches and gives an impression of lack of maintenance.

14.12 Structural

(a) General

This chapter establishes the basic structural engineering criteria to be used in the design of Light Rail Transit (LRT) stops. The criteria were based on the requirements for passenger comfort and safety, stability and accepted engineering practice.

(i) Scope

A. This chapter presents the criteria for Waterloo LRT stops.

B. This section establishes the basic structural criteria to be used for the design of LRT stop structures. Criteria of the structural design of transit stops is in accordance with the following:

Type of Structure	Loads	Design Codes
LRT Stops	Load and Combination factors: OBC	CAN/CSA-A23.3 CAN/CSA-S16.1 CAN/CSA-O86 CAN/CSA-S304.1
	Load factors are to be as found in the above Criteria and Codes	Resistance Factors are to be as found in the above Criteria and Codes

(ii) Codes and Standards

A. Structural design of all LRT Stops shall be in accordance with the Ontario Building Code supplemented by criteria in this Performance Output Specification.

Other Applicable Codes and Standards

B. Other Codes and Standards which may be applicable for particular aspects of the design include:

1. CAN/CSA-A23.1/A23.2-09 Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete

2. CAN/CSA-A23.3-04 Design of Concrete Structures

3. CAN/CSA-O86-01 Consolidation (R2006) Engineering Design in Wood (temporary works only)
4. CAN/CSA-S16-01 Consolidation (R2007) Limit States Design of Steel Structures
5. CAN/CSA-S304.1-04 Design of Masonry Structures
6. National Building Code of Canada 2010
7. User's Guide – NBC 2010: Structural Commentaries (Part 4)
8. Latest Code, Standards revision and Code Amendments to be used.

(iii) Fire Protection of Structures

A. LRT Stop structures shall be protected in accordance with Part 3 "Fire Protection, Occupant Safety and Accessibility" of the Ontario Building Code and Schedule 15-3 Article 2.

B. All material other than concrete, masonry, tile, metals, and similar materials shall have certified classification of non-combustible as defined by ASTM E136, "Determining Non-Combustibility of Elementary Materials." Flameproofing of material is not acceptable. In cases where no suitable material conforms to these requirements, very minor quantities of an accessory material may be permitted if prior approval in writing is obtained from The Region.

(b) Design Method

(i) Limit States Design Method to be used in design of all structures under the scope of Transit Expansion Projects.

(c) Loads

(i) Dead Loads (D)

A. The dead load shall consist of the weight of the basic structure and the weight of secondary elements permanently supported by the structure.

B. Dead load shall include miscellaneous loads of any system or facility that shall apply a permanent load on the structures.

C. The dead load shall include the weight of utilities or other permanent loads that are planned for future installation.

D. To assure that dead load calculations are consistent throughout the project activities, the following unit loads shall be used for various materials, when encountered:

1. Concrete, plain or reinforced 24 kN/m³
2. Steel, or cast steel 78.5 kN/m³
3. Cast Iron 72.8 kN/m³
4. Aluminum Alloys 28 kN/m³
5. Glass 25.6 kN/m³

6. Timber 9.6 kN/m³
7. Ballast, crushed stone 19.2 kN/m³
8. Pavement 24 kN/m³
9. Rock and Stone Masonry 27.2 kN/m³
10. Ceilings, cement plaster 6.3 N/m²(or actual)
11. Ceilings, gypsum plaster 4.2 N/m² (or actual)
12. Epoxy terrazzo tile, 10mm 2.5 N/m²
13. Terrazzo (25mm inch), plus 50mm stone concrete 13.5 N/m²
14. Stay in place forms 6.7 N/m²
15. Cable splice boxes (maximum length 9m) 2.4 kN/m
16. Acoustical barrier 5.2 kN/m
17. Groundwater 9.8 kN/m³

(ii) Transitory and Exceptional Loads (L) Due to Use and Occupancy

A. Transitory Loads

1. Transitory loads shall consist of any live loads including the weight of machinery, equipment, stored materials, persons, transit vehicles, or other moving objects, including impact (dynamic load allowance), construction loads and loads due to maintenance operations.

2. Transitory loads shall also consist of environmental loads such as loads due to snow, ice and rain, wind, shrinkage and creep, thermal loads including seasonal changes of temperature and thermal gradient effects, and differential settlement and stream flow. Exceptional loads shall include earthquake, ice pressure or debris torrent effects, loads due to flooding as well as special loadings due to vehicle collision (on or under a structure), emergency braking, extreme centrifugal force, derailment and broken rail forces as well as forces due to broken catenary system.

3. These specified loading are applicable for LRT stops. Structures.

(iii) Floor and Miscellaneous Live Loads

A. Public Areas

1. All public areas including stop platforms, stairs, ramps and passageways shall be designed for a specified load of 7.2 kPa applied uniformly over the entire area, or on any portions of the area, whichever produces the most critical effects in the members concerned. The specified live load shall be reduced for structural members supporting large tributary areas in accordance with Ontario Building Code requirements for assembly occupancies. A concentrated load of 9 kN applied over an area 750 mm by 750 mm and positioned so as to cause maximum effects shall also be considered. Requirements for the future transport of equipment and safes

over public areas shall be reviewed with the Commission. The most critical loading condition shall govern.

B. Safety Guards / Fences

1. Safety guards and fences on elevated structures or any route structure where there is a drop of over 600 mm from one side to the other in the possible path of an exit and where a vehicle evacuation could occur between designated stops shall be designed for a minimum horizontal load of 3.0 kN/m applied 1.0 m above the high side deck or grade level.

(iv) Environmental Loads

A. Importance Category Normal

1. Transit structures shall be designed for environmental loads in accordance with the provisions of the Ontario Building Code, for Importance Category Normal.

B. Transitory Loads Due to Snow, Rain and Ice (SL)

1. Transit structures shall be designed for snow, rain and ice loads in accordance with the provisions of the Ontario Building Code

C. Transitory Loads Due to Wind (W)

1. Transit structures shall be designed for wind loads, in accordance with the provisions of the Ontario Building Code with a reference wind pressure, q, based on a return period of 50 years

D. Exceptional Loads Due to Earthquake (Q)

1. Transit structures shall be designed for earthquake loads in accordance with the provisions of the Ontario Building Code and National Building Code of Canada.

(d) Load Factors and Load Combinations

The factor of safety commonly used in working stress standards, is divided in limit states standards, into two parts – a load factor and a resistance factor. A load factor (α) is applied to the specified load to take into account the variation of load (loads higher and lower than the nominal design load may exist), and also take into account approximations and model uncertainties in the analysis of the load effects. A resistance factor (φ) is applied to the theoretical member strengths, or resistances (R), to take into account that the resistance of the member due to the variability of the material properties, dimensions and workmanship may be less than anticipated, and also to take into account the type of failure and uncertainty in the prediction of the resistance.

Notations

α_D = Load Factor on Dead Loads.

α_E = Load Factor on Earth and Water Pressures.

α_P = Load Factor on Secondary Prestress Effects.

α_L = Load Factor on Live Loads.

The legend or description of the various loads is provided in Figure 13.4.1.

For ultimate limit states loading the maximum and minimum load factor values given in Figure 14.3.2 shall be used for Permanent Loads such that the total factored load effect is maximized.

The loading combinations to be considered and the load factors to be used including permanent, Transitory and Exceptional Loads shall be as shown in Figure 14.3.2.

(i) Total Factored Load Effect

A. For each loading combination, every load that is to be included shall be multiplied by the load factor specified and the resulting load effects shall be computed. The factored load effects shall then be added together to obtain the total factored load effect. The total factored load effect shall include load factors for each combination specified in Figure 14.3.2. Each total factored load effect shall include all significant effects due to elastic distortions caused by the load.

(ii) Permanent Loads

A. In obtaining total factored load effects, all permanent loads shall be included.

(iii) Staging Loads

A. It is critical for safety to analyze and provide a safe design for the structure at all the stages during construction and rehabilitation with the loads present in each stage. Construction stage loads may result in more severe total load effects than for the completed structure. At various construction stages, all permanent loads are often not yet present, or are not present over the entire structure.

(iv) Transitory Loads

A. Transitory loads shall be included in the loading combinations only if there is a possibility of the loads being applied to the structure at the stage being considered, and if their inclusion increases the total factored load effect.

(v) Exceptional Loads

A. When there is a possibility of occurrence of exceptional loads on the structure and at the stage being considered, the one load which produces the largest total factored load effect shall be included. Exceptional loads rarely occur and the possibility of more than one occurring simultaneously can be neglected.

(vi) Resistance Factors

A. Resistance factors are applied to the resistance or specified material property to take into account the variability of material properties and dimensions, workmanship, type of failure and uncertainty in the prediction of resistance. Resistance factors used in checking ultimate limit states for different types of structures.

Permanent Loads	
D	Dead load including vertical effects of earth load (or cover) and surcharges
E	Loads due to horizontal earth pressure (including surcharges), water pressure and buoyancy (B).
P	Secondary prestress effects.
LR	Longitudinal and radial forces due to track restraint. (LR_1, LR_2, RT_1, RT_2).
Transitory Loads	
L	Live load. Vehicle live load to include for impact (DLA), rolling (lurching) force (RF), hunting (nosing) force (HF) or centrifugal force (CF), normal acceleration or braking (LN) and LIM forces.
W	Wind loads on structure.
V	Wind loads on vehicle.
SL	Snow and ice loads on guideway (SIG) and ice on vehicles (SIV).
F	Load due to stream flow
K	Effects of strains due to thermal (T), shrinkage (SH), creep (CR).
S	Load due to differential foundation settlement.
Exceptional Loads	
CFe	Extreme centrifugal force
LE	Emergency braking.
BR	Broken rail.
CL	Collision with pier or column (by other vehicles)
DR	Derailment load (by transit vehicle).
Q	Earthquake.
ICE	Loads due to ice pressure or debris torrent.
FL	Flooding (underground structures).

LEGEND – DESIGN LOADS

LRT STOP STUCTURES

Load factors and Load Combinations *

Load Combination	Permanent Loads				Transitory Loads					Exceptional Loads					
	D	E	P	LR	L	W	SL	K	S	CFe	LE	DR	BR	Q	CL
Fatigue Limit States															
FLS Combination 1	1	1	1	1	0.9	0	0	0	0	0	0	0	0	0	0
Serviceability Limit States															
SLS Combination 1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
SLS Combination 2	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
SLS Combination 3	1	1	1	1	0.9	0	0	0.8	1	0	0	0	0	0	0
SLS Combination 4	1	1	1	1	0.8	0	0.8	0.8	0	0	0	0	0	0	0
Ultimate Limit States															
ULS Combination 1 [6]	1.4	αE	αP	1	1.4	0	0	0	0	0	0	0	0	0	0
ULS Combination 2 [7]	αD	αE	αP	1	1.5	0	1.5	0	0	0	0	0	0	0	0
ULS Combination 3 [7]	αD	αE	αP	1	1.5	0.4	0	0	0	0	0	0	0	0	0
ULS Combination 4	αD	αE	αP	1	0	0.4	1.5	0	0	0	0	0	0	0	0
ULS Combination 5 [8]	αD	αE	αP	1	1.3	0	1.3	1.15	0	0	0	0	0	0	0
ULS Combination 6	αD	αE	αP	1	0.5	1.65	0.5	1.25	0	0	0	0	0	0	0
ULS Combination 7 [1]	αD	αE	αP	1	1.1	0	0	0	0	1.3	0	0	0	0	0
ULS Combination 8 [2]	αD	αE	αP	1	1.1	0	0	1	0	0	1.3	1.3	0	0	0
ULS Combination 9	αD	αE	αP	1	1	0	0.25	0	0	0	1	0	0	1.3	0
ULS Combination 10 [2]	αD	αE	αP	1	1	0	0	0	0	0	0	0	1.3	0	1.3

* This figure applies to above grade and below grade portions of station buildings.

Notes:

1 Do not use CF or HF in L

2 Use one exceptional load only

3 For non-redundant structures (structures in which failure of a single component could lead to total collapse), permanent, transitory and exceptional loads at ULS shall be multiplied by an importance factor as follows:

1.15 x (Factored Load Combination)

4 This load factor and combination table is based on studies undertaken by the TTC in 1995 and 2002

5 Refer to Figure 13.4.2 for permanent load factors

6 This combination may govern for dead load dominant structures and must be checked for all structures

7 Use 1.7 factor of CHBDC live load, where such is applicable to structure.

8 Use 1.6 factor on CHBDC live load, where such is applicable to structure.

Fig. 14.13.2

(e) Durability

(i) Consideration shall be given in all aspects of design to minimize the deterioration of the appearance, structural capacity and performance of the structures during their design lifetime.

(ii) All aspects of the design shall minimize the effects of such environmental factors as temperature variations, snow, ice, salt, rain, wind, earthquakes and solar radiation.

(iii) Durability shall be enhanced by selection of the proper design criteria, loads, load factors, allowable stresses, materials and structural systems.

14.13 Mechanical and Electrical Systems

(a) Water Service

(i) Minimum 25 mm diameter water service connections shall be provided to each LRT Stop for platform cleaning. Water service for irrigation may also be required. Water service(s) shall be coordinated and meet all applicable local code requirements.

(ii) Provide water connections or hose bibs so any location on the platform can be reached by a 30m long hose. Consider water connection applications for winter use.

(b) Shelter heating at selected Stops

(i) Provide electric passenger activated (via push button control with appropriate signage) on demand heating in the enclosed shelter area of Stops listed in (iii) below. Remaining station LRT Stop shelter design to be such that future heater installation can be easily accommodated into the structure and finishes.

(ii) The heating device is to be provided with a timer which causes the device to turn off after 5 minutes following activation. The heating devices are to mounted or enclosed to be safe from tampering and touch, to prevent theft and vandalism, and to be integrated with the overall station design.

(iii) Heated LRT Stop locations:

A. Fairview Park Mall

B. Block Line Road

C. Grand River Hospital

D. Northfield Drive

E. Conestoga Mall

(c) Electrical Service

(i) 120VAC receptacles will be provided for use by vendors & maintenance within the platform areas. Receptacles to be incorporated into the canopy support columns or other stop furnishing/elements and be spaced maximally at 10m apart.

(d) Power Supply Cabinets for ITS Systems

(i) Include power supply cabinets and cabinets for equipment for powering ITS systems, lighting, etc. at platforms and coordinate connection to local power source.

(ii) Integrate all equipment cabinets into the shelter design in an organized cohesive manner. Ensure access to cabinets is protected and vandalism proof (tamperproof screws etc.).

(e) Lighting

(i) The LRT Stop lighting shall include all lighting required to light the platform, bus loading area, passenger drop-off (kiss-and-ride) area, park-and-ride lots and pedestrian walkways associated with the LRT Stop.

(ii) Lighting design shall be subject to local jurisdictional design criteria and follow appropriate lighting guidelines for public transit facilities.

(iii) Architectural Arm-Mounted Full Cutoff Area Light with single head or double head at 180 degrees, 5.5m in height is the standard light. Changes will be made to accommodate illumination requirements, as required by applicable code.

(iv) Artificial lighting shall be provided for safety in all open LRT Stop site areas with due consideration for adjacent land uses. . The average foot-candles may require reduction at LRT Stop locations in low-density residential areas. Light fixtures shall be provided with a cutoff feature to eliminate candle power at high angles.

(v) Artificial light sources to obtain the required foot-candle levels shall be no higher than 4.57m in LRT Stops and 9.14 m in parking lots. Light fixture size, pole height, and number of poles shall be selected to optimize foot-candle and aesthetic design criteria. Design consideration should be given to place lighting on separate circuits in order to phase lighting levels and provide reliability.

(vi) Pole foundations shall extend approximately 610mm above parking lot grade to reduce pole damage. However, pole locations within the lot area shall be selected to permit future re-configuration of stall and aisle layout to accommodate vehicle size. Pole locations should be placed in landscape islands with curbing whenever possible to add extra protection from vehicle damage.

(vii) Lighting control shall be accomplished by the use of photocell units and contactors. This will provide operational cost savings. Lighting fixtures shall be operated as follows: one head of each fixture is to operate from dusk to dawn. All other fixtures are to operate from dusk to a specified time and from a specified time to dawn. Normally off from 1:00am to 4:30am.

(viii) The lighting colour spectrum should be as close to natural light as possible to bring out the true colour of objects.

(ix) Lighting should be constant, uniform, and diffused. Glare should be minimized.

(x) Lighting, particularly interior lighting, should be instant on to enable immediate recovery after a power outage.

(xi) The lighting design must promote safety by identifying and properly illuminating areas and elements of potential hazard.

(xii) Pedestrian access lighting should provide well-defined walkways, crosswalks, ramps, stairs, and bridge corridors, platform edges, shelters, seating areas, fare collection equipment areas, ramps and stairs.

(xiii) Use LED light fixtures with appropriate security guards to prevent theft and to prevent vandalism. (xiv)LRT and bus loading areas, pedestrian walkways and crossings and way-finding signage must be appropriately illuminated.

(xiv) Light trespass into adjacent neighborhoods areas should be minimized.

(xv) Light fixtures and standards should be incorporated into the architectural elements of the LRT Stops as much as possible.

14.14 Materials & Finishes

(a) General Guidelines

(i) The following basic requirements and criteria have been established for the design and selection of platform amenities materials and finishes and the finish of public areas generally within the LRT system. While convenience, comfort, and attractiveness shall be considered in the selection and application of these finishes, safety, durability, and economy are essential attributes.

(b) Materials

(i) Materials shall be selected to provide durable, low maintenance, anti-graffiti surfaces.

(ii) All surfaces shall have a permanent finish. No site painting is allowed within 2.4m of the floor. Consideration shall be given to low-maintenance and attractive surfaces. Examples of acceptable finishes are stainless steel, glass, ceramics and porcelain enamel.

(iii) If used, ceramic tiles on the walls shall be of the anti-graffiti type.

(iv) Floors are to be of low-maintenance, non-slip finish with excellent wear qualities. Base boards shall be of the same material as the floor. Platform edge strips are to have yellow AODA or similar tiles installed.

(v)

(c) Safety

(i) Flammability and smoke generation hazard from fire shall be reduced by using finish materials with minimum burning rates, smoke generation, and toxicity characteristics consistent with Code requirements as noted in OBC and NFPA 101, Life Safety Code (most current edition).

(ii) Hazard from dislodgment due to temperature change, vibration, wind, seismic forces, aging, or other causes, shall be reduced by using proper fasteners and adequate bond strength.

(iii) Pedestrian safety shall be increased and the presence of the disabled shall be recognized by using floor materials with non-slip qualities. Stairways, platform edge strips, ramps, and areas around equipment shall have high non-slip properties.

(iv) Edging and flooring shall be electrically insulated. No grounded metallic surface shall be installed within 1.5m of the edge of the platform adjacent to trains.

(v) Electrical protection and conductors shall be sized in accordance with NFPA 70 (NEC).

(vi) All current-carrying enclosures shall be effectively grounded.

(d) Ease of Maintenance

(i) Cleaning: Facilitate cleaning and reduce cleaning costs by the use of materials that do not soil or stain easily, which have surfaces that are easy to clean in a single operation using standard equipment and cleaning agents, and on which minor soiling is not apparent.

(ii) Repair or Replacement: To reduce inventory and maintenance costs, materials shall be used that can be easily repaired or replaced without undue cost or interference with the operation of the LRT system. For example, hose bibs, electrical outlets, lighting fixtures and lamps, glass or plastic lights, etc. shall be standardized with commonly available sizes and finishes to ease inventory stocking or direct purchase.

(iii) Resistance to Vandalism: Materials and details that do not encourage vandalism and that are difficult to deface, damage, or remove shall be used. All surfaces exposed to the public shall be finished in such a manner that the results of casual vandalism can be readily removed with common maintenance techniques.

(iv) Criteria governing the design and selection of platform amenities materials and finishes are provided in Articles herein and the Project Agreement.

(e) Shelters

(i) The materials and finishes of passenger shelters shall be selected to maximize durability, minimize maintenance and, at the same time, respond to Region standards and coordinate with LRT Stop urban design goals.

(ii) Shelter columns, where exposed to patrons, shall resist corrosion by being either 316 grade stainless steel or high performance paint finish (subject to Region approval).

(iii) Shelter structure elements that will be in contact with the public shall be coated with an abrasion-resistant coating system.

(iv) Powder coating shall only be used with Region approval. Follow coating manufacturer's preparation recommendations.

(v) Shelter metal roof should be highly durable metal such as 20-gauge stainless steel metal deck (2B finish) or similar.

(vi) Shelter glass roof shall incorporate laminated safety glazing with PPG Solex or similar tinted glass for shade protection. Provide panel sizes that are standard and minimize special maintenance equipment.

(vii) Shelter guardrails shall be stainless steel with "bead-blast" finish.

(viii) Shelter elements, assembly and finish must allow reasonable access for electrical wiring of light fixtures and ease of future equipment.

(f) Platforms

(i) Platform surface materials should be selected for durability, slip resistance, ease of maintenance and retrofit accessibility. Colours, patterns, sizes, textures and materials need to be coordinated with maintenance, public art, urban design and Accessibility programs.

(ii) Concrete should be judiciously used to minimize future maintenance or systems access concerns. Proper slip resistance needs to be provided by light broom or other appropriate finish. Provide scoring to minimize shrinkage and settlement cracking.

(iii) Sand-set pavers are nominal 102 x 203mm or 203 x 203mm. Coordinate actual size pavers with other platform elements to maximize use of whole or half paver units. Provide solid-edge protection to minimize settlement. Provide joint sand stabilizer.

(iv) Brick masonry pavers may also be used with The Region's approval.

(v) Electrical and mechanical box lids shall be flush fit, checkered sidewalk lids with tamperproof screws.

(vi) Platform inserts for public art, communications or other equipment shall pass ASTM 1028-89 Standard for Slip-Resistance.

(vii) Tree Wells (see Appendix E) for information related to plantings and irrigation systems. Trees planted in a hardscape on a light rail platform, shall only be planted when required by the local jurisdiction or other special design requirement. When trees are required, the use of the Deep Roots product "Silva Cell", or equivalent, utilizing a plastic structural cellular system with posts, beams and deck designed to be filled with planting soil for tree rooting, should be considered for incorporation into the design. Tree wells shall have tight fit paver stones that provide 1220 mm x 1220 mm tree opening, and have crushed decorative rock or bark mulch (preferred) around the tree base.

(g) Windscreens

(i) Minimum of 2400 mm high.

(ii) Structure shall be galvanized or stainless steel.

(iii) Glazing support system shall be aluminum.

(iv) Finish shall be either stainless steel, galvanized or abrasion resistant coating system. Powder coating is not acceptable.

(v) Laminated safety glass is required.

(vi) Glass surface should be treated with either a public art or other design pattern that maintains effective transparency with no more than 40% of the surface area obscured, to minimize vandalism with the exception of canopy roof which can be obscured to provide additional sun shading.

(h) List of Finishes

(i) This list shall apply to all areas of public use. The use of items listed as "acceptable" is subject to location and environmental considerations. All materials shall conform to Accessibility requirements.

(ii) Acceptable Paving Materials

A. Non-slip or other textured-finish concrete

B. Stamped-pattern concrete

C. Bituminous paving (in carefully defined areas or where required for consistency with adjacent paving)

D. Quarry tiles (non-slip)

E. Paver brick (dense hard)

F. Selected artificial stone materials

G. Precast pavers

H. Natural stone pavers

I. Other paving materials may be acceptable, subject to Region and local jurisdictional approval.

(iii) Unacceptable Paving Materials

A. Synthetic resin surfacing

B. Standard cement terrazzo

C. Bituminous surfacing, except as noted above

D. Marble

E. Wood products

(iv) Acceptable Surfaces and Finishes

A. Stainless steel (areas of high pedestrian use)

B. Black wrought iron

C. Unfinished galvanized steel (where there is no contact with pedestrian touch)

D. Factory applied hard-baked enamel

E. Color anodized aluminum (where there is a low degree of pedestrian touch)

F. Pressure-treated heavy timber and glue-laminated wood (min.76mm dimension)

(v) Unacceptable Surface Finishes

A. Job site painted metals are unacceptable metallic surface finishes.

(vi) Acceptable Canopy Materials

A. Steel with factory finished baked enamel

B. Safety glass

C. Silicone or Teflon coated fiberglass (where out of reach of vandals)

D. Painted enamel

E. Anodized aluminum

(vii) Unacceptable Canopy Materials

A. Ordinary glass

B. Uncoated fabric

D. Ordinary plastics

E. Combustible materials

(i) Public Art

(i) Public Art is to be incorporated into eligible public areas of LRT Stops in accordance with the various Cities Public Art Policy. Project Co will be directed by the Region on all issues surrounding Public Art and the municipal or stakeholder engagement it may require.

(j) Street and LRT Stop Furniture

(i) Bollards

A. Bollards are required to be designed and constructed in accordance with applicable code(s). The following guidelines shall also be considered:

B. Shall be able to withstand pedestrian impacts without showing damage.

C. Should be secured with anchor devices that can facilitate bollard re-installation if struck by a vehicle.

D. The typical type is galvanized steel with industrial strength coating system. In some cases plastic bollards may be used in the LRT Stops as directed by Region.

E. Embedded bollards shall only be used when required by the Authority Having Jurisdiction or if specifically called out by the Region.

F. Refer to the reference drawings for bollard types and typical placement.

(ii) Benches

A. Benches and/or seating units shall be of designs that will prevent individuals from lying down, sleeping or sitting on top of the back rest. Seating design shall comply with Accessibility Guidelines and some portion of the platform seating should be designed with backs and full-length armrests to facilitate use by persons with disabilities.

B. Benches shall be designed to provide ease of maintenance and to prevent garbage build-up below the seat or supports. Finish materials to be durable and to prevent vandalism.