McElhanney

Report

25 AVENUE LRT GRADE SEPARATION – FUNCTIONAL PLANNING STUDY

April 2018

Prepared for The City of Calgary
by McElhanney

Calgary

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Functional Planning Study

Prepared By:

Irini Akhnoukh, M.Eng., P.Eng., PTOE
Sr. Transportation Engineer

Reviewed By:

Dan Bolger, P. Eng.
Project Manager

Executive Summary

ES 1.0 Study Purpose and Objective

The intersection of Macleod Trail and 25 Avenue S.E. is an important node in Calgary's road network, where converging traffic from the southern part of the city crosses the Elbow River to reach Downtown. Adjacent to the intersection, the Erlton Station, on the Red Line LRT (C-Train), attracts pedestrians from the surrounding area and provides access to the Calgary Stampede Grounds north of the Elbow River.

The presence of the Red Line LRT adjacent to Macleod Trail complicates the operation of the traffic signal system at the 25 Avenue S.E. intersection by pre-empting the signal phasing to accommodate the passing of C-Trains in both directions. The at-grade track crossing is gate-arm controlled and facilitates the clearing of vehicles off the track as trains approach. This disruption of the optimal signal phasing is most detrimental to the southbound left-turn movement and the westbound through and left-turn movements, which accommodate heavy traffic volumes to and from the industrial area to the east.

The intersection has been under review by The City of Calgary's Transportation Department, including the Roads and Transportation Planning business units, to identify optimization opportunities. However, optimisation opportunities do not remove the interaction between the LRT and roadway, which is one the primary cause of congestion at this location. In addition, Calgary Transit has recently upgraded the C-Trains to 4-car configurations to increase service capacity. With a future (planned but unfunded) separation of the Red and Blue lines at 8 Avenue S, Calgary Transit also plans to increase the frequency of trains from 5 minutes to 3 minutes during peak periods. These two factors will further exacerbate the problems currently experienced at the intersection.

In July 2016, City Council discarded a previously approved interchange plan for this location and directed Administration to develop a recommended plan for grade separation of the Red Line LRT tracks at 25 Avenue S.E. east of Macleod Trail. While the interchange would have resolved the traffic operation issues experienced at the intersection as a result of LRT pre-emption, it no longer aligns with the Urban Boulevard classification of Macleod Trail provided in the Calgary

Transportation Plan (CTP). The interchange plan also does not align with land use policies in the area, such as the Municipal Development Plan (MDP) and the Erlton Area Redevelopment Plan (ARP), nor with the Urban Corridor designation of lands adjacent to Macleod Trail. Specifically, an interchange would require a significant footprint of potentially developable land as well as the introduction of a physical and visual barrier.

The study boundary, as shown in *Figure ES-1*, is further extended during the project to integrate the 17 Avenue S.E. extension project. The focus of this project was to determine how a grade separation of 25 Avenue S. the LRT could be accomplished to relieve the traffic congestion caused by the LRT pre-emption at the intersection of Macleod Trail and allow for an increase in LRT service. Other important considerations include land use policies, transit operation, active modes, safety, community and property access, river flooding, and preservation of the Reader Rock Garden historical site.

There are three primary objectives for the study:

- **Road:** Improve accommodations for all road users in accordance with the Complete Streets Policy.
- **Rail:** Enhance transit service to attract transit users, improve customer experience, and meet future demands.
- **Redevelopment:** Encourage transit supportive development on lands adjacent to Erlton Station.

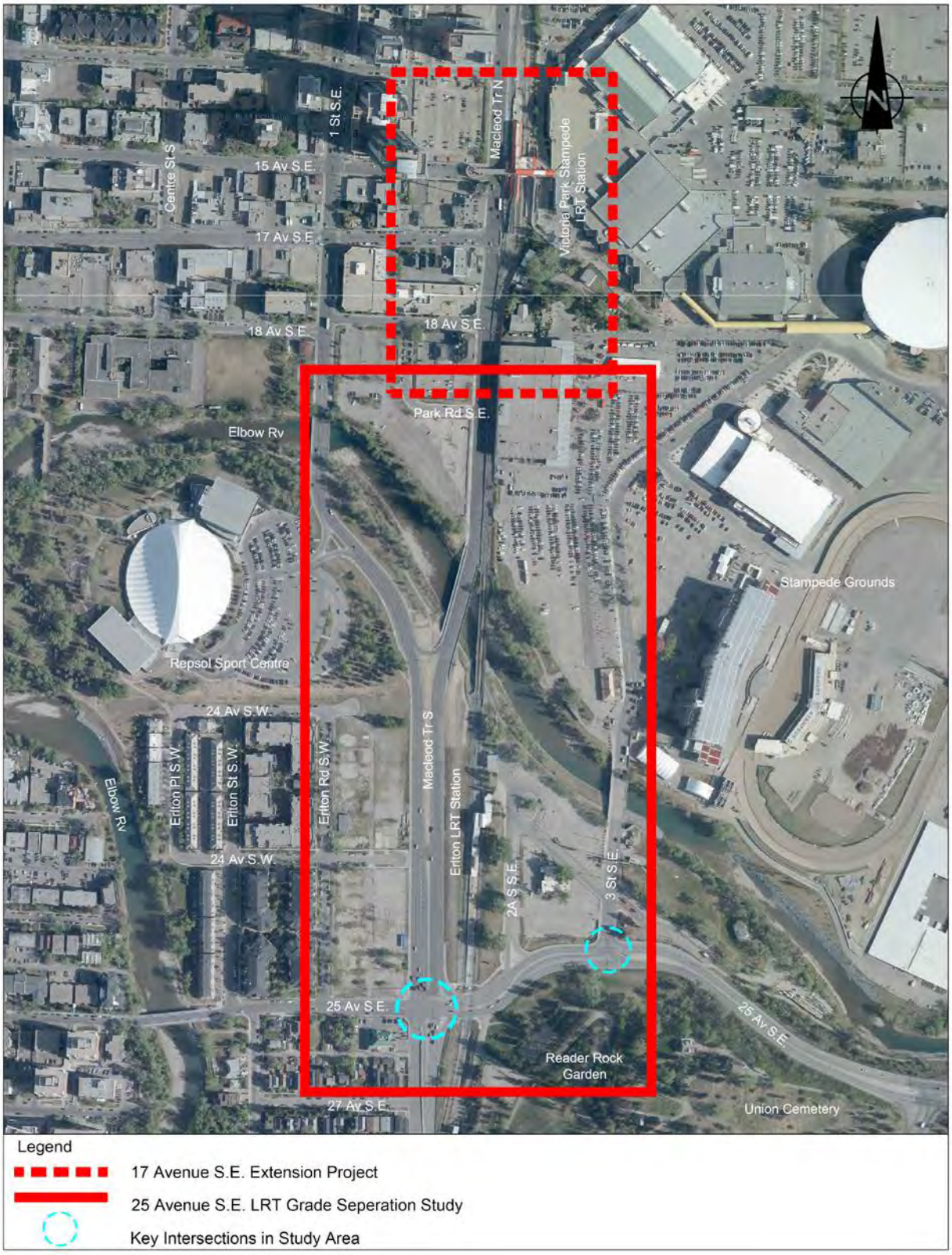


Figure ES-1: Study Area

ES 2.0 Existing Conditions

2.1 Road Network

Macleod Trail is an urban boulevard that acts as a central spine connecting south Calgary (and beyond) with the Downtown core. The corridor is used by over 50,000 commuters per day. Macleod Trail extends from Riverfront Avenue S.E. in the north to the southern City limits, where it becomes Highway 2A. Macleod Trail forms a one-way couplet with 1 Street SE and accommodates traffic in the northbound direction north of the Elbow River. It is a two-way roadway south of the Elbow River, where 1 Street S.E. joins and becomes the southbound portion of Macleod Trail.

25 Avenue S.E. is an east-west roadway with a collector classification west of Macleod Trail, and an arterial classification east of Macleod Trail. It connects the communities of Cliff Bungalow, Mission, Erlton, Ramsay and Alyth / Bonnybrook / Manchester. It extends west to Hillcrest Avenue and east to Dartmouth Road. 25 Avenue S.E. provides an important east-west connection to Macleod Trail and is used by commuters from adjacent communities. As approved by Council in the 25 Avenue S.E. Connector Study, the 25 Avenue S.E. corridor is planned to connect Macleod Trail with Blackfoot Trail in the future. As such, 25 Avenue S.E. is expected to carry higher traffic volumes once a direct connection to Blackfoot Trail is provided.

2A Street S.E. is a two-lane local road located east of Macleod Trail. It provides access to the Erlton LRT Station and Calgary Stampede Grounds parking lots.

3 Street S.E. is a four-lane local road located east of 2A Street S.E. It provides direct access into the Calgary Stampede Grounds.

Erlton Road is a two-lane local road located west of Macleod Trail. It provides access to the multi-family developments northwest of the study intersection.

Within the study area, Macleod Trail intersects with 25 Avenue S.E. to form a four-leg signalized intersection. 25 Avenue S.E. intersects with Erlton Road and 2A Street S.E. to form three-leg unsignalized intersections and with 3 Street S.E. to form a three-leg signalized intersection.

2.2 Adjacent Projects

Calgary Stampede Master Plan

Calgary Municipal Land Corporation (CMLC) is currently undertaking a master plan of the River District, which includes Victoria Park and Calgary Stampede Grounds. CMLC is working with Denver-based Civitas and Calgary's Gibbs Gage on a 20-year visioning plan that includes removing the Stampede Corral building, increasing the BMO Centre area, construction of a potential new arena, hotels, condo buildings, and increased retail/commercial development. While the master planning is still underway, it is assumed that there will be an additional 10 million square feet of mixed-use development.

Anthem's Crosstown Development

Anthem Properties has an approved transit-oriented development (TOD) plan for the lands along the west side of Macleod Trail within the study area. The Crosstown Development includes a pedestrian overpass over Macleod Trail connecting it with the Erlton LRT Station. Crosstown consists of 745 residential units, 70,000 square feet of commercial/retail area, and 4,000 square feet of office space.

Repsol Sport Centre Redevelopment

Repsol Sport Centre has submitted a Land Use Application to The City of Calgary to upgrade and expand their existing recreational facility by approximately 7,000 m^2 (75,000 ft^2). The proposed land use district retains the adjacent Special Purpose – Recreation (S-R) District and adjusts the land use boundary to reflect the expansion of the building. It also reproduces the existing approved use of "multi-purpose sports complex"; and additionally, includes four new discretionary uses.

17 Avenue S.E. Extension

To support the East Village Development, the River District Master Plan, and the Calgary Stampede Master Plan, a new pedestrian/vehicle access is proposed at-grade at 17 Avenue S.E. across the Red Line LRT tracks into Stampede Park. Calgary Transit was tasked with reviewing the previous studies and developing a Proof of Concept based on a mid-term solution to ensure that transportation needs can be met (Phase 1). The Proof of Concept report was received from Hatch in November 2016 and concluded that at a conceptual level, it is possible to extend 17 Avenue S.E. across Macleod Trail, and proceeding with the preliminary design was recommended.

The scope of the 17 Avenue S.E. Extension project includes a review of previous studies, stakeholder engagement, public open house presentations, detailed multi-modal traffic and open track modelling, cost estimating, a review of operational and safety concerns, risk assessment and mitigation, land transfer assessments, site investigations and surveys, materials testing, geotechnical studies, and operations protocol for the crossing and Calgary Stampede parking gates. Also included is the assessment of impacts to Calgary Transit and the LRT, as well as the resulting modifications of the Victoria Park/Stampede LRT Station, the C-train, infrastructure for tracks, signals, and communications. Modifications to roads, sidewalks, crosswalks, traffic signals and urban realm integration is also within the project scope.

2.3 Floodway

The Elbow River is a dominant natural feature that flows north of the study area. The Elbow River is subject to periodic flooding causing Provincial and City flood hazard mitigation policies to be in effect. Provincial policies emanate from the *Water Act* and are administered by Alberta Environment and Parks (AEP). In 1983 (with updates in 1996), the AEP created maps showing the Flood Hazard Area (FHA) in Calgary. The FHA was divided into three zones:

- Floodway – the river channel and some areas just out of the channel, where the flood water is deepest and fastest. Most of the flood water flows through the floodway;
- Flood Fringe – areas along the river that flood, but where the water is not as deep or as fast as in the floodway; and
- Overland Flow Zone – Areas where water leaves the river channel, flows over land through streets or communities, and eventually flows back into the river somewhere downstream.

Figure ES-2 outlines the Floodway and Flood Fringe boundaries that are delineated in the current (1996) mapping. The provincial flood hazard map is the basis of the flood policy and zones in Calgary's Land Use Bylaw. Current City Bylaw states that no new building or other new structures are allowed in the floodway.

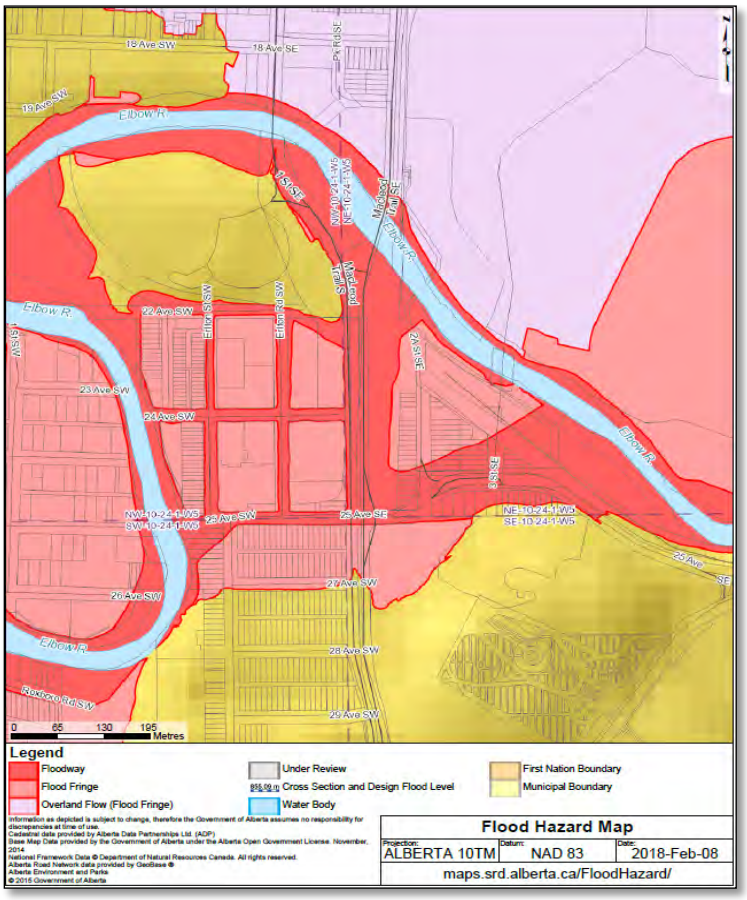


Figure ES-2: Provincial Flood Hazard Map for Study Area

Following the major 2013 flood event in Calgary, The City of Calgary (The City) has conducted several studies to better understand the flood risk and identify mitigation measures. Current flood mitigation projects underway include raising the gates at the Glenmore Dam, and constructing several parries at key locations, such as West Eau Claire, Heritage Drive, Bonnybrook Wastewater Facility, and the Centre Street Bridge. In addition, the Government of Alberta confirmed in 2015 that it would proceed with the development of a dry-storage reservoir at

Springbank. The Springbank Reservoir is currently undergoing a federal Environmental Impact Assessment. It is expected that the upstream reservoirs, including the proposed Springbank Reservoir, and the new gates on the Glenmore Dam will be able to support a 2013-sized flood without overland flooding along the Elbow River. This would likely impact the developability of the parcels that are currently in the floodway around the Erlton Station.

2.4 Traffic Volumes Projection

Traffic volumes for the 2038 future horizon were developed with consideration of several factors. These included the existing traffic volumes and patterns, adjacent sites proposed for development, area road network changes and anticipated future connections to major roadways, as well as potential redevelopment plans of existing developments in the area.

- Traffic associated with Anthem's proposed Crosstown development in the northwest corner of the intersection of Macleod Trail and 25 Avenue S.E. was included in the review. Development volumes were taken from the *Transportation Impact Assessment for the Proposed Development at Erlton Road / 25th Ave, Calgary, Alberta* completed by IBI Group in 2013.
- The proposed construction of the 25 Avenue S.E. Connector to Blackfoot Trail was considered, along with the associated rerouting of anticipated traffic.
- Traffic associated with the redevelopment of the Stampede Grounds was based on the *Green Line LRT Beltline Traffic Modeling Assumptions* technical memorandum completed by Stantec in 2017.
- The traffic generation associated with the redevelopment of the existing Repsol Sport Centre was estimated based on existing traffic patterns and trip generation data provided by The City of Calgary.

Based on these road network, traffic volume, and area development details, 2038 future horizon traffic volumes were developed as follows:

- 100% balanced existing volumes (no growth assumed for future horizons)
- 100% of Anthem's Crosstown development volumes
- 50% of volumes associated with the redevelopment of the Stampede Grounds
- 50% of volumes associated with the redevelopment of the Repsol Centre
- 100% of volumes associated with the 25 Avenue S.E. Connector (assumed to be constructed)

ES 3.0 Concept Development

3.1 Study Constraints

There are multiple other projects occurring within the study area that need to be considered when developing concepts. In addition, Macleod Trail and 25 Avenue S. are important traffic and transit links within the transportation network. As such, it was important to develop an understanding of design constraints and assumptions that should be taken into consideration. The following list highlights the main constraints and assumptions considered during the concept development stage.

- The majority of the study area falls within either the floodway or the flood fringe. The City's Land Use Bylaw does not permit alteration of grades or construction of new structures in a floodway. Any structures or grade changes require further analysis and approval.
- Reader Rock Garden has been designated as a Municipal Historic Resource and any impacts to it should be minimized.
- If changes are made to the station location, the pedestrian bridge from Anthem's Crosstown development should be reviewed to ensure the continued provision of a pedestrian crossing of Macleod Trail.
- 17 Avenue S.E. will extend east of Macleod Trail into Stampede Grounds as part of another project being undertaken between The City, Calgary Stampede, and CMLC.
- Long-term plans for the Big Four building are currently unknown and impacts to the building should be minimized.
- Impacts to the Union Cemetery grounds should be minimized.
- A storage track in a siding must be provided in the Erlton Station study area in the interim and ultimate horizons due to changes associated with the 17 Avenue S.E. Extension project.
- The Erlton LRT Station platform must accommodate a future 5 car train (135m overall length).
- Modification of the Cemetery Hill Tunnel north portal track structure should be avoided to eliminate the need for a major LRT service disruption, making this portal the southern limit of any LRT track re-alignment.
- The existing LRT right-of-way adjacent to the south-west corner of the Big Four building is assumed to be the northern limit of any LRT track re-alignment.
- New construction within the existing LRT right-of-way should be minimized to reduce the duration of service disruption when transitioning from existing to any new LRT alignment.
- LRT re-alignment should not result in any significant increase in travel time.
- Either a centre or side-loading platform station configuration is acceptable for a new station if required to replace the existing Erlton Station.

3.2 Initial Concepts

The first step in the development of concepts was to meet with stakeholders and the public. The community priorities were identified through the use of a dotmocracy process. This process allows the public and stakeholders to select the criteria they feel is most important by placing sticker dots on a board identifying a wide range of criteria. The top community priorities identified were:

- Pedestrian accommodation, such as new or improved pedestrian infrastructure.
- Improved vehicle travel times, including looking at the signal timing and dedicated turn lanes.
- Bicycle accommodation, such as new infrastructure or improvements that enhance cycling.
- Improved public transit
- Revitalization of the community.

In addition to the public engagement, a concept development workshop was held with key internal and external stakeholders including City of Calgary business units, Calgary Stampede, CMLC, and project team members. The objectives of the workshop were to:

- Work with the internal and external stakeholders to generate feasible concepts to grade separate the LRT at Erlton Station, while meeting the multiple study objectives.
- Produce several ultimate LRT grade separation design concepts that can be further refined and evaluated.
- Reduce re-work and fast-track the evaluation process by including stakeholder feedback early as part of the concept development process.

Following the initial engagement events, preliminary concepts were developed with the intention of addressing the following:

- Issues identified by the internal, external and public stakeholders.
- Maintaining access to key developments and attractions.
- Better accommodation for pedestrians and cyclists.
- Removing the LRT pre-emption at the intersection of Macleod Trail and 25 Avenue S.E.
- Optimizing future opportunities for redevelopment within the study area.

Concept A – Elevated LRT Station

This concept elevates the Red Line LRT tracks as they come out of the existing Cemetery Hill tunnel. Erlton Station is also elevated, and the new LRT guideway continues over the Elbow River returning to grade approaching the Big Four building. All roadways remain at-grade, but the east leg of 25 Avenue S.E. is relocated north of the existing intersection at Macleod Trail. *Figure ES-3* illustrates a 3D rendering of the preliminary concept with hypothetical future development.

Figure ES-3:Concept A Aerial Rendering

Benefits

- Access to Reader Rock Garden and Stampede Grounds have been improved.
- Pathways and sidewalks have been added to improve connections for people walking and cycling within the study area.
- Complete separation between the LRT and traffic and removal of the LRT and vehicle conflict at the intersection of Macleod Trail and 25 Avenue S.E.
- Two at-grade pedestrian crossings along Macleod Trail.

Trade-offs

- Stairs, ramps and elevators are required to access the Erlton LRT Station.
- High construction costs.
- The travel distance for people driving along 25 Avenue S. is slightly longer.

Concept B – Median Flyover to Existing 25 Avenue

This concept does not move the LRT station and tracks, but grade separates the traffic through a be-directional flyover from the median of Macleod Trail. The U-turn south of the river is also reversed. The east leg of the Macleod Trail and 25 Avenue S.E. intersection is closed and motorists on 25 Avenue S. must use ramps and the U-turn to complete certain movements. *Figure ES-4* illustrates a 3D rendering of the preliminary concept with hypothetical future development.

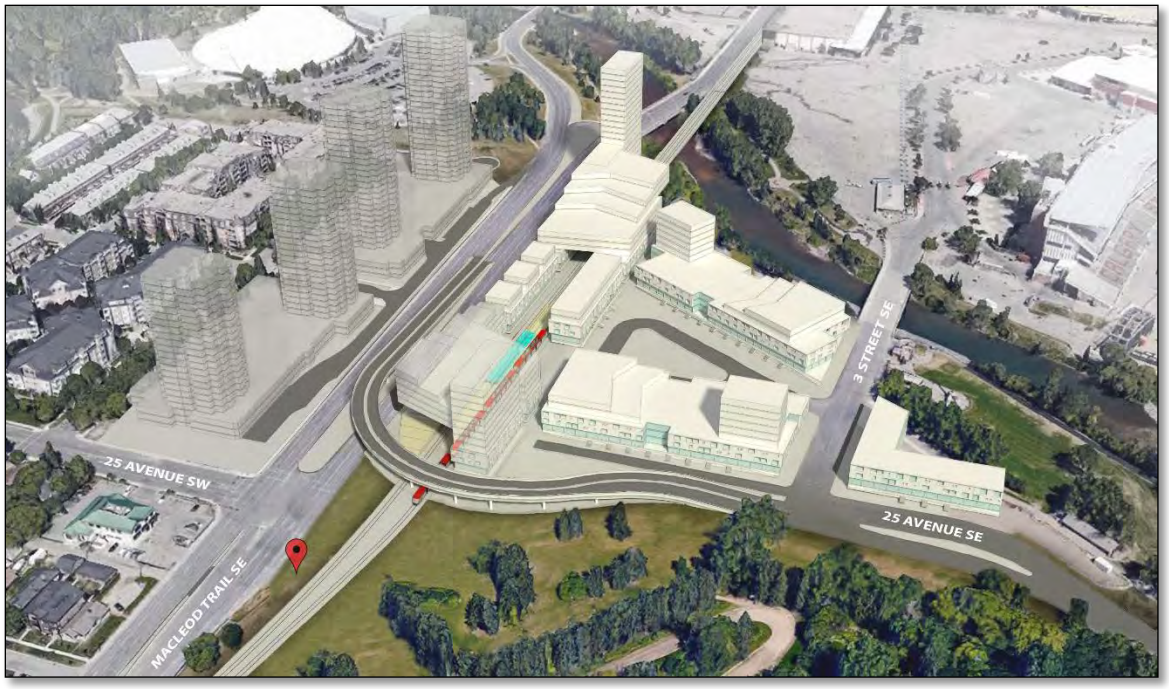


Figure ES-4:Concept B Aerial Rendering

Benefits

- Low construction costs.
- Complete separation between the LRT and traffic and removal of the LRT and vehicle conflict at the intersection of Macleod Trail and 25 Avenue S.E.
- Least disruptive to LRT service long term and during construction.

Trade-offs

- Increased travel distance and convoluted paths for vehicular traffic along 25 Avenue S. relative to existing network.
- The ramp is inconsistent with the characteristics of Macleod Trail's designation as an Urban Boulevard.

Concept C – Relocated At-Grade LRT Crossing

This concept leaves the LRT alignment, station and surrounding roads at-grade. The LRT alignment is shifted to the east where it intersects with a realigned 25 Avenue S.E. at a new level crossing. By shifting the LRT further east from Macleod Trail, this concept eliminates traffic signal delays due to the pre-emption at the existing 25 Avenue S.E. and Macleod Trail intersection. *Figure ES-5* illustrates a 3D rendering of the preliminary concept with hypothetical future development.

Figure ES-5: Concept C Aerial Rendering

Benefits

- Removes the LRT and vehicle conflict on 25 Avenue S.E. and Macleod Trail.
- Improved access to Reader Rock Garden.
- The LRT station and road are all at-grade.
- There are two at-grade pedestrian crossings along Macleod Trail.

Trade-offs

- People walking, cycling and driving cross the Red Line LRT tracks at an at-grade crossing.
- The travel distance for people driving along 25 Avenue S. is slightly longer.
- Limited opportunities for LRT service to increase in frequency as the LRT still impacts the vehicular operation of 25 Avenue S.
- High construction costs.

3.3 Depressed LRT Considerations

The option of constructing a depressed LRT alignment beneath 25 Avenue S.E. was raised at various times during the study. Initial assessment of this option presented several major difficulties in the constrained confines of the area between Cemetery Hill and the Elbow River.

The profile shows the existing LRT tracks are on a steep downward slope as they approach the Cemetery Hill tunnel portal and then transition into an upward 3.7% gradient to cross 25 Avenue.

Re-grading the LRT alignment to pass below the existing 25 Avenue would mean that the complete tunnel portal would have to be reconstructed. Alternatively, the east leg of 25 Avenue could be relocated farther north to provide some distance in which to depress the alignment below the roadway without major reconstruction of the tunnel portal. In order for the LRT to pass under a relocated 25Avenue E and then re-connect to the existing LRT bridge across the Elbow River, the station would have to be constructed on the maximum permitted 1.5% grade adjacent to a significant 4.5% approach grade north of the station. In addition, this re-alignment requires severe horizontal curvature resulting in less than desirable sub-standard geometry for the LRT operation.

Construction of any form of below-grade LRT would shut down LRT service for an extended period and also impact the operation of adjacent roadways. Ameliorating the impacts of ground water and flooding would also have to be considered in the design of the depressed station. The below-grade option south of the river would be much more disruptive to LRT service requiring closure of Erlton Station and a temporary mainline diversion, as well as lower standard, more expensive infrastructure to build and maintain than any of the at-grade or above-grade concepts investigated in this study.

Given the complexities, disruption and costs associated with this option, it was not considered further as a viable concept.

3.4 Refined Concepts

Additional investigation was undertaken to see how the three concepts could be further refined to incorporate:

- stakeholder feedback regarding redevelopment, accessibility, and Stampede Grounds operations;
- retaining adequate capacity for traffic entering and exiting the Stampede Grounds;
- accommodating people walking and cycling, with allowances for sidewalks or pathways along all new roadways and connections to existing facilities;
- providing access for transit vehicles servicing Erlton Station;
- providing access to Reader Rock Garden; and
- keeping maintenance access to the LRT tunnel portal.

The proposed access in each concept provides a replacement U-turn route for traffic exiting from the Repsol Sport Centre that wishes to travel northbound on Macleod Trail.

Concept A – Elevated LRT Station

The plan view for the refined Concept A is provided in *Figure ES-6.* Refinements to this concept include:

- Pathways and sidewalks added along all new roadways and connections to existing facilities to improve connections for people walking and cycling.
- Relocation of current southbound U-turn traffic on Macleod Trail to an alternative route. This is to create additional southbound left-turn storage at 25 Avenue S.

- Bus pullouts on 25 Avenue S.E. to accommodate transit service and access to Erlton Station.
- New intersection on 25 Avenue S.E. to provide access to Reader Rock Garden and the LRT portal.
- Extension of the Anthem Crosstown development's pedestrian overpass to the new elevated Erlton Station.

Concept B – Median Flyover to Existing 25 Avenue S.E.

Concept B originally proposed the use of flyover ramps and the U-turn south of the Elbow River to route traffic to and from the east leg of 25 Avenue S.E. This concept was further refined to use both the U-turn as well as 18 Avenue S.E. to serve the traffic originally expected to use the U-turn, thereby reducing the volume of traffic at the U-turn. In this way, the weaving issues along northbound and southbound Macleod Trail would be improved, with increased space for vehicle storage.

This refinement, Concept B2, allows a portion of the east leg of 25 Avenue S.E. to remain at-grade forming a right-in/right-out with Macleod Trail. The refined concept also includes a single southbound left-turn lane ramp from the median of Macleod Trail to 25 Avenue S.E. Through movements would still not be allowed at the intersection to keep the signal operating without LRT pre-emption. Westbound vehicles on 25 Avenue S.E. would use the at-grade right-out but would be prohibited from merging in with northbound Macleod Trail until north of the U-turn.

Vissim analysis showed overall capacity improvements and a reduction in weaving issues along Macleod Trail. Maintaining some at-grade access for the east leg of 25 Avenue S.E. was also preferred by Calgary Stampede relative to the original Concept B as it provides better connections in and out of the Stampede Grounds. Overall, Concept B2 has slightly better active modes accommodation, vehicle operations, and community/property access than Concept B. However, traffic is no longer completely separated from the LRT and gates would still be required at the LRT crossing.

The plan view for Concept B and refined Concept B2 are provided in *Figure ES-7* and *Figure ES-8.* Other refinements, in addition to the road configuration discussed above, include:

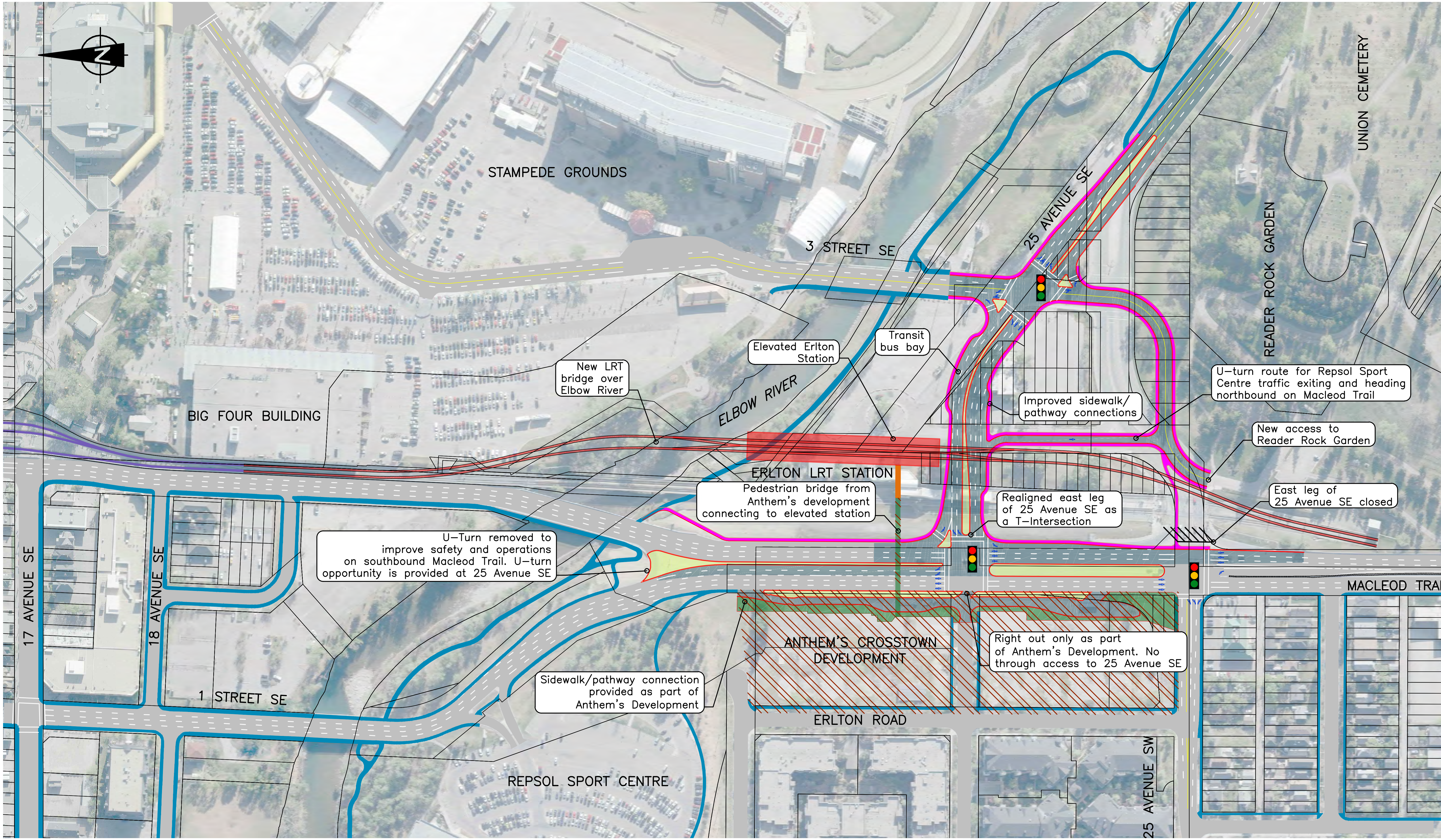
- Pathways and sidewalks have been added along all new roadways and connections to existing facilities to improve connections for people walking and cycling.
- A cul-de-sac to allow Erlton Station traffic to turn around.
- A roundabout at the intersection of 25 Avenue S.E. and 3 Street to facilitate multiple turning movements.

Concept C – Relocated at-Grade LRT Crossing

The plan view for the refined Concept C is provided in *Figure ES-9*. Refinements to this concept include:

- Pathways and sidewalks have been added along all new roadways and connections to existing facilities to improve connections for people walking and cycling.

- Relocation of current southbound U-turn traffic on Macleod Trail to an alternative route. This is to create additional southbound left-turn storage at 25 Avenue S.
- Bus pullouts on 25 Avenue S.E. and the new road in front of Erlton Station.
- A cul-de-sac to allow Erlton Station traffic to turn around.
- Relocation of 3 Street and 25 Avenue S.E. intersection.
- A ramp extension from the Crosstown development pedestrian overpass to the relocated Erlton Station.



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EXISTING PAVEMENT
EXISTING PATHWAY
EXISTING ERLTON STATION
EXISTING LRT TRACKS
ANTHEM'S PEDESTRIAN CONNECTIONS
ANTHEM'S DEVELOPMENT

NEW / ALTERED PAVEMENT
PROPOSED STRUCTURE
PROPOSED CONCRETE SURFACING
PROPOSED PATHWAY/ SIDEWALK
PROPOSED PEDESTRIAN OVERPASS
FLOODWAY

PROPOSED CURB & GUTTER
PROPOSED CONCRETE BARRIER
PROPOSED ERLTON STATION
PROPOSED LRT TRACK
101+200 ROAD STATIONING
21+600 LRT STATIONING

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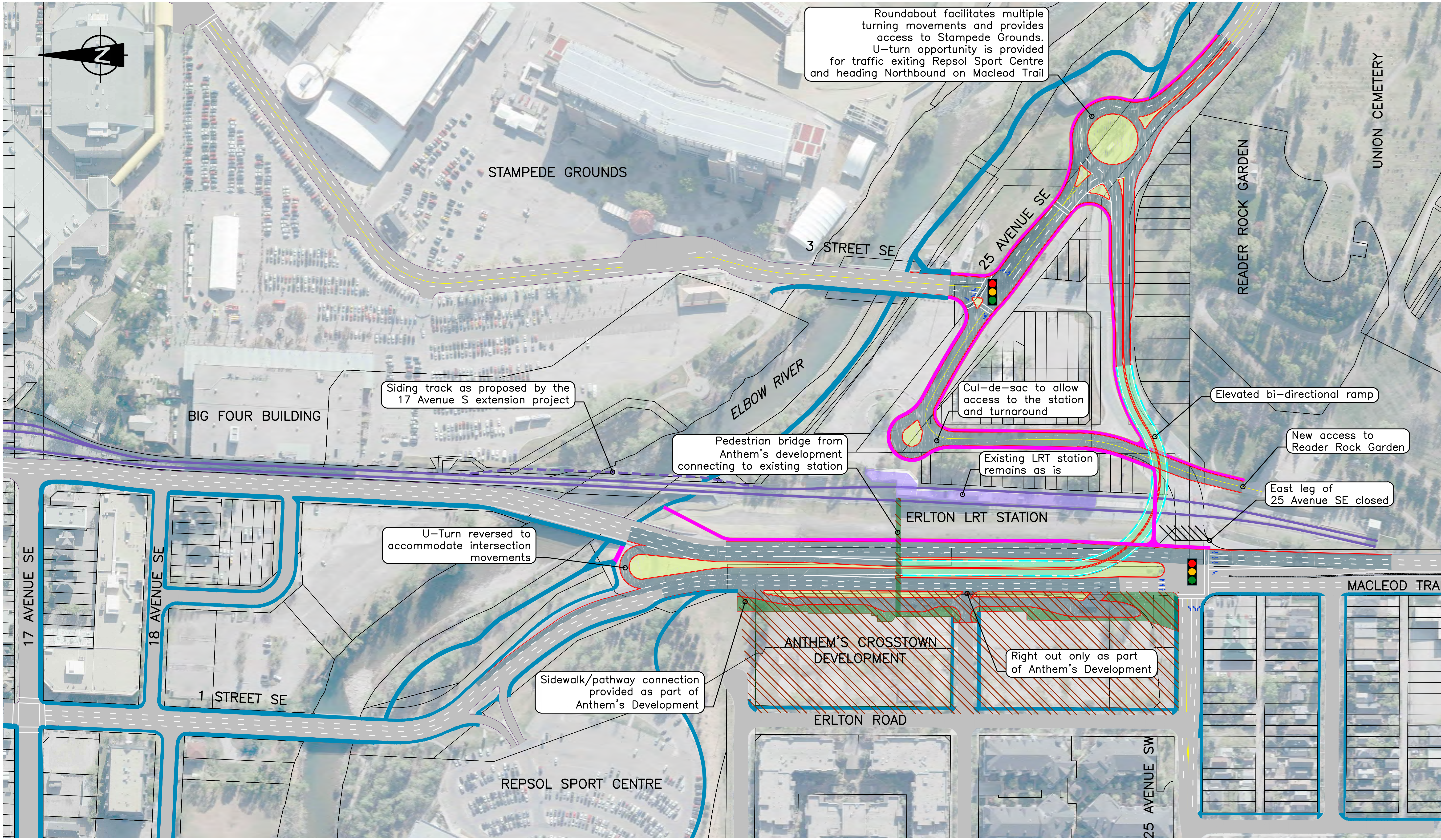
Refined Concept A
Elevated LRT Station

Plan

25 Avenue SE LRT Grade Separation Study

Fig. ES-6



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- EXISTING PAVEMENT
- EXISTING PATHWAY
- EXISTING ERLTON STATION
- EXISTING LRT TRACKS
- ANTHEM'S PEDESTRIAN CONNECTIONS
- ANTHEM'S DEVELOPMENT
- NEW / ALTERED PAVEMENT
- PROPOSED STRUCTURE
- PROPOSED CONCRETE SURFACING
- PROPOSED PATHWAY/ SIDEWALK
- PROPOSED PEDESTRIAN OVERPASS
- FLOODWAY
- PROPOSED CURB & GUTTER
- PROPOSED CONCRETE BARRIER
- PROPOSED ERLTON STATION
- PROPOSED LRT TRACK
- 101+200 ROAD STATIONING
- 21+600 LRT STATIONING

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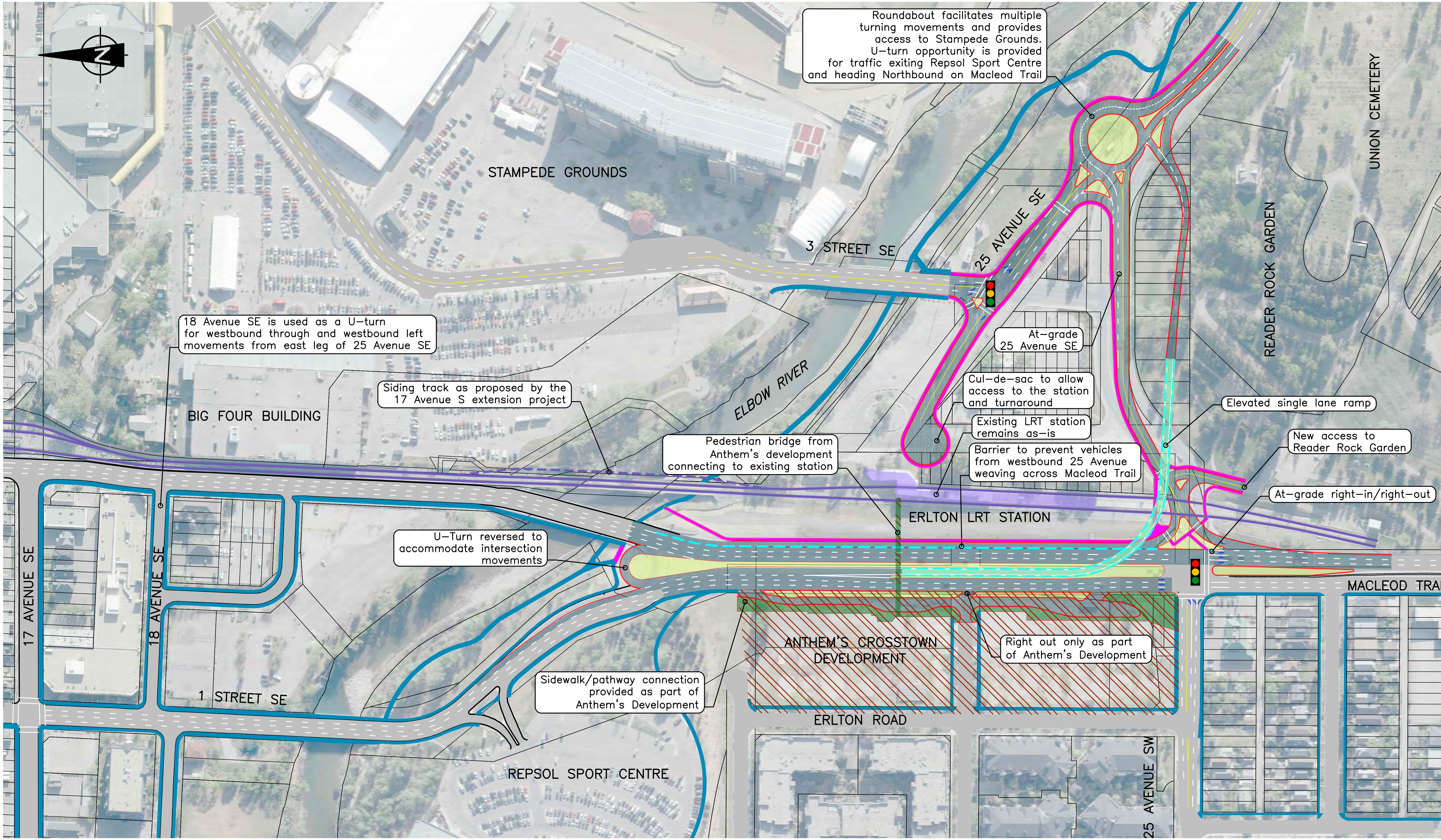
Refined Concept B
Bi-Directional Median Flyover

Plan

25 Avenue SE LRT Grade Separation Study

Fig. ES-7



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EXISTING PAVEMENT
EXISTING PATHWAY
EXISTING ERLTON STATION
EXISTING LRT TRACKS
ANTHEM'S PEDESTRIAN CONNECTIONS
ANTHEM'S DEVELOPMENT

NEW / ALTERED PAVEMENT
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PROPOSED CONCRETE BARRIER
PROPOSED ERLTON STATION
PROPOSED LRT TRACK
101+200 ROAD STATIONING
21+600 LRT STATIONING

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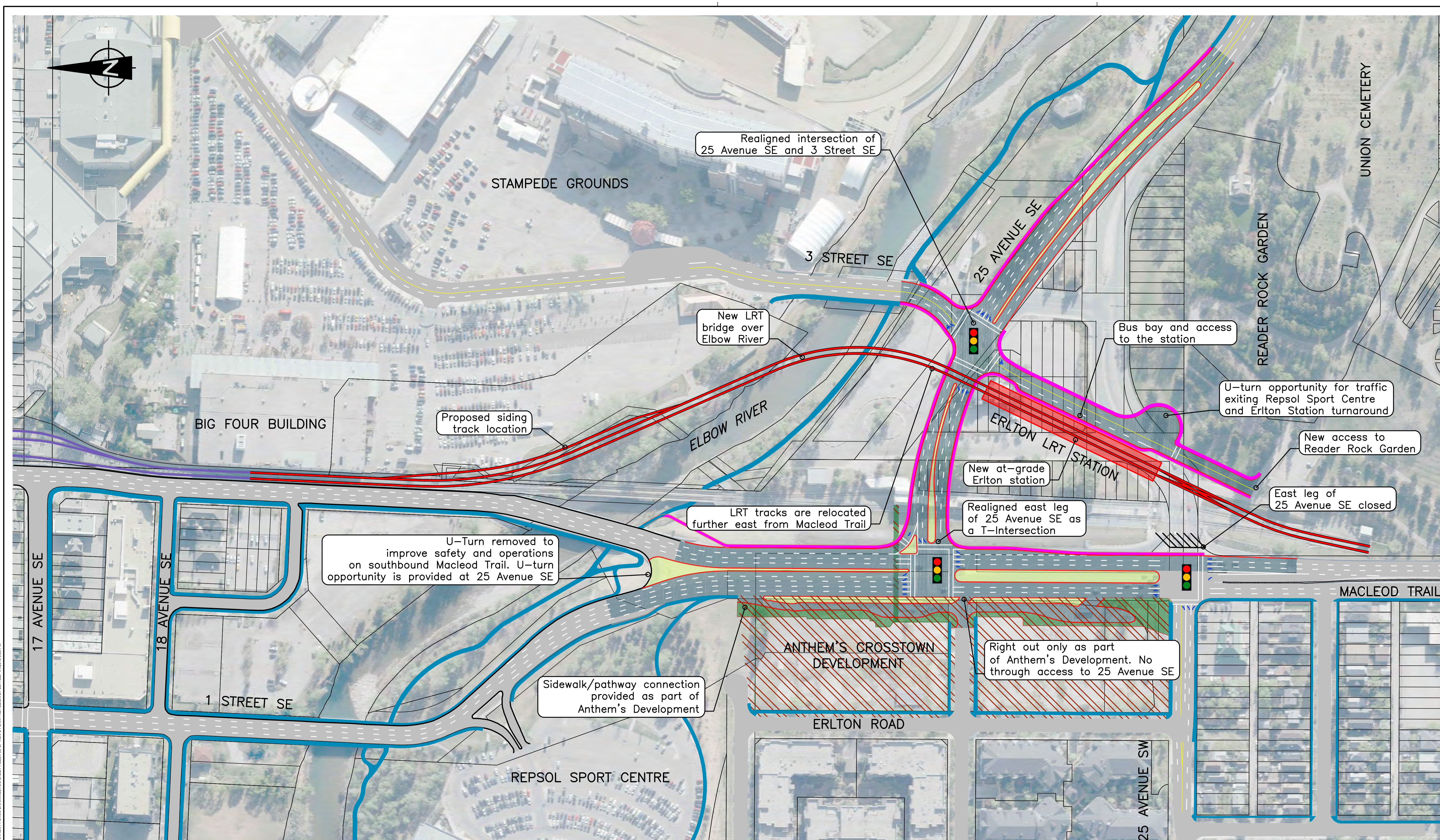
Refined Concept B2
Single Lane Median Flyover

Plan

25 Avenue SE LRT Grade Separation Study

Fig. ES-8



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EXISTING PAVEMENT
EXISTING PATHWAY
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PROPOSED CONCRETE BARRIER
PROPOSED ERLTON STATION
PROPOSED LRT TRACK
101+200 ROAD STATIONING
21+600 LRT STATIONING

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Refined Concept C
Relocated At-Grade LRT Crossing

Plan

25 Avenue SE LRT Grade Separation Study

Fig. ES-9

3.5 Concept Evaluation

The evaluation criteria were established by the project team based on the feedback received from stakeholders during the initial engagement events, as well as input provided by The City of Calgary based on policies and guidelines. Combining the feedback received from stakeholders and The City identified a total of eleven major evaluation criteria categories. A summary of the selected evaluation criteria is provided in *Table ES-1,* along with descriptions of each criterion.

Table ES-1: Evaluation Criteria and Description

Evaluation Criteria	Description
LRT Service	▪ Ability to increase train frequency ▪ Changes to LRT speed or travel time
Active Modes Accommodation	▪ Active modes opportunities to cross Macleod Trail ▪ The ease of access to the LRT station
Vehicle Operations	▪ The efficiency of vehicular travel within and through the area, including delays, travel distances, wayfinding, and maneuverability
Access Management	▪ Changes to existing property access (Calgary Stampede Grounds, Reader Rock Garden, Repsol Sport Centre) ▪ Changes to community access ▪ Future development access opportunities
TOD Potential	▪ The attractiveness of the developments given the surrounding area and infrastructure for leasing / resale, including land parcel sizes and orientation ▪ Total land area available
Staging of Development	▪ The ease with which surrounding land can be utilized/developed in the short-term
Safety	▪ Conflict points at intersections, vehicular maneuvering abilities, and geometric/operational issues ▪ Crossings of the LRT with pedestrian, cyclist, or vehicular traffic
Disruption to Floodway	▪ Impacts to the flow of water in storm events
Construction Cost	▪ The total cost of construction & contingencies
LRT Service Disruption During Construction	▪ The disruption to LRT service and operations that construction will cause, including service interruptions, shut down or shuttle service, and extended delays
Traffic Disruption During Construction	▪ The disruption to traffic operations that construction will cause, including lane closures, detours, and extended delays

Each criterion was prioritized based on its relative importance in achieving the project objectives and community priorities. Prioritization was assigned by giving each criterion a different weighting. The higher the weighting of each criterion was, the higher its priority would be. As such, pedestrian and cyclist accommodation, safety, TOD potential, and LRT service were given higher weightings than the other criteria, as identified by the community prioritization exercises.

The completed evaluation matrix, including the weighting of each criterion and overall scores, can be found in *Table ES-2* and *Table ES-3*. The current potential for development in the study area is very dependent on existing flood mapping and the Land Use Bylaw. However, the flood mapping and Land Use Bylaw may change with the flood mitigation measures currently underway and/or planned. The overall evaluation of the concepts was undertaken for the two development scenarios: conservative TOD potential based on current bylaws, and maximum TOD potential assuming full development of the area can occur. All other criteria remain the same for the two scenarios.

Table ES-2: Refined Concept Evaluation Matrix with Conservative TOD Potential

Evaluation Criteria	Weight	Do Nothing	Concept A	Concept B	Concept B2	Concept C
LRT Service	10.0	1.0	3.0	5.0	4.0	2.0
Pedestrian and Cyclist Accommodation	14.0	2.0	4.0	3.0	4.0	5.0
Vehicle Operations	8.0	1.0	4.0	3.0	4.0	2.0
Access Management	8.0	3.0	4.0	2.0	3.0	3.0
TOD Potential	13.0	5.0	2.0	4.0	4.0	3.0
Staging of Development	6.0	5.0	2.0	4.0	4.0	3.0
Safety	16.0	1.0	5.0	3.0	3.0	2.0
Disruption to Floodway	5.0	5.0	4.0	2.0	2.0	3.0
Construction Cost	8.0	5.0	1.0	4.0	4.0	2.0
LRT Service Disruption During Construction	8.0	5.0	1.0	5.0	5.0	3.0
Traffic Disruption During Construction	4.0	5.0	4.0	2.0	2.0	3.0
Total Score	100	38.0	34.0	37.0	39.0	31.0
Total Weighted Score	**500**	**306.0**	**320.0**	**346.0**	**366.0**	**286.0**

Table ES-3: Refined Concept Evaluation Matrix with Maximum TOD Potential

Evaluation Criteria	Weight	Do Nothing	Concept A	Concept B	Concept B2	Concept C
LRT Service	10.0	1.0	3.0	5.0	4.0	2.0
Pedestrian and Cyclist Accommodation	14.0	2.0	4.0	3.0	4.0	5.0
Vehicle Operations	8.0	1.0	4.0	3.0	4.0	2.0
Access Management	8.0	3.0	4.0	2.0	3.0	3.0
TOD Potential	13.0	3.0	4.0	2.0	2.0	5.0
Staging of Development	6.0	5.0	2.0	4.0	4.0	3.0
Safety	16.0	1.0	5.0	3.0	3.0	2.0
Disruption to Floodway	5.0	5.0	4.0	2.0	2.0	3.0
Construction Cost	8.0	5.0	1.0	4.0	4.0	2.0
LRT Service Disruption During Construction	8.0	5.0	1.0	5.0	5.0	3.0
Traffic Disruption During Construction	4.0	5.0	4.0	2.0	2.0	3.0
Total Score	100	36.0	36.0	35.0	37.0	33.0
Total Weighted Score	**500**	**280.0**	**346.0**	**320.0**	**340.0**	**312.0**

Based on the evaluation, the 'Do Nothing' and Concept C were the lowest scored concepts for both development scenarios and should not be pursued further. Concept A and Concept B2 continue to have merits in meeting the study objectives and should be re-evaluated once the flood mitigation measures are in place and a new floodway zone has been identified. At that time, the TOD potential can be better determined with the actual developable land area.

ES 4.0 Cost Estimates

The cost estimation includes four basic types of costs; Roadway, Track, Station, and Structural costs. All costs were based on recent costs from similar projects. The costs are presented in 2017 dollars and have not been adjusted for inflation as timelines for this project are unknown. Contingency (25%) and engineering costs (15%) have been added on to the construction sub totals to account for the high-level nature of this estimate and uncertain timelines. Costs for Concept A, Concept B, Concept B2 and Concept C are included in *Table ES-4*.

Table ES-4: Refined Concept Cost Estimates

Description	Concept A	Concept B	Concept B2	Concept C
Roadway				
Removals & site preparation	$1,800,000	$1,800,000	$1,800,000	$1,800,000
New roadway (paved area)	$1,500,000	$2,045,000	$2,310,000	$1,800,000
New walkway (sidewalk/pathways)	$652,500	$652,500	$697,500	$731,250
New roadway (concrete medians / islands)	$495,000	$690,000	$750,000	$555,000
New roadway (barriers)	$0	$180,000	$292,500	$0
New roadway (storm system)	$200,000	$100,000	$100,000	$200,000
Subtotal	$4,647,500	$5,467,500	$5,950,000	$5,166,250
LRT Track				
At-grade track (including earthworks)	$5,720,000	$0	$0	$10,230,000
Level crossing infrastructure	$140,000	$0	$0	$840,000
Elevated track (including guideway structure)	$7,440,000	$0	$0	$0
At-grade track (including siding & all earthworks)	$26,100,000	$0	$0	$22,620,000
Special trackwork (crossovers, turnouts etc.)	$2,700,000	$0	$0	$2,400,000
Traction power sub-station	$990,000	$0	$0	$3,000,000
LRT systems (traction power, train control, comms.)	$4,488,000	$0	$0	$4,785,000
Subtotal	$47,578,000	$0	$0	$43,875,000
Station				
Demolition and removal of existing LRT track/station	$2,500,000	$0	$0	$2,500,000
Maintaining transit service during LRT closure	$3,000,000	$0	$0	$2,000,000
Elevated station infrastructure	$33,000,000	$0	$0	$ 18,000,000
Subtotal	$38,500,000	$0	$0	$22,500,000
Other Structures				
Flyover structure	$0	$23,400,000	$10,800,000	$0
LRT river crossing bridge	$0	$0	$0	$5,850,000
Subtotal	$0	$23,400,000	$10,800,000	$5,850,000
Miscellaneous Costs				
Traffic signals	$750,000	$300,000	$300,000	$750,000
Utility relocations	$1,000,000	$1,000,000	$1,000,000	$1,000,000
Subtotal	$1,750,000	$1,300,000	$1,300,000	$1,750,000
Cost Summary				
Subtotal	$92,475,500	$30,167,500	$18,050,000	$79,141,250
Contingency (25%)	$23,118,875	$7,541,875	$4,512,500	$19,785,313
Engineering (15%)	$13,871,325	$4,525,125	$2,707,500	$11,871,188
Total	$129,465,700	$42,234,500	$25,270,000	$110,797,750

ES 5.0 Recommendations

The intersection of Macleod Trail and 25 Avenue S.E. will continue to play a key role in Calgary's transportation system. The continued evolution of Macleod Trail as an Urban Boulevard, including future mixed-use and TOD development, will further increase the importance of this area. Due to its location, the intersection is a key node for all modes of travel and is expected to be so well into the future. There are potential solutions to improve pedestrian and cyclist accommodation and traffic flow in the area, while maintaining LRT operations and providing opportunities for development.

This study identified three alternative concepts to an interchange and has evaluated these concepts relative to The City's policies and objectives as well as stakeholder priorities. The three concepts were:

- Concept A: elevated LRT and Erlton Station above realigned 25 Avenue S.E.
- Concept B: a median flyover from Macleod Trail to existing 25 Avenue S.E.
- Concept C: relocated at-grade crossing further east of Macleod Trail.

The lack of clarity regarding the relationship between the Elbow River Floodway and hypothetical redevelopment in the area poses a dilemma. This area of the Elbow River is one of the most complex and important flood areas in Calgary. The boundary of the floodway is under review by Alberta Environment and Parks and may be subject to further modification when upstream flood mitigation measures are implemented. It is expected that with the upstream reservoirs, Springbank Reservoir, and the new gates on the Glenmore Dam, a 2013-sized flood could be managed without overland flooding along the Elbow River. Consequently, until these mitigation measures are in place, the area of land that may be developable under future Provincial and City flood mitigation policies is uncertain.

Nevertheless, it has been established that Concept B2 would provide several improvements over the existing conditions and could be implemented at City Council's discretion whenever deemed necessary. Concept A may also be a viable choice depending on the resolution of redevelopment and floodway issues.

Since there is neither funding allocated for grade separation of 25 Avenue S.E. and the Red Line LRT, nor new redevelopment proposals imminent in the area, it is recommended to defer a decision between Concept A and Concept B2 until the flooding and redevelopment matter is clarified. Once the mitigation measures are in place and a new floodway zone has been identified, a re-evaluation of the TOD potential can be undertaken at that stage.

In the interim, modest traffic improvements can be achieved by implementing improved traffic signal control technology at the 25 Avenue S.E. and Macleod Trail intersection. Construction of a pathway along the east side of Macleod Trail would improve connectivity between the Elbow River Pathway and Reader Rock Garden. Re-grading the pathway area between Macleod Trail and the Red Line LRT would improve floodwater conveyance in the area as well. Also, reduction of the posted speed limit on Macleod Trail to 50 km/h in the study area would improve the pedestrian environment on both sides of the roadway.

1. Introduction

1.1. Background

The intersection of Macleod Trail and 25 Avenue S.E. is an important node in Calgary's road network where converging traffic from the southern part of the city crosses the Elbow River to reach Downtown. Adjacent to the intersection, the Erlton Station on the Red LRT line (C-Train) attracts pedestrians from the surrounding area and provides access to the Calgary Stampede Grounds north of the Elbow River.

The presence of the Red Line LRT adjacent to Macleod Trail complicates the operation of the traffic signal system at the 25 Avenue intersection by 'pre-empting' the signal phasing to accommodate the passing of C-Trains in both directions. The at-grade track crossing is gate-arm controlled and facilitates the clearing of vehicles off the track as trains approach. This disruption of optimal signal phasing is most detrimental to the southbound left-turn movement and the westbound through and left-turn movements that accommodate heavy traffic volumes to/from the industrial area to the east.

The intersection has been under review by The City of Calgary's Transportation Department, including the Roads and Transportation Planning business units, to identify optimization opportunities. However, optimisation opportunities do not remove the interaction between the LRT and roadway, resulting in signal pre-emption, which is the primary cause of congestion at this location. Calgary Transit has recently upgraded the C-Trains to 4-car configurations to increase the service capacity. In addition, with a future (planned but unfunded) separation of the Red and Blue Lines at 8 Avenue S, Calgary Transit plans to increase the frequency of trains from 5 minutes to 3 minutes during peak periods. These two factors will further exacerbate the problems currently experienced at the intersection.

In July 2016, City Council discarded a previously approved interchange plan for this location and directed Administration to develop a recommended plan for grade separation of the Red Line LRT tracks at 25 Avenue S.E. east of Macleod Trail. While the interchange would have resolved the traffic operation issues experienced at the intersection as a result of LRT pre-emption, it no longer aligns with the Urban Boulevard classification of Macleod Trail provided in the Calgary Transportation Plan (CTP). The interchange plan also does not align with land use policies in the

area, such as the Municipal Development Plan (MDP) and the Erlton Area Redevelopment Plan (ARP), nor with the Urban Corridor designation of lands adjacent to Macleod Trail.

1.2. Study Scope and History

The focus of this study, as shown in *Figure 1-1*, was the intersection of Macleod Trail and 25 Avenue S.E. The study boundary was further extended during the project to provide integration with the 17 Avenue S.E. Extension project.

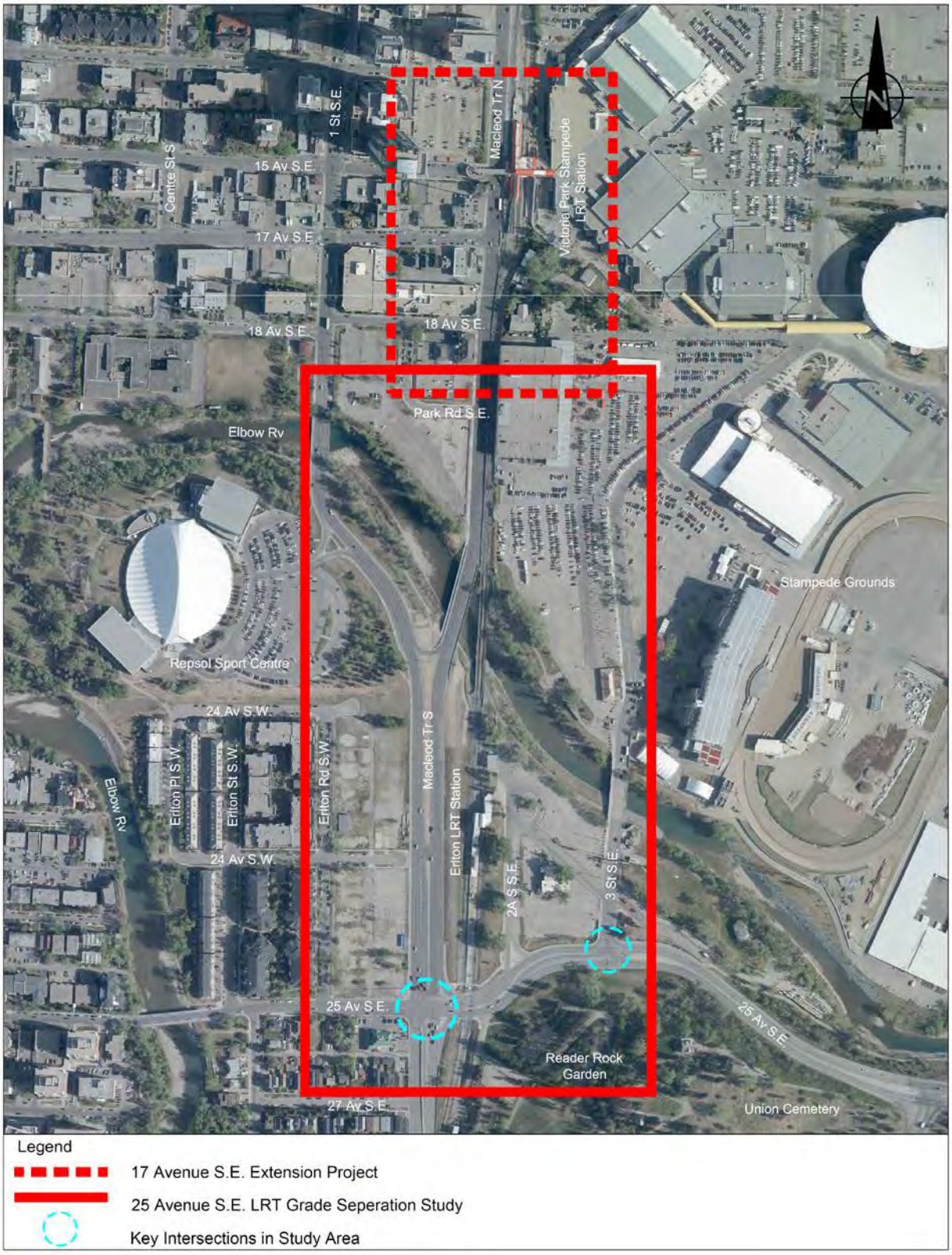


Figure 1-1: Study Area

As mentioned previously, there have been several previous studies conducted in the area, as summarized below:

1970's Planning for a grade separated interchange began to address traffic volumes and the LRT interruption of intersection traffic operations.

2006 25 Avenue S.E. Connector project initiated to determine future upgrades to 25 Avenue S.E. between Macleod Trail and Blackfoot Trail.

2009 The 25 Avenue S.E. Connector project recommended plan, which included an interchange at 25 Avenue S.E. and Macleod Trail, approved by Council.

2015 Council directed Administration to look at alternatives to an interchange at 25 Avenue S.E. and Macleod Trail. An interchange was no longer considered appropriate because of the road types and adjacent land uses.

2016 A feasibility study was conducted to determine if grade separating the LRT tracks without an interchange is possible. The feasibility study showed that an alternative to an interchange is possible as illustrated in *Figure 1-2*. Based on the results:

i. Council directed Administration to undertake a functional planning study to establish a recommended grade separation plan for the Red Line LRT tracks and 25 Avenue S.E.

ii. Land protection for an interchange at this location was removed.

2017 25 Avenue S.E./LRT Grade Separation Study begins.

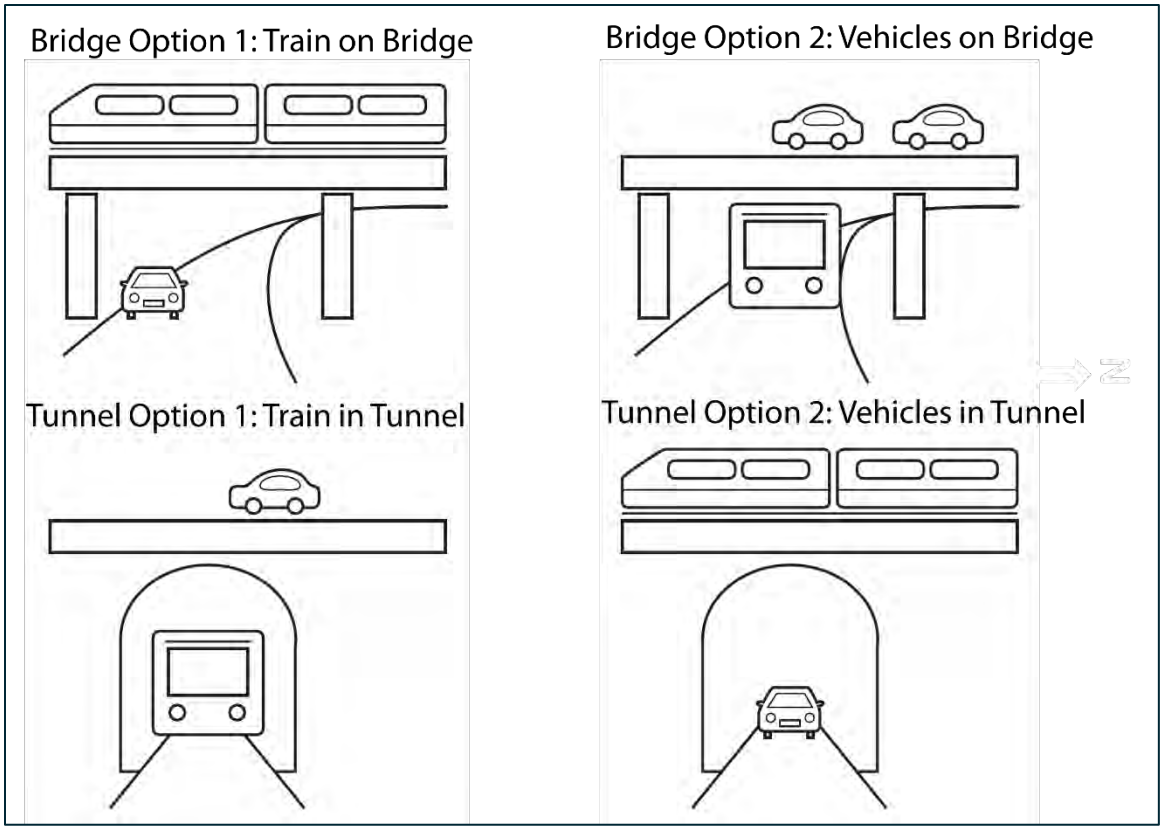


Figure 1-2: Feasibility Study Options

1.3. Study Purpose & Objectives

The focus of this project was to determine how a grade separation of 25 Avenue S.E. with the LRT could be accomplished to relieve the traffic congestion caused by the LRT pre-emption at the intersection and allow for an increase in LRT service. Other important considerations include land use policies, transit operation, pedestrian and cyclist accommodation, safety, community and property access, river flooding, and preservation of the Reader Rock Garden historical site.

There are three primary objectives for the study:

- Road: Improve accommodations for all road users in accordance with Complete Streets Policy.
- Rail: Enhance transit service to attract transit users, improve customer experience and meet future demands.
- Redevelopment: Encourage transit supportive development on lands adjacent to Erlton Station.

1.4. Study Process

The study process consisted of three phases, as outlined in *Figure 1-3* and elaborated on below.

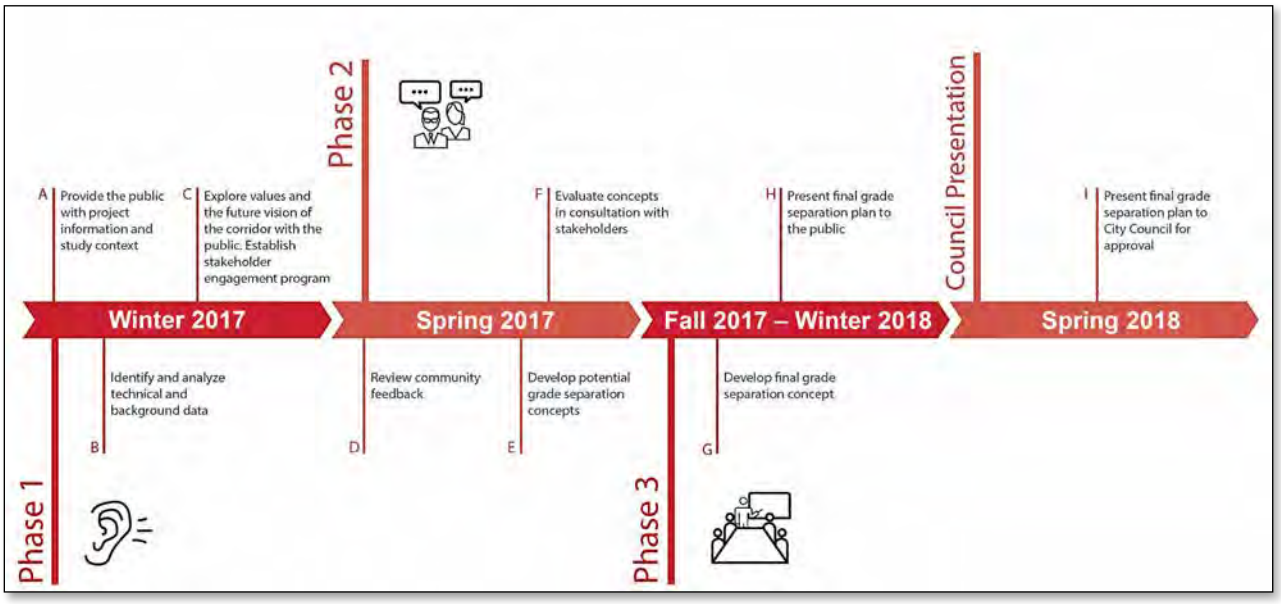


Figure 1-3: Study Process

Phase 1: Project Initiation & Review Existing Conditions

Phase 1 informed the community and key stakeholders of the project objectives, scope and context. Public engagement was carried out to establish community values and future vision for the study area prior to investigating any improvement concepts. On the technical side, existing conditions were established and analyzed.

Phase 2: Develop Potential Concerts

During Phase 2, the feedback from Phase 1 was reviewed. Preliminary concepts were developed that met the community priorities and project objectives. Preliminary traffic analysis and geometric design review were undertaken to ensure preliminary concepts were feasible. The preliminary concepts were prepared and presented to stakeholders for feedback. An evaluation criteria matrix was developed based on the project objectives, community priorities, and feedback from The City team. The concepts were then evaluated with consideration for both the technical and stakeholder engagement findings.

Phase 3: Select and Present Recommended Concepts

In the final phase, the study recommendations were presented to stakeholders and were documented for City approval.

2. Existing Conditions

2.1. Road Network

Macleod Trail - is an urban boulevard that acts as a central spine connecting south Calgary (and beyond) with the downtown core. The corridor is used by over 50,000 commuters per day. Macleod Trail extends from Riverfront Avenue S.E. in the north to the southern City limits, where it becomes Highway 2A. Macleod Trail is a one-way roadway in the northbound direction north of the Elbow River. It is a two-way roadway south of the Elbow River, where 1 Street S.E. joins and becomes the southbound portion of Macleod Trail.

25 Avenue S.E. - is an east-west roadway with a collector classification west of Macleod Trail, and an arterial classification east of Macleod Trail. It connects the communities of Cliff Bungalow, Mission, Erlton, Ramsay and Alyth / Bonnybrook / Manchester. It extends west to Hillcrest Avenue. and east to Dartmouth Road. 25 Avenue provides an important east-west connection to Macleod Trail S.E. and is used by commuters from adjacent communities. As approved by Council in the 25 Avenue S.E. Blackfoot Trail Connector Study, the 25 Avenue S.E. corridor is planned to connect Macleod Trail with Blackfoot Trail in the future. As such, 25 Avenue S.E. is expected to carry higher traffic volumes when a direct connection with Blackfoot Trail is provided.

2A Street S.E. - is a local two-lane road located east of Macleod Trail. It provides access to the Erlton LRT Station and Stampede parking lots.

3 Street S.E. - is a four-lane local road located east of 3 Street S.E. It provides direct access into the Calgary Stampede Grounds.

Erlton Road S.W. - is a local two-lane road located west of Macleod Trail. It provides access to the multifamily developments northwest of the intersection.

Within the study area, Macleod Trail intersects with 25 Avenue S.E. to form a four-leg signalized intersection. 25 Avenue S.E. intersects with Erlton Road. and 2A Street S.E. to form three-leg unsignalized intersections and with 3 Street S.E. to form a three-leg signalized intersection. Geometric features of the intersections analyzed in this study are summarized in Sections 2.1.1 through 2.1.4.

2.1.1. Macleod Trail and 25 Avenue S.E. Intersection

The intersection of Macleod Trail and 25 Avenue S.E. is a four-leg signalized intersection. It is located in close proximity to the at-grade LRT crossing 25m to the east. The existing geometric features of the intersection are summarized in *Table 2-1*.

Table 2-1: Macleod Trail and 25 Avenue S.E. Intersection Characteristics

Eastbound Direction ▪ Two eastbound through lanes and one left-turn lane with storage (65 m). ▪ Centerline road marking. ▪ Monolithic sidewalk on both sides: 1.4m wide.	
Westbound Direction ▪ One dedicated through lane, one shared left-through lane, and one dedicated left-turn lane with storage (40m) westbound. ▪ Channelized right-turn lane westbound that becomes an added lane on Macleod Trail. ▪ Centerline road marking. ▪ Two sets of LRT tracks in advance of the approach with signals, gates and road markings. ▪ Sidewalks on both sides: north sidewalk transitions from separated (2.6m wide) to monolithic (1.4m wide), south sidewalk is monolithic (2.2m - 1.2m).	
Southbound Direction ▪ Two through lanes and one shared through-right lane southbound. ▪ Two southbound left-turn lanes with storage (130m). ▪ Median island between opposing traffic. ▪ Monolithic sidewalk on both sides: 1.2m wide on west side and 2.8m wide on east side.	
Northbound Direction ▪ Three through lanes and channelized right turn-turn lane with storage (40m) northbound. ▪ One northbound channelized left-turn lane with storage (90m). ▪ Median island between opposing traffic. ▪ Monolithic sidewalk on west side (1.4m wide).	

2.1.2. Erlton Road and 25 Avenue S.W. Intersection Characteristics

The intersection of Erlton Road and 25 Avenue S.W. is a three-leg unsignalized intersection. The existing geometric features of the intersection are summarized in *Table 2-2*.

Table 2-2: Erlton Road and 25 Avenue S.W. Intersection Characteristics

Eastbound Direction ▪ Two eastbound through lanes (uncontrolled). ▪ Parking prohibited on the south side. ▪ On-street parking allowed for up to 2 hours without a permit from 08:00 - 17:00, Mon. – Fri. on the north side. Permit holders do not have parking restrictions. ▪ Centerline road marking. ▪ Separated sidewalk on both sides: 1.3m wide.	
Westbound Direction ▪ Two westbound through lanes (uncontrolled). ▪ Parking prohibited on both sides. ▪ Centerline road marking. ▪ Monolithic sidewalk on both sides (1.4m wide).	
Southbound Direction ▪ One shared left/right turn lane southbound. ▪ On-street parking allowed for up to 2 hours without a permit from 08:00 - 17:00, Mon. – Fri. on the west side. Permit holders do not have parking restrictions. ▪ On-street parking prohibited on the east side, except for permit holders. ▪ Stop-controlled. ▪ Separated sidewalk on both sides (1.3m wide).	

2.1.3. 2A Street and 25 Avenue S.E. Intersection Characteristics

The intersection of 2A Street and 25 Avenue S.E. is a three-leg unsignalized intersection. Access is only provided to and from the westbound direction due to the presence of a raised median on 25 Avenue S.E. The existing geometric features of the intersection are summarized in *Table 2-3*.

Table 2-3: 2A Street and 25 Avenue S.E. Intersection Characteristics

Westbound Direction ▪ Two westbound through lanes. ▪ Median island between opposing traffic. ▪ Separated sidewalk on north side (1.4m wide).	
Southbound Direction ▪ One channelized right-turn lane southbound. ▪ Stop-controlled. ▪ Monolithic sidewalk on both sides: 2.2m wide on west side and 1.5m wide on east side.	

2.1.4. 3 Street and 25 Avenue S.E. Intersection Characteristics

The intersection of 3 Street and 25 Avenue S.E. is a three-leg signalized intersection. The existing geometric features of the intersection are summarized in *Table 2-4*.

Table 2-4: 3 Street and 25 Avenue S.E. Intersection Characteristics

Eastbound Direction ▪ Two eastbound through lanes. ▪ Left turn lane with storage bay (100m) eastbound. ▪ Median island between opposing traffic. ▪ Separated sidewalk on both sides: 1.6m wide on north side and 1.2m wide on south side.	
Westbound Direction ▪ Two through lanes and one right-turn lane with storage (80m) westbound. ▪ Median island between opposing traffic. ▪ Variable lane designation sign for the right-hand through lane. Converts to a dual right-turn during high volume events. ▪ Monolithic sidewalk on north side only (1.6m wide).	
Southbound Direction ▪ One left-turn lane and one right-turn lane southbound. ▪ Variable lane designation signs for lane conversions during high volume events. ▪ Centerline road marking ▪ Monolithic sidewalk on both sides (1.6m wide)	

2.2. Active Modes Network

The active modes infrastructure in the vicinity of the study area provides access to several area amenities and connections to adjacent pathway systems. There are currently no designated cycle routes or bikeway facilities connecting to the intersections analyzed within the study area. However, the multi-use Bow River Pathway trail system, located on the south side of the Elbow River, connects to several area on-street bikeways. These links allow for connections to the wider network of bikeways and cycle tracks within and through Calgary's downtown and beltline areas.

Monolithic and separated sidewalks are also provided to facilitate pedestrian mobility within the study area. Details of the dimensions and location of each of the sidewalk sections within the study area are summarized in Section 2.1. It should be noted that the majority of sidewalks in the area would be considered narrow by today's standards and may not adequately accommodate large numbers of pedestrians. Typically, the recommended width of sidewalks ranges from 1.5m to 2m. Additionally, wheelchair ramps are absent or misaligned at some intersections, including the entrance to Reader Rock Garden at 25 Avenue S.E., and at the intersection of 25 Avenue and 3 Street S.E.

Marked crosswalks are provided for all approaches at the intersection of Macleod Trail and 25 Avenue S.E., with the exception of the south leg, where metal barriers prohibit pedestrians from crossing Macleod Trail. Actuated push-buttons are provided for the north crosswalk to allow pedestrians to cross Macleod Trail. East of the intersection, maze barriers are provided where the Red Line LRT tracks intersect with sidewalks.

Marked crosswalks with actuated push-buttons are provided at the intersection of 3 Street and 25 Avenue S.E. for all approach legs. Unmarked crosswalks are in place at the intersection of 2A Street and 25 Avenue S.E. The intersection of Erlton Road and 25 Avenue S.W. has a marked crosswalk on the west leg.

2.3. Transit Network

The bus route map for the study area is shown in *Figure 2-1* and the transit operating times are illustrated in *Table 2-5*.

Route 17 (Ramsey/Renfrew) operates east and west on 25 Avenue S.E. It connects to the communities of Manchester and Ramsay to the east and Mission, Cliff Bungalow, Beltline and downtown communities to the west. Stops are located west of Macleod Trail on 25 Avenue S.E. Service operates:

- Weekday AM/PM peak – 20-minute intervals
- Midday, evenings and weekends – 35-minute intervals

Route 10 (Southcentre/Dalhousie) operates north and south on Macleod Trail. To the south it travels on Macleod Trail to Chinook Station and to the north it travels to the downtown core. Stops are located on Macleod Trail at the intersection of 25 Avenue S.E. Service operates:

- Weekday AM/PM peak – 20 to 25-minute intervals
- Midday, evenings and weekends – 45-minute intervals

The Red Line LRT (Crowfoot/Somerset-Bridlewood) operates on the east side of Macleod Trail. Trains are primarily at or near capacity when they reach this station during peak times. The C-Train currently operates every 10 minutes at all times except the following:

- Weekday AM/PM peak – 2 to 5-minute intervals (average of 4 minutes)
- Night – every 15 minutes before 04:40 and after 22:30
- Overnight – No service between 02:00 and 03:40

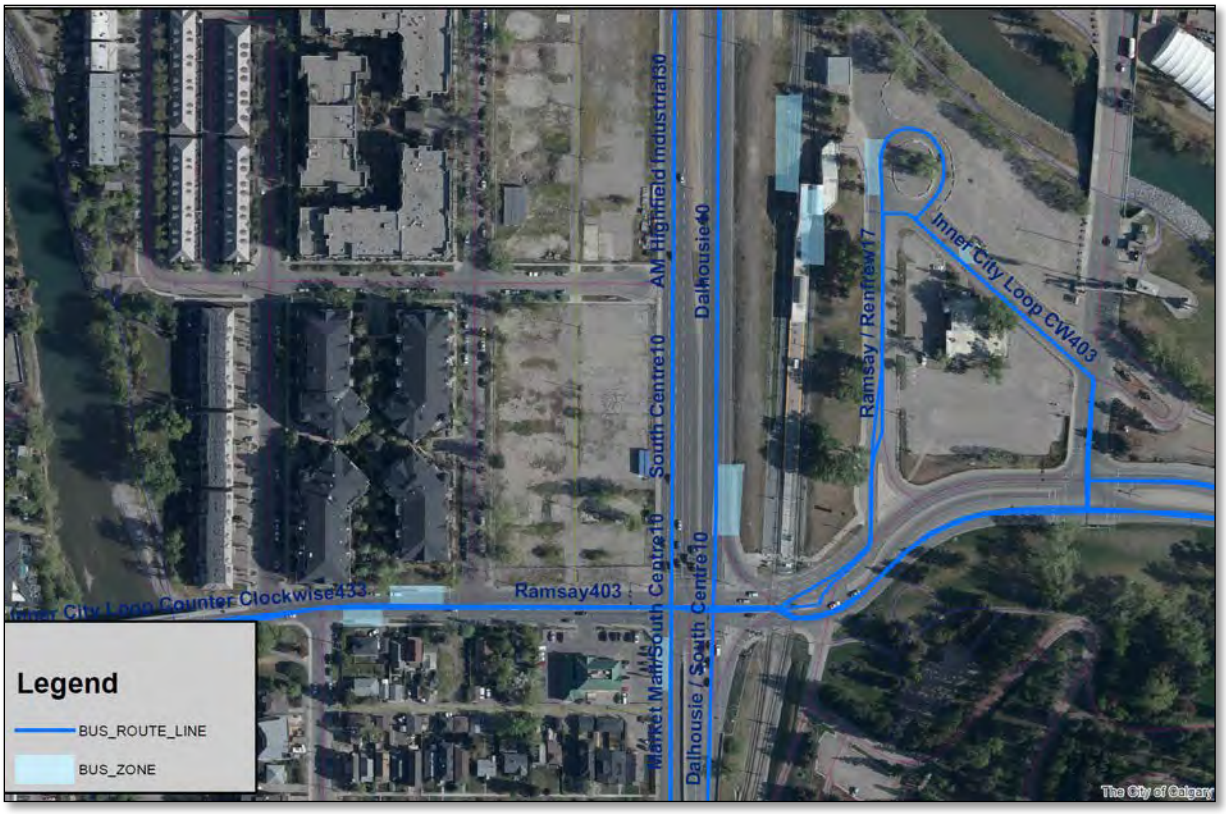


Figure 2-1: Transit Map in Study Area

Table 2-5: Transit Operation in Study Area

Route #	Route Name	Hours of Service
10	▪ Dalhousie/Southcentre	5:40 am - 12:30 am
17	▪ Ramsay/Renfrew	5:24 am - 12:20 am
30	▪ Highfield Industrial	6:20 am - 8:53 pm
403	▪ Ramsay	6:20 am - 8:53 pm
Red Line LRT	▪ Somerset-Bridlewood/Crowfoot	3:48 am - 1:11 am

The 2015 Fall LRT ridership information for Erlton and Victoria stations is provided in *Table 2-6.* The highlighted hours represent the AM and PM peak hours in LRT service.

Table 2-6: Existing LRT Service

Hour of Operation	Erlton LRT Ridership		Victoria LRT Ridership	
	Total Boarding	Total Alighting	Total Boarding	Total Alighting
4	5	0	0	0
5	10	5	25	30
6	45	70	60	115
7	95	105	85	270
8	100	90	90	520
9	45	45	95	150
10	30	25	110	85
11	20	25	80	90
12	40	20	105	135
13	30	45	150	165
14	55	45	170	260
15	50	60	470	595
16	105	115	515	800
17	100	130	610	645
18	60	95	1,265	430
19	35	135	515	240
20	20	45	945	185
21	10	25	145	145
22	125	10	240	110
23	35	15	175	85
24	5	5	120	25
25	0	0	20	10
Total	**1,020**	**1,110**	**5,990**	**5,090**

2.4. Adjacent Projects

2.4.1. Stampede Master Plan

Calgary Municipal Land Corporation (CMLC) is currently undertaking a master plan of the River District, which includes Victoria Park and Calgary Stampede's lands. CMLC is working with Denver-based Civitas and Calgary's Gibbs Gage on a 20-year visioning plan that includes tearing down the Corral, increasing the BMO Centre, a potential new arena, hotels, condo buildings, and retail/commercial development. While the master planning is still underway, it is assumed that there will be an additional 10 million square feet of mixed-use development

2.4.2. Anthem's Crosstown Development

Anthem Properties has an approved transit-oriented development (TOD) plan, shown in *Figure 2-2*, for the lands along the west side of Macleod Trail within the study area. The Crosstown Development includes a pedestrian overpass over Macleod Trail connecting it with the Erlton LRT

Station. Crosstown consists of 745 residential units, 70,000 square feet of commercial/retail area, and 4,000 square feet of office space.

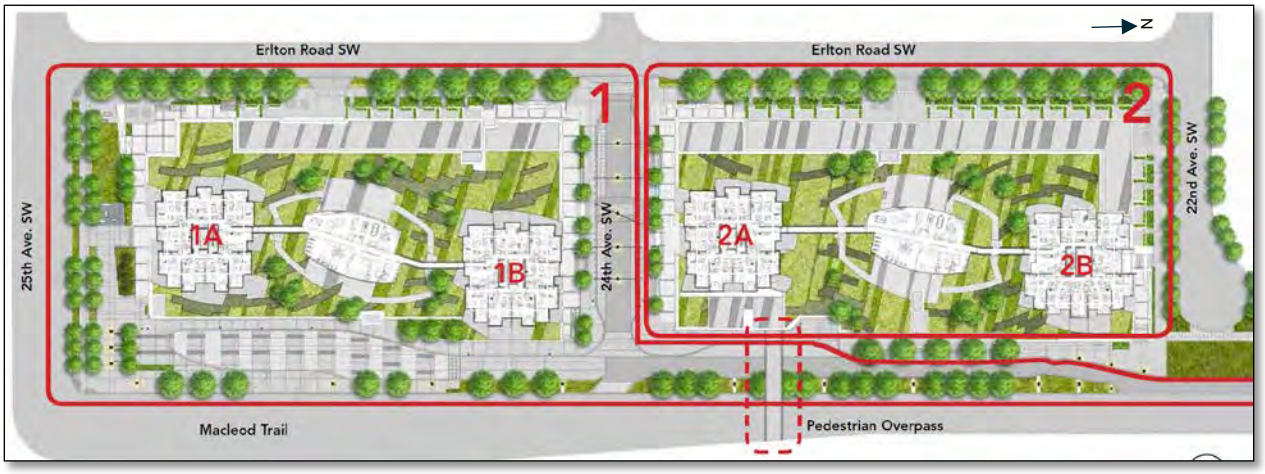


Figure 2-2: Anthem's Crosstown Development

2.4.3. Repsol Sport Centre Redevelopment

Repsol Sport Centre has submitted a Land Use Application to The City of Calgary to upgrade and expand their existing recreational facility by approximately 7,000 m^2 (75,000 ft^2). The proposed land use district retains the adjacent Special Purpose – Recreation (S-R) District and:

- Adjusts the land use boundary to reflect the expansion of the building;
- Reproduces the existing approved use, "multi-purpose sports complex"; and,
- Includes four new discretionary uses.

2.4.4. 17 Avenue S.E. Extension

To support the East Village Development, the River District Master Plan, and the Calgary Stampede Master Plan, a new pedestrian/vehicle access is proposed at-grade at 17 Avenue S.E. across the Red Line LRT tracks into Stampede Park. Calgary Transit was tasked with reviewing the previous studies and developing a "Proof of Concept" based on a mid-term solution to ensure that transportation needs can be met (Phase 1). The Proof of Concept report was received from Hatch in November 2016 and concluded that at a conceptual level, it is possible to extend 17 Avenue S.E. across Macleod Trail, and proceeding with the preliminary design was recommended.

The scope of the 17 Avenue S.E. Extension project includes a review of previous studies, stakeholder engagement, public open house presentations, detailed multi-modal traffic and open track modelling, cost estimating, a review of operational and safety concerns, risk assessment and mitigation, land transfer assessments, site investigations and surveys, materials testing, geotechnical studies, and operations protocol for the crossing and Calgary Stampede parking

gates. Also included is the assessment of impacts to Calgary Transit and the LRT, as well as the resulting modifications of the Victoria Park/Stampede LRT Station, the C-train, infrastructure for tracks, signals, and communications. Modifications to roads, sidewalks, crosswalks, traffic signals and urban realm integration is also within the project scope.

2.5. Floodway

The Elbow River is a dominant natural feature that flows north of the study area. The Elbow River is subject to periodic flooding causing Provincial and City flood hazard mitigation policies to be in effect. Provincial policies emanate from the *Water Act* and are administered by Alberta Environment and Parks (AEP).

In 1983 (with updates in 1996), the AEP created maps showing the Flood Hazard Area (FHA) in Calgary. The FHA was divided into three zones:

- Floodway – the river channel and some areas just out of the channel, where the flood water is deepest and fastest. Most of the flood water flows through the floodway;
- Flood Fringe – areas along the river that flood, but where the water is not as deep or as fast as in the floodway; and
- Overland Flow Zone – Areas where water leaves the river channel, flows over land through streets or communities, and eventually flows back into the river somewhere downstream.

Figure 2-3 outlines the Floodway and Flood Fringe boundaries that are delineated in the current mapping. The provincial flood hazard map is the basis of the flood policy and zones in Calgary's Land Use Bylaw. The City of Calgary regulations are contained in Land Use Bylaw (LUB) 1P2007, Part 3, Division 3, which states:

> *"56 (1) For parcels located in the floodway on which a building existed and the use of that parcel was approved as of September 9, 1985, the use may continue as a permitted or discretionary use provided that the use is listed in the land use district that the parcel is designated.*
>
> *(2) Subject to subsection (1),* ***in the floodway only those permitted and discretionary uses which are listed below, and which are also listed in the land use district for which the parcel is designated, may be allowed*** *as permitted and discretionary uses:*
>
> *(a) Extensive Agriculture;*
> *(b) Natural Area;*
> *(c) Outdoor Recreation Area;*
> *(d) Park; and*
> *(e) Utilities.*
>
> ***New Buildings and Alterations***
>
> *57 (1) No new buildings or other new structures are allowed in the floodway, except for the replacement of existing Accessory Residential Buildings, Backyard Suites, Duplex*

Dwellings, Secondary Suites, Semi-detached Dwellings and Single Detached Dwellings on the same building footprint.

(2) An addition to a building in the floodway may only occur if it does not increase the building footprint or increase the obstruction to floodwaters.

(3) In the floodway, nothing must be stored outside of a building.

Alterations to the Floodway and Riverbanks

58 On those areas of land within the floodway that are subject to municipal jurisdiction, no alterations shall be made to a floodway and no structures including, but not limited to, berms, decks, docks, fences, gates, patios, rip¬rap or walls shall be constructed on, in or under a floodway unless those structures are being constructed by, or on behalf of, the City for the purpose of erosion control, where the primary purpose is to protect public infrastructure."

The study area is one of the most complex, and important, flood areas in Calgary. In general, during a large flood, water flows from the Elbow River on the west side of Erlton, eastward through the streets of Erlton, crosses Macleod Trail, and enters back into the Elbow River. There is a berm that runs north-south just west of the existing Erlton station, which protects the station and creates an "island" in the floodway. Most of the flow runs north along this berm and enters back into the Elbow River north of the existing station. Significant flow, however, goes south of the station along the 25 Avenue S.E. alignment, to re-enter the Elbow River near the Stampede track. It is critical to maintain floodwater conveyance through both flow paths.

In June 2013, Calgary experienced significant flooding and studies showed that the water flow in the Elbow River was much higher than a 100-Year flood event. The size of a flood can be described in several ways, one of which is the flow rate. River flow is measured in cubic metres per second (m^3/s or cms). Typical high spring flows in Calgary are:

- Elbow River: 30 m^3/s
- Bow River: 100 m^3/s

In 2013, the highest flows on the rivers through Calgary were:

- Elbow River: ~700 m^3/s (downstream of Glenmore Dam)
- Bow River: ~1840 m^3/s (upstream of the confluence with the Elbow River)

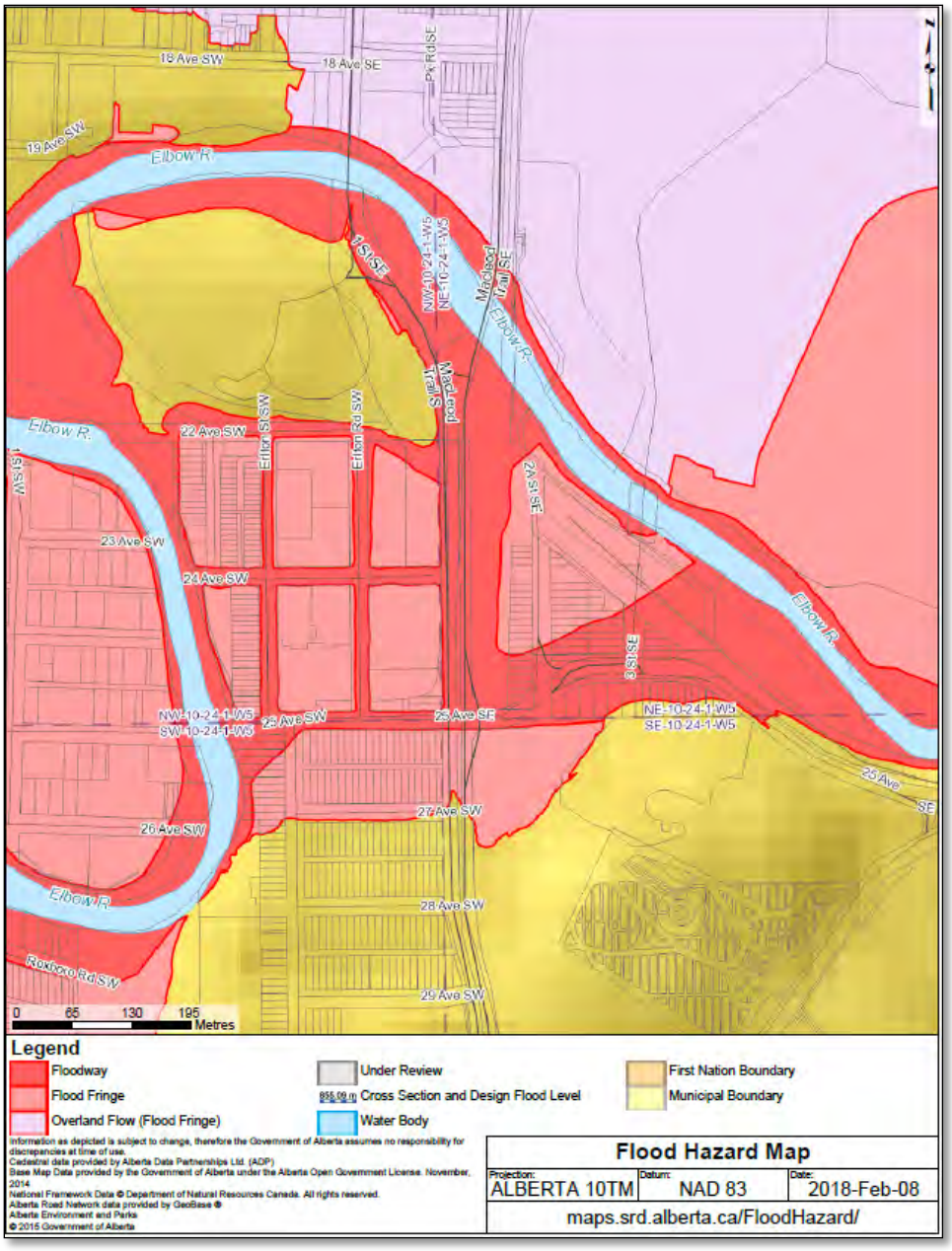


Figure 2-3: Provincial Flood Hazard Map for Study Area

According to Golder 2014, during a 100-Year flood event, the Erlton district would be inundated between 27 Avenue SW and 22 Avenue SW. The portion of flood flow conveyed along 25 Avenue S.W. would flow back into the Elbow River near the Stampede Park. The study also assumed that 25 Avenue forms an additional side channel that is activated for flood events with return periods greater than 35 years.

Following the 2013 flood, The City has conducted several studies to better understand the flood risk and identify mitigation measures. Current flood mitigation projects underway including raising the gates at the Glenmore Dam and constructing several parries at key locations such as West

Eau Claire, Heritage Drive, Bonnybrook Wastewater, and Centre Street Bridge. In addition, the Government of Alberta confirmed in 2015 that it would proceed with the development of a dry-storage reservoir at Springbank. The Springbank Reservoir is currently undergoing a federal Environment Impact Assessment. It is expected that the upstream reservoirs, including the proposed Springbank Reservoir, and the new gates on the Glenmore Dam will be able to support a 2013-sized flood without overland flooding along the Elbow River.

2.6. Utilities

According to city provided base mapping, all typical utilities are present within the project site, except for cable. Based on the age of the provided information, it is believed that cable or fibre optic utilities have since been provided alongside existing telecommunications lines. Existing utilities are widespread and located under Macleod Trail, 25 Avenue S.E., 3 Street S.E., 2A Street S.E., the LRT track, and 24 Avenue S.E. alignments. Existing utilities in the study area are included in Appendix F.

Enmax currently has overhead transmission facilities travelling parallel to the Elbow River through the middle of the site. Enmax has a proposal to realign and place the transmission line underground with commissioning in early 2021.

2.7. Historical Resources

Reader Rock Garden, shown in *Figure 2-4*, comprises 12,140 square meters (3.0 acres) of land. Through Bylaw 9M2017, it has been designated as a Municipal Historic Resource. As such, any alternation, rehabilitation, repair or change to the Regulated Portions must be in accordance with the terms of the Parks Canada 2010 Standards and Guidelines for the Conservation of Historic Places in Canada.

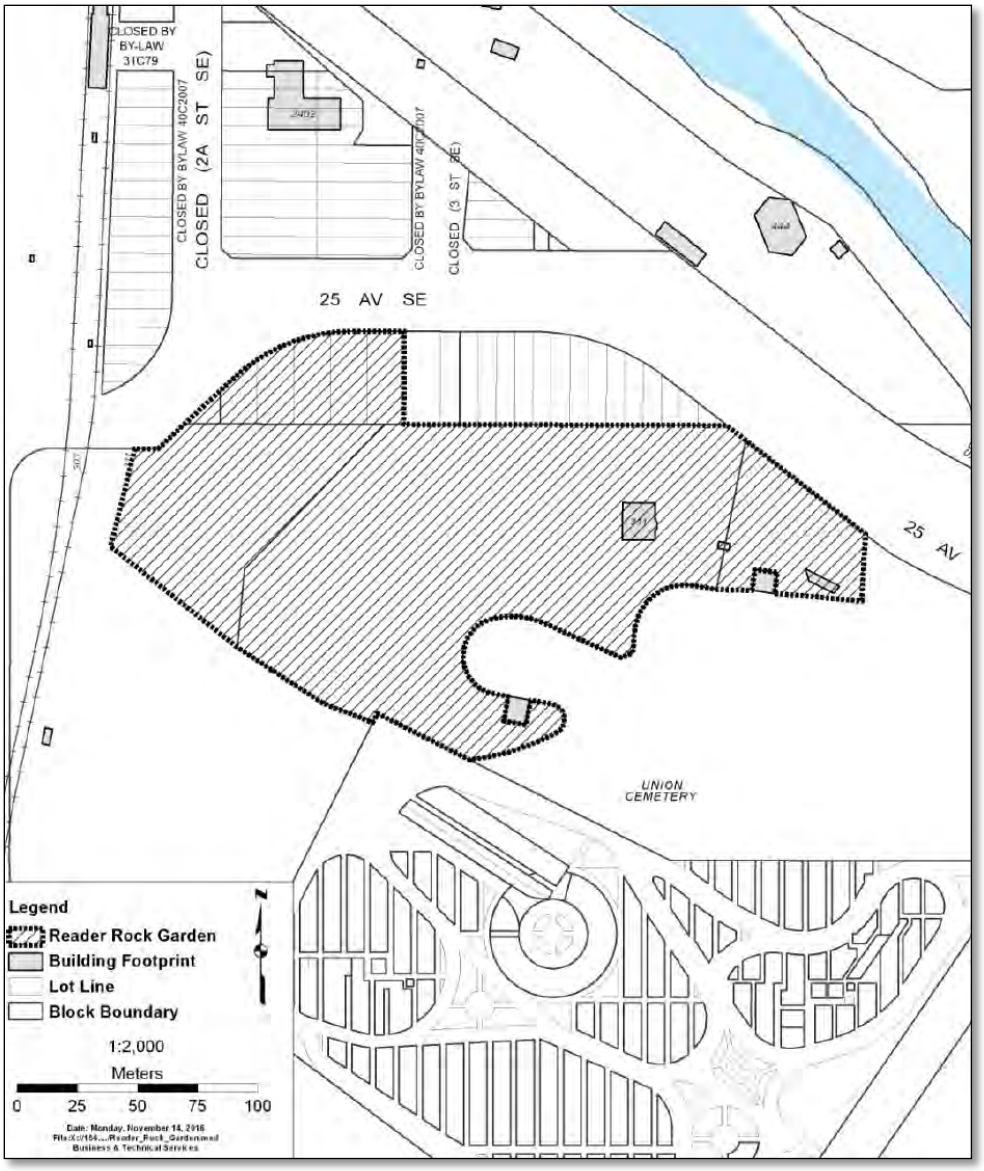


Figure 2-4: Reader Rock Historical Resource

2.8. Traffic Volumes & Operations

2.8.1. Existing Traffic Volumes

The most recent intersection turning movement traffic data available for all intersections within and around the study area was obtained from The City of Calgary. Most of the traffic counts ranged in date from 2015 to 2017, with the exception of the traffic count at 25 Avenue and 3 Street S.E., which was collected in 2012. In addition to the intersection data, 24-hour midblock hose count data was also obtained where available to supplement the intersection traffic counts.

Due to the relatively well-established and built-out nature of the study area, no traffic growth was assumed between the dates the traffic counts were carried out and present day, as the area road network is expected to be fully saturated and at capacity during peak travel times. In addition, because the majority of the counts were conducted during non-summer months between September and April, and all counts were carried out on weekdays, no seasonal or day-of-week adjustment factors were applied to the traffic counts. As such, the collected traffic count data was determined to be representative of present-day traffic conditions.

The traffic count volumes were manually adjusted to balance between adjacent intersections in order to account for volume discrepancies arising from counts being conducted on different days. Where traffic volumes were not available (including turning movements at the 2A Street and 25 Avenue S.E. intersection, as well as at the southbound U-turn on Macleod Trail north of 25 Avenue S.E.), volumes were estimated based on adjacent intersections, area traffic patterns, as well as midblock hose count data.

2.8.2. Future Horizon Traffic Volumes

Traffic volumes for future horizons were developed with consideration of several factors, including the existing traffic volumes and patterns, adjacent sites proposed for development, area road network changes and anticipated future connections to major roadways, as well as potential redevelopment plans of existing developments in the area. The data was obtained from a variety of sources, as detailed in the following subsections.

2.8.2.1. Traffic Volumes Assumptions

As discussed, existing traffic volumes were based on traffic data that was obtained from The City of Calgary and manually adjusted to account for approved and planned developments in the area, as well as roadway network changes. As such:

- Future background volumes were based on the balanced existing traffic volumes.
- No growth rate was applied to the volumes to estimate future horizon traffic levels, as the area is assumed to be fully built-out with saturated traffic conditions.

Approved Developments

- Traffic associated with the proposed development of Anthem's Crosstown development on the northwest corner of the intersection of Macleod Trail and 25 Avenue S.E. was included in the review. Development volumes were taken from the *Transportation Impact Assessment for the Proposed Development at Erlton Road / 25th Ave, Calgary, Alberta* completed by IBI Group in 2013.

Future Road Network Changes

- The proposed construction of the 25 Avenue S.E. Connector to Blackfoot Trail was considered, along with the associated rerouting of traffic anticipated. Because the timing of the connector

is unknown, it was assumed that the connector would be in place for the 2048 horizon. Two scenarios were reviewed at the 2038 horizon: with and without the connector in place. To be conservative, the final 2038 volumes used in the analysis of future conditions included traffic associated with the 25 Avenue S.E. Connector to Blackfoot Trail in place.

- Volumes associated with the proposed network changes were estimated based on difference plots provided by The City of Calgary Forecasting Division.

Redevelopment Plans

- Traffic associated with the redevelopment of the Stampede Grounds was based on the *Green Line LRT Beltline Traffic Modeling Assumptions* technical memorandum completed by Stantec in 2017.
- The traffic generation associated with the redevelopment of the existing Repsol Sport Centre was estimated based on existing traffic patterns and trip generation data provided by The City of Calgary.

Based on these road network, traffic volume, and area development details, future horizon traffic volumes were developed as outlined below.

2.8.2.2. Traffic Volumes Projections

Interim 2038 Volumes – With 25 Avenue S.E. Connector:

- 100% balanced existing volumes (no growth assumed for future horizons)
- 100% of Anthem's Crosstown development volumes
- 50% of volumes associated with the redevelopment of the Stampede Grounds
- 50% of volumes associated with the redevelopment of the Repsol Sport Centre
- 100% of volumes associated with the 25 Avenue S.E. Connector (assumed to be constructed)

Full Build 2048 Volumes:

- 100% balanced existing volumes (no growth assumed for future horizons)
- 100% of Anthem's Crosstown development volumes
- 100% of volumes associated with the redevelopment of the Stampede Grounds
- 100% of volumes associated with the redevelopment of the Repsol Sport Centre
- 100% of volumes associated with the 25 Avenue S.E. Connector (assumed to be constructed)

The traffic volumes for the existing and 2038 horizons are provided in *Figure 2-5* and *Figure 2-6.*

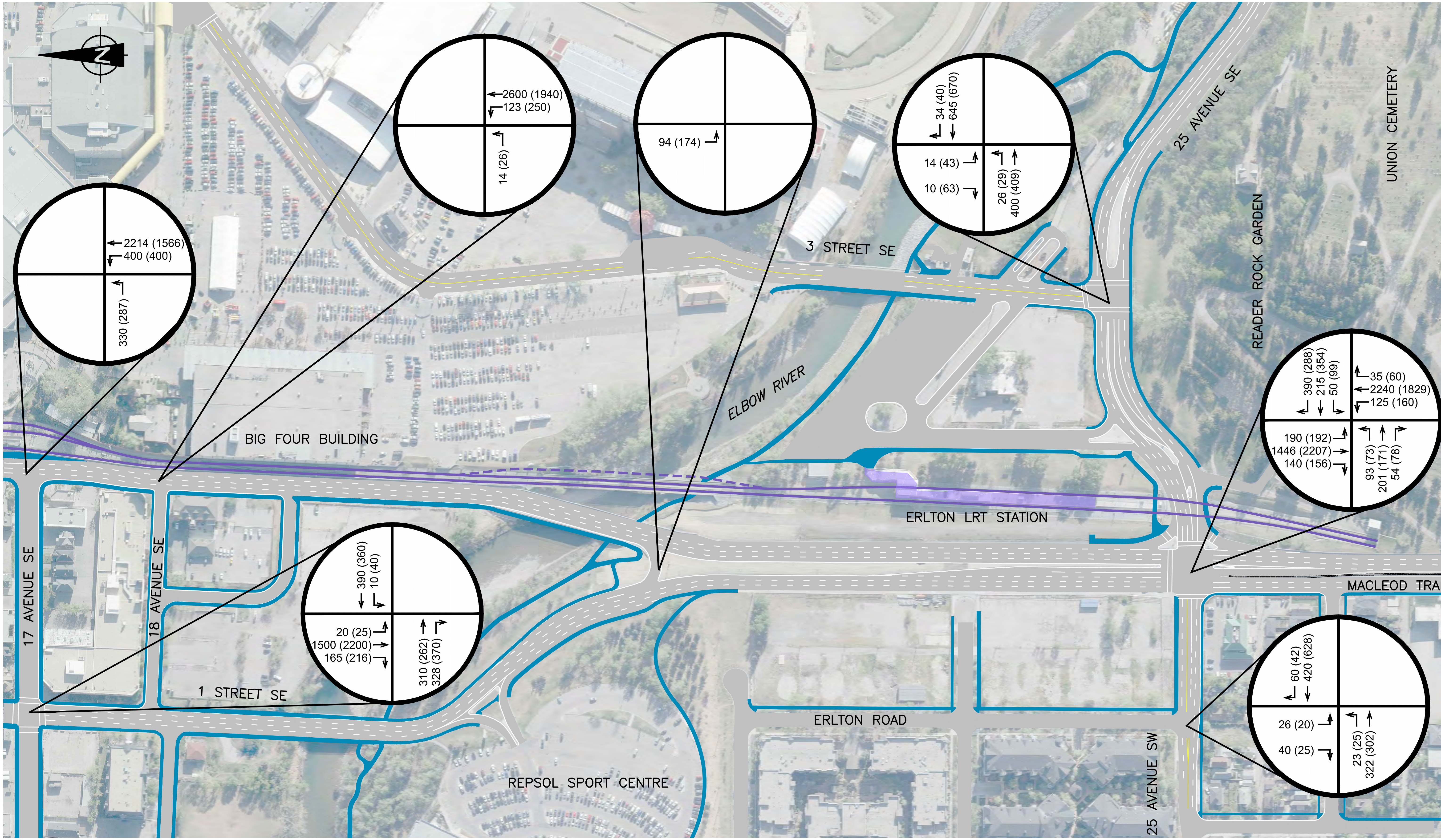
PM Peak Hour Pre-Event Volumes

To estimate the increase in traffic observed along the area road network during the PM peak hour prior to major events being held within the Stampede Grounds (such as concerts, hockey and lacrosse games, tradeshows and conferences), a "PM Pre-event" traffic scenario was developed.

The pre-event volumes included balanced 2038 PM peak hour volumes from which general every-day trips to the Stampede Grounds were netted out. The increase in traffic volumes to and from the Stampede Grounds arising from major events was then superimposed on the base 2038 PM peak hour volumes to achieve PM peak hour pre-event volumes.

The traffic associated with major events was obtained from Bunt and Associates based on a recent study completed by Bunt for Calgary Stampede.

To be conservative and test worst-case scenario traffic conditions, the PM pre-event volumes were used for all PM peak hour analyses carried out.



205 (220) PEAK HOUR VOLUME - AM (PM)

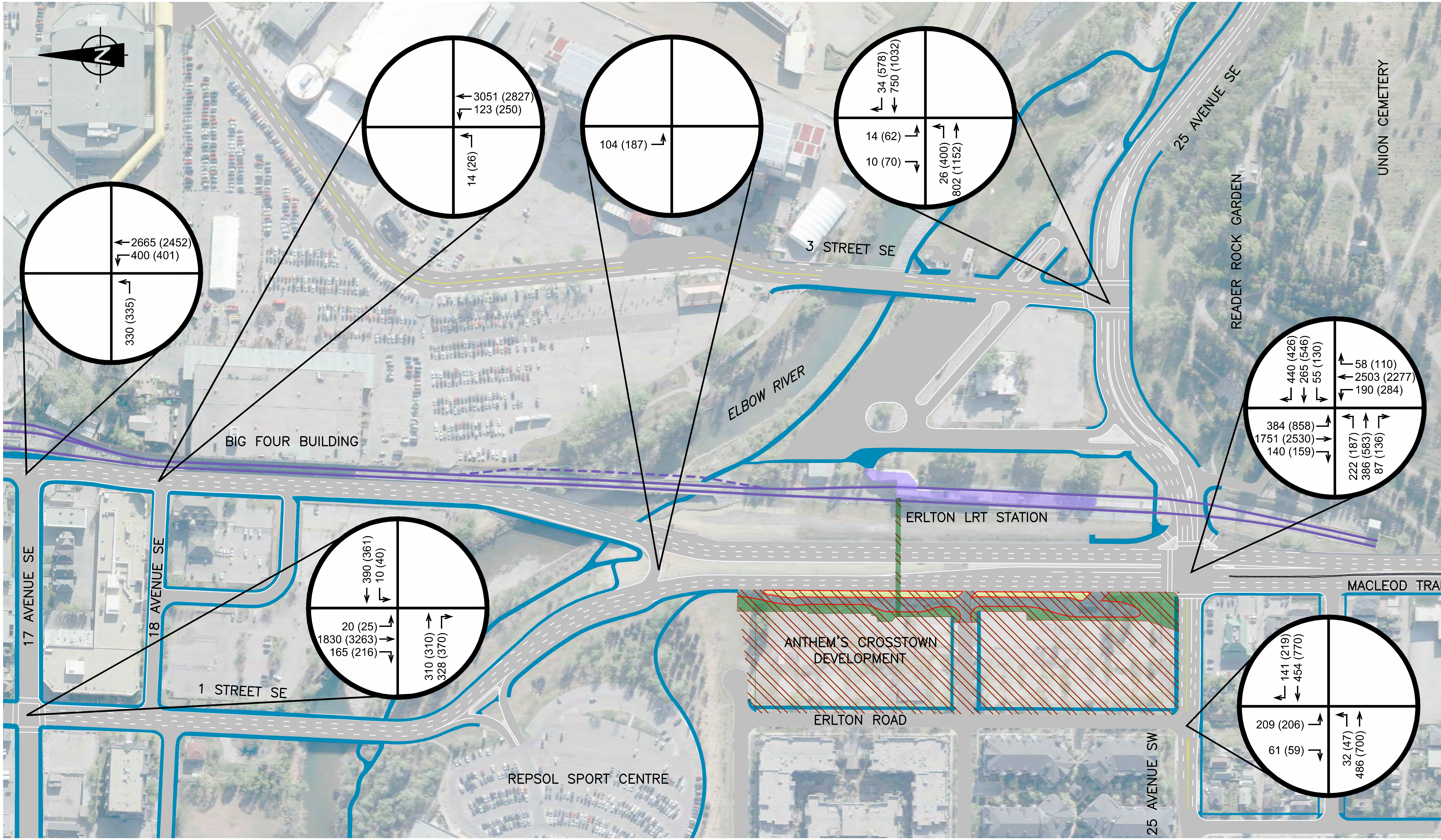
↰ MOVEMENT DIRECTION

25 0 50
1:2500

McElhanney

Existing Traffic Volumes

25 Avenue SE LRT Grade Separation Study | Fig. 2-5



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205 (220) PEAK HOUR VOLUME - AM (PM)

MOVEMENT DIRECTION

25 0 50
1:2500

Design (2038) Traffic Volumes

25 Avenue SE LRT Grade Separation Study

Fig. 2-6

3. Concept Development

3.1. Study Constraints

As previously discussed in the existing conditions section of this report, there are multiple other projects occurring within the study area that need to be considered when developing concepts. Macleod Trail and 25 Avenue S.E. are important traffic and transit links in the transportation network. As such, it was important to develop an understanding of design constraints and assumptions that should be taken into consideration. *Figure 3-1* and the following list highlight the main constraints and assumptions considered during the concept development stage.

- The majority of the study area falls within either the Floodway or the Flood Fringe. The City of Calgary Land Use Bylaw does not permit the alteration of grades or the construction of new structures within a Floodway. Any structures or grade changes require further analysis and approval.
- Reader Rock Garden has been designated as a Municipal Historic Resource and any impacts to it should be minimized.
- If changes are made to the LRT station location, the location of the pedestrian bridge from Anthem's Crosstown development should be reviewed to provide a pedestrian crossing across Macleod Trail.
- 17 Avenue S.E. will extend east of Macleod Trail into Stampede Grounds as part of another project between The City of Calgary, Calgary Stampede, and CMLC.
- Long term plans for the Big Four building are currently unknown and impacts to the building should be minimized.
- Impacts to the Union Cemetery grounds should be minimized.
- A storage track in a siding must be provided for in the Erlton Station study area in the interim and ultimate horizons as a result of the 17 Avenue S.E. Extension project.
- Modification of the Cemetery Hill Tunnel north portal track structure should be avoided to eliminate the need for a major LRT service disruption, making this portal the southern limit of any LRT track re-alignment.

- The existing LRT right-of-way adjacent to the south-west corner of the Big Four building is assumed to be the northern limit of any LRT track re-alignment.
- New construction within the existing LRT right-of-way should be minimized to reduce the duration of service disruption when transitioning from existing to any new LRT alignment.
- LRT re-alignment should not result in any significant increase in LRT travel time.
- Either a centre or side-platform station configuration is acceptable for a new station, if required, to replace the existing Erlton Station.
- The Erlton LRT Station platform must accommodate a future 5 car train (135m overall length).

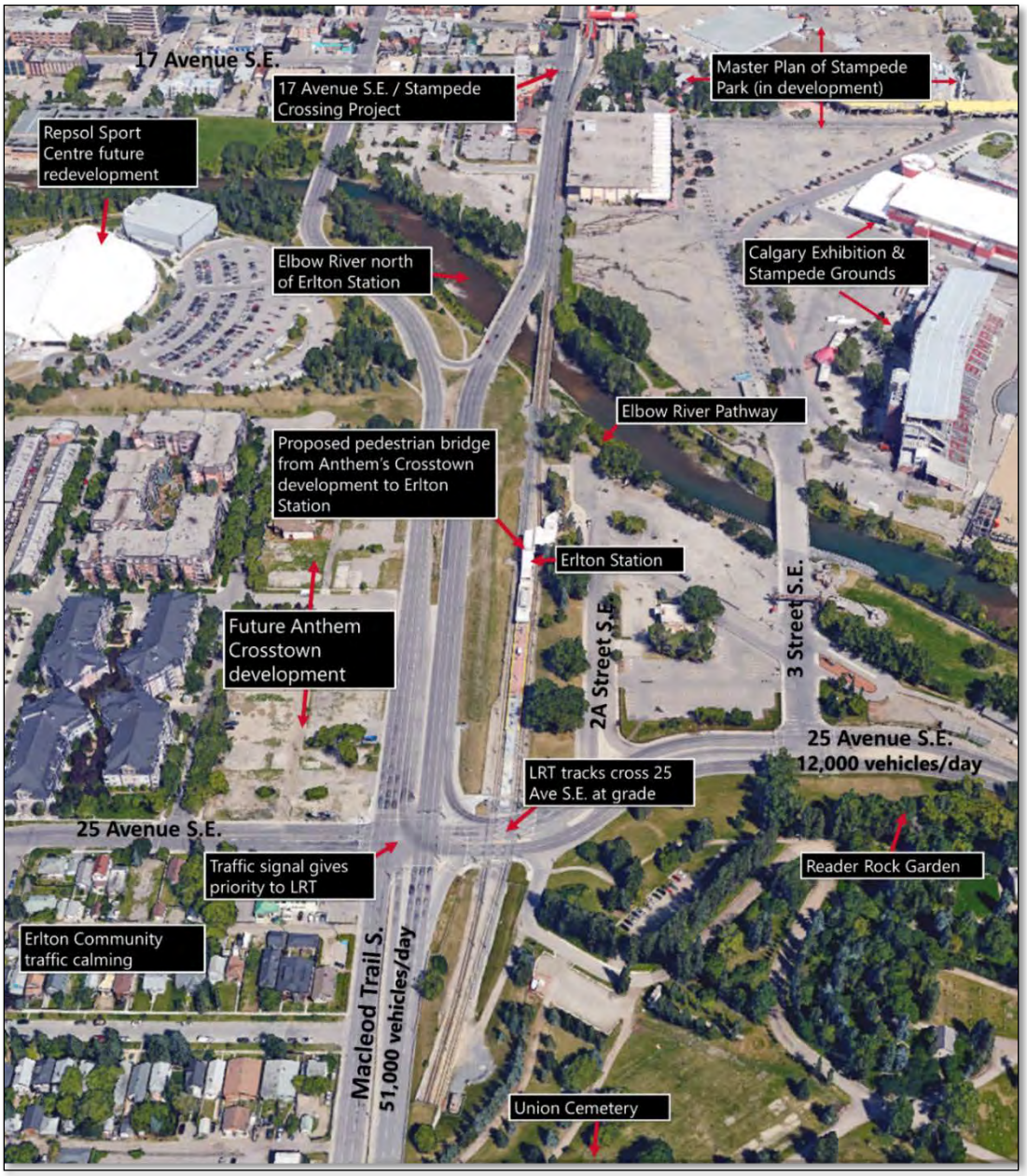


Figure 3-1: Study Area Issues & Constraints

3.2. Initial Concepts

The first step in the development of concepts was to meet with stakeholders and the public. The objectives of the initial engagement sessions were to:

- Inform stakeholders and the public of the project, including the purpose, scope and objectives;
- Present a summary of the existing conditions, including traffic operations and potential safety issues;
- Discuss existing stakeholder and public concerns and their desired improvements; and,
- Identify the evaluation criteria that are most important to stakeholders and the public, that could be incorporated into an evaluation matrix to be used in selecting the recommended concept.

Discussing the project with stakeholders and the public ***prior*** to the development of any options was crucial for two reasons:

1. The project team was able to develop options with a more complete understanding of citizen and stakeholder needs.
2. Citizens and stakeholders felt engaged in the design process, which is not always the case when preliminary options are developed prior to the first engagement event.

A summary of the initial engagement activities is provided in Section 6.0.

The community priorities were identified through the use of a dotmocracy process. This process allows the public and stakeholders to select the most important criteria to them by placing sticker dots on a board identifying a wide range of criteria. The public and stakeholders were also encouraged to add any additional criteria that they felt was missing. A summary of the dotmocracy results from the first open house, which was held on February 28, 2017, and the online feedback received is provided in *Figure 3-2*.

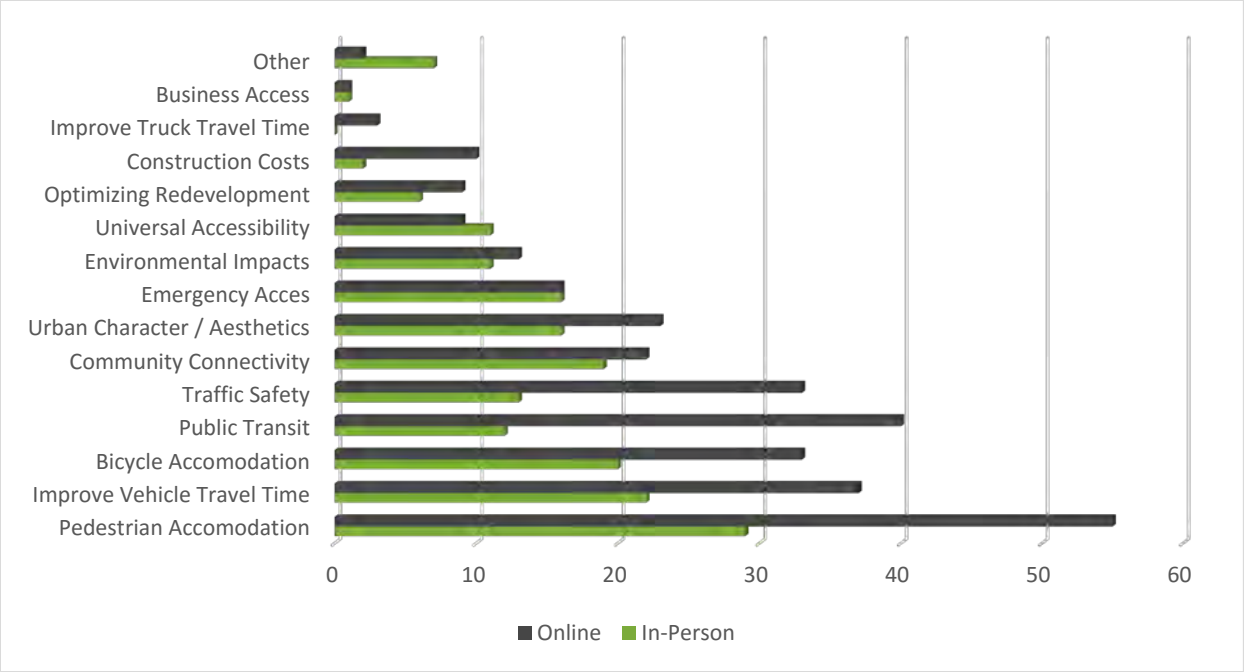


Figure 3-2: Community Priorities at Open House & Online Survey

As shown in *Figure 3-2*, the "other" option was a combination of comments that did not fall into the designated categories. This captured numerous one-off items such as comments related to shortcutting, better connections to green space, and traffic signal improvements. The top community priorities identified were:

- Pedestrian accommodation, such as new or improved pedestrian infrastructure.
- Improved vehicle travel times, including looking at the signal timing and dedicated turn lanes.
- Bicycle accommodation, such as new infrastructure or improvements that enhance cycling.
- Improved public transit
- Revitalization of the community.

In addition to the public engagement, a concept development workshop was held with key internal and external stakeholders including City of Calgary business units, Calgary Stampede, CMLC, and project team members. The objectives of the workshop were to:

- Work with the internal and external stakeholders to generate feasible concepts to grade separate the LRT at Erlton Station, while meeting the multiple study objectives.
- Produce several ultimate LRT grade separation design concepts that can be further refined and evaluated.
- Reduce re-work and fast-track the evaluation process by including stakeholder feedback early as part of the concept development process.

Following the initial engagement events, preliminary concepts were developed with the intention of addressing the following:

- Issues identified by the internal, external and public stakeholders.
- Maintaining access to key developments and attractions.
- Better accommodation for pedestrians and cyclists.
- Removing the LRT pre-emption at the intersection of Macleod Trail and 25 Avenue S.E.
- Optimizing future opportunities for redevelopment within the study area.

The LRT and road design criteria used in developing all concepts are included in *Table 3-1* and *Table 3-2* respectively.

Table 3-1: LRT Design Criteria

Horizontal Alignment	
Desirable minimum radius	As required to maintain full track speed up to 80km/h or 300m
Absolute minimum radius	150m with Calgary Transit approval
Desirable horizontal tangent through station	165m
Length of spiral	Greater of speed x superelevation/108 or 25m
Minimum tangent between reverse curves	Greater of 25m or length of sum of adjacent spirals
Vertical Alignment	
Maximum mainline grade	6%
Minimum mainline grade	0%
Maximum grade in stations	1.5%
Minimum length of constant grade	200m preferred; 25m absolute
Maximum superelevation of track	110mm
Minimum length of vertical curve (>50km/h): ▪ on tangent or horizontal curve with balanced superelevation ▪ on horizontal curve with unbalanced superelevation	Greater of 60m or ▪ 25x grade difference ▪ 50x grade difference
Minimum length of vertical curve(<50km/h): ▪ On tangent or horizontal curve with balanced superelevation ▪ On horizontal curve with unbalanced superelevation	Greater of ▪ 15x grade difference ▪ 30x grade difference

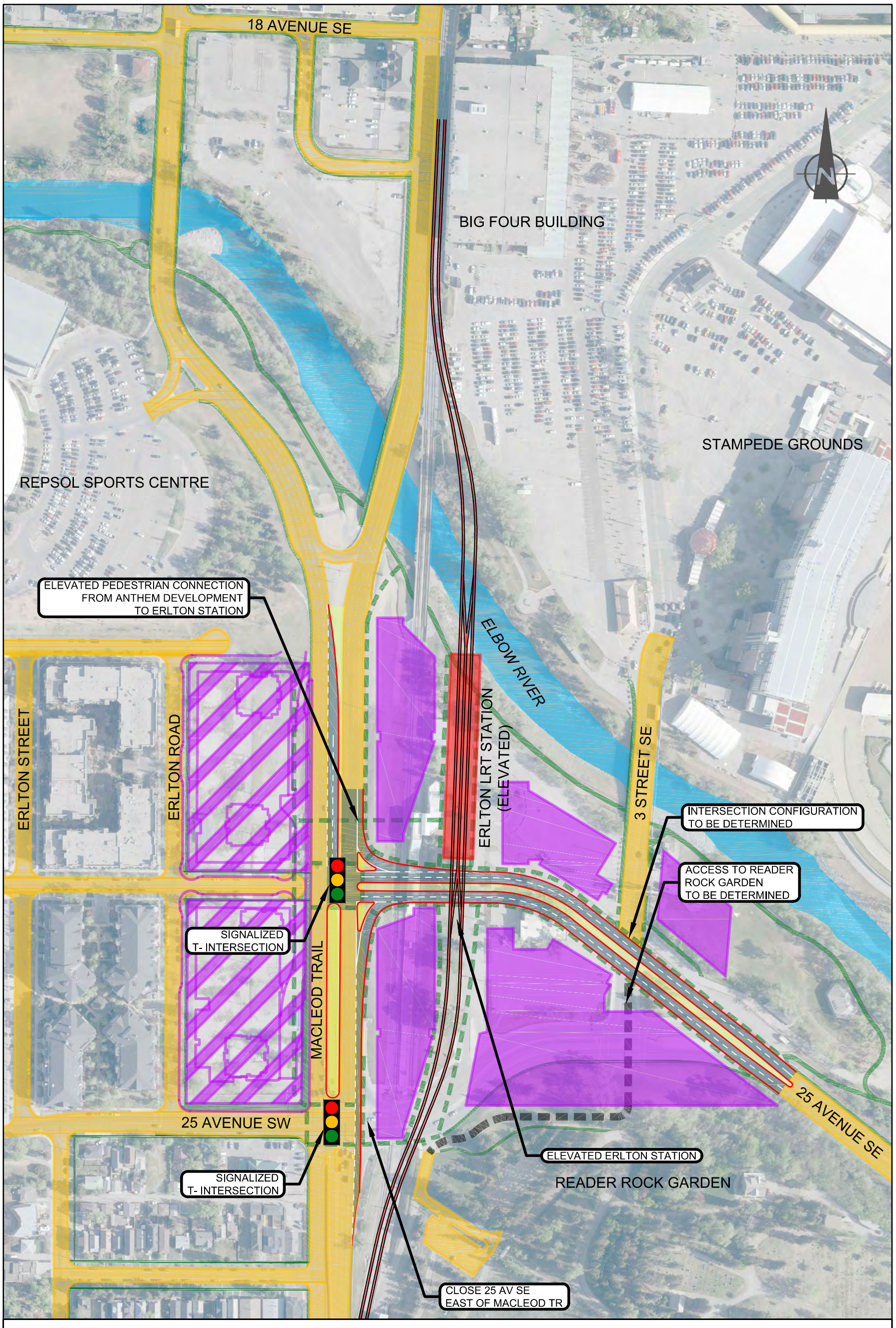
Roadway design for Macleod Trail and 25 Avenue S.E. was based on The City's Complete Streets and Design Guidelines for Subdivision Servicing. Transportation Association of Canada guidelines were used as a supplement for other design items that were either discretionary or not contained within The City's documents.

Macleod Trail is classified as an Urban Boulevard, which is part of the Arterial family of roadways in The City of Calgary's Complete Streets Guidelines. 25 Avenue is a Collector roadway west of Macleod Trail and an Arterial roadway east of Macleod Trail, and all other roadways are considered local roads.

Table 3-2: Road Design Criteria

Item	Macleod Trail	25 Avenue S.E.	Roundabout	Flyover
Classification	Arterial	Primary Collector		
Design Speed	60km/h	60km/h	40km/h	40km/h
Posted Speed	60 / 50km/h	50km/h	50km/h	50km/h
Basic Lanes	6	4	2	1 or 2
Minimum Radius/ Inscribed Diameter	130m	130m	56m	55m
K Factor - Crest	15	15	4	4
K Factor - Sag	10	10	4	4
Max. / Min. Grade	6% / 0.6%	6 % / 0.6%	8% / 0.6%	8% / 0.6%
Max. Superelevation	0.06	0.06	0.02	0.06
Minimum S.S.D.	85m	85m	45m	45m
Through Lane Width	3.5m	3.7m	5.0m	4.0m
Right Lane Width	3.5m	3.5m	N/A	N/A
Turn Lane Width	3.3m	3.5m	N/A	N/A
Shoulder Lane Width			N/A	0.5m
Sidewalk	monowalk	monowalk	none	none
Roadside Barrier	Concrete	W-Beam	Concrete	Concrete
Median Type	Raised	Raised / none	Raised Concrete	Low Profile Curbed
Median Width	9.5m	6.0m	Varies	1.50m
Design Vehicle	WB-21	WB-15	WB-15	WB-15
Vertical Clearance	5.41m	5.41m	N/A	5.41m (roadway) 6.0m (LRT rail)

A total of three concepts were developed, as detailed in the following subsections. Conceptual drawings of the preliminary three concepts are included in *Figure 3-3*, *Figure 3-4*, and *Figure 3-5*.



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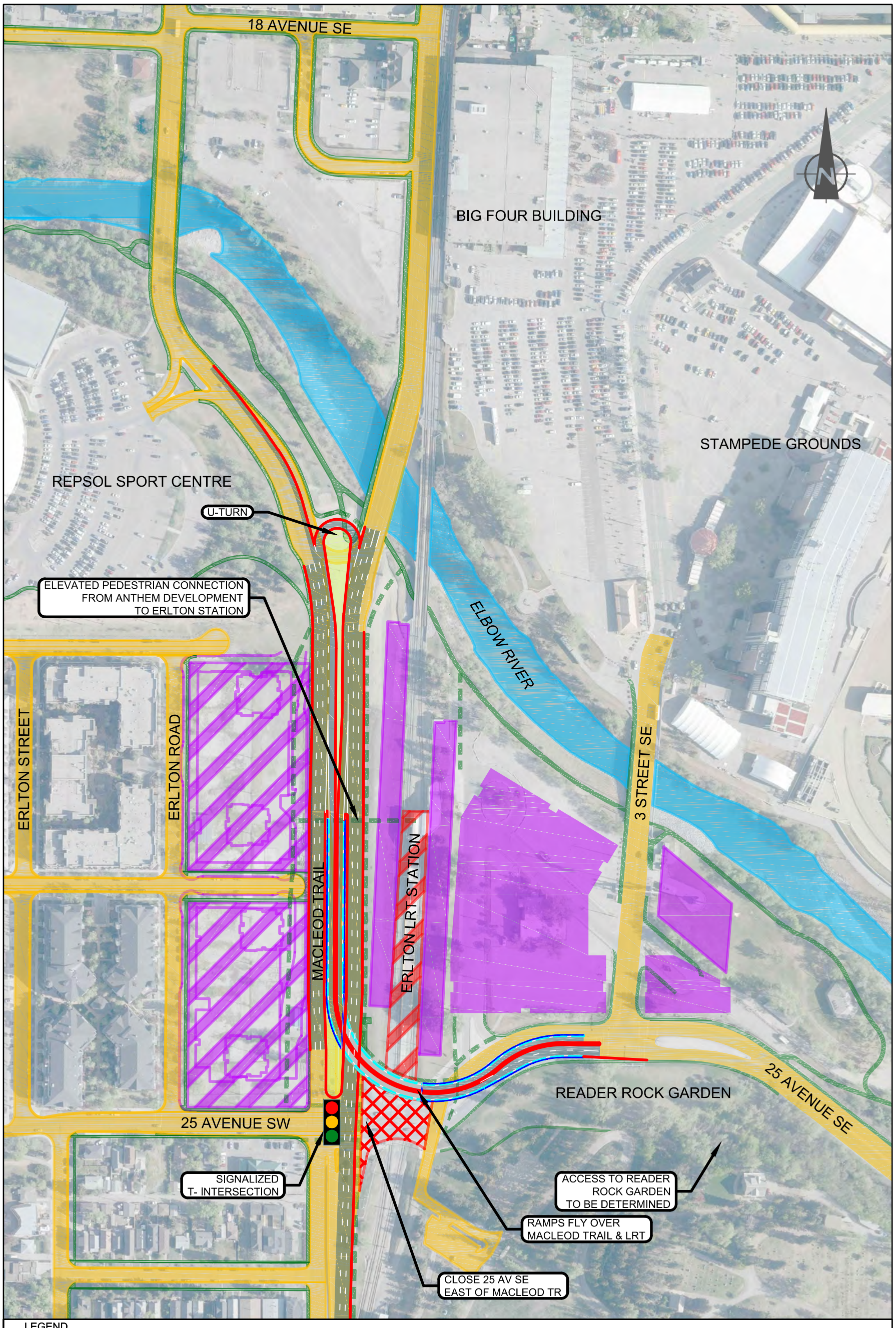
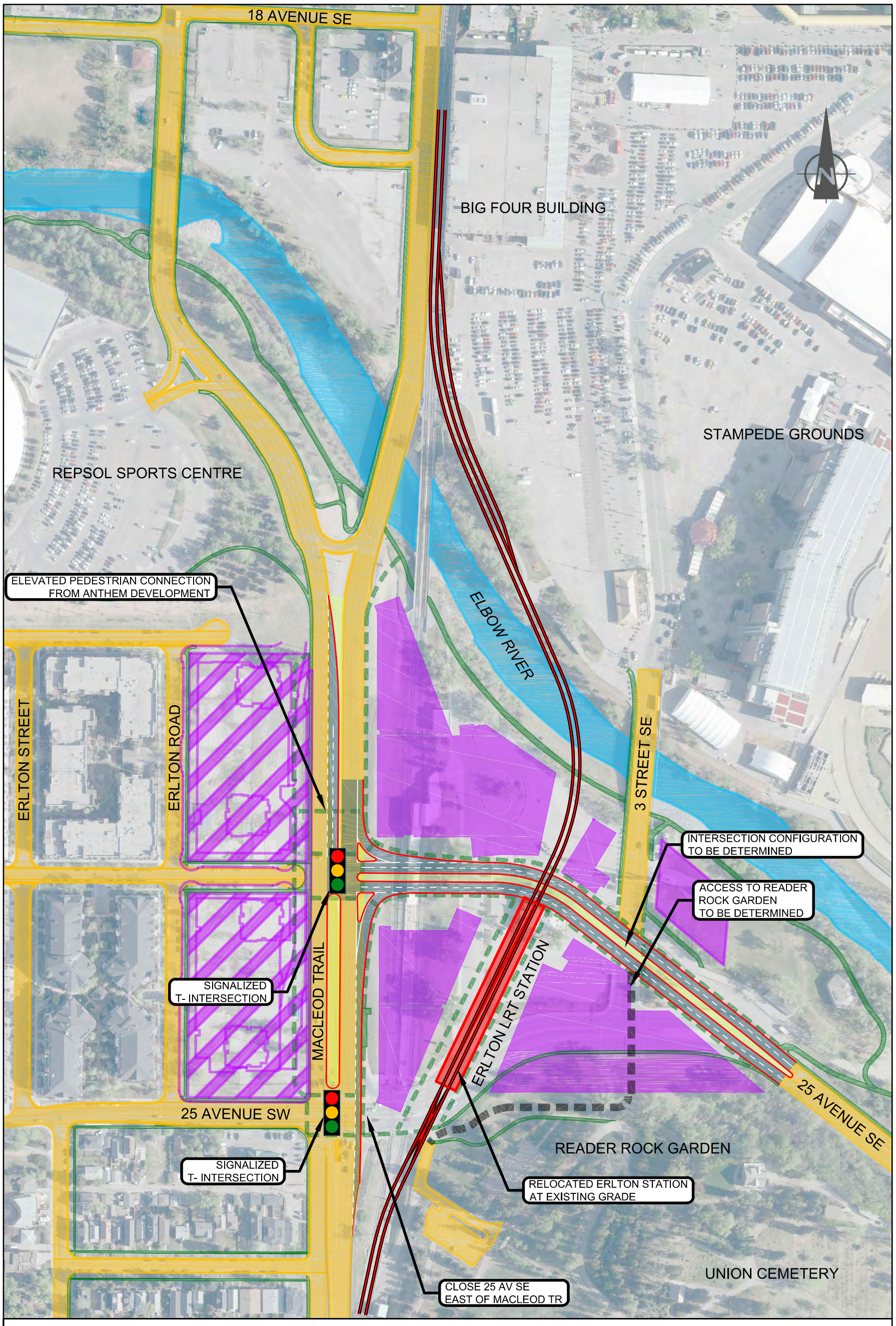
Concept A
Elevated LRT Station

Overview

25 Avenue & LRT Grade Separation

Fig. 3-3





McElhanney

Concept C
Relocated At-Grade LRT Crossing

Overview

25 Avenue & LRT Grade Separation

Fig. 3-5

3.2.1. Concept A – Elevated LRT Station

This concept elevates the LRT tracks starting north of the Cemetery Hill tunnel. In this concept, an elevated guideway for the LRT is constructed over the Elbow River and connects to the existing LRT tracks approaching the Big 4 building on the Stampede Grounds. In this concept, Erlton Station is re-constructed as an elevated station north and slightly east of the existing Erlton Station. All roadways remain at-grade, but the east leg of 25 Avenue S. is relocated north of the existing intersection at Macleod Trail. *Figure 3-6* illustrates a 3D rendering of the preliminary concept with hypothetical future development.

Figure 3-6: Concept A Aerial Rendering

The approximately 660m length of re-aligned horizontal and vertical LRT track available for grade separation extends from the existing southern limit of the Big Four building to the northern limit of the Cemetery Hill tunnel portal track slab (i.e. no removal of any part of either the Big Four building or the tunnel portal). Horizontally, the re-alignment comprises a diversion of the mainlines to the east with reverse curves enabling the elevated station tangent to be positioned parallel to and approximately 30m east of the existing station.

In order to gain sufficient elevation over the proposed re-aligned 25 Avenue S.E., the present 3.67% grade south of the existing level crossing is increased to 6% to reach a station tangent at the typical 0.3% grade. From the north end of a 5-car platform on this tangent, the vertical re-alignment continues downward at a 5% grade to rejoin the existing grade immediately south of the concrete track slab adjacent to the Big Four building.

For this concept, either a centre or side-platform station configuration can be accommodated, although the overlapping horizontal and vertical curvature within the station approaches requires designing to minimum standards and imposes speed restrictions, mainly on trains proceeding north from the station.

Benefits:

- At-grade pedestrian crossing time is optimized.
- Pathway to connect the Elbow River Pathway to Reader Rock Garden.
- No LRT/vehicle conflict at Macleod Trail and 25 Avenue S.E.
- Pedestrians do not cross the LRT tracks
- Two at-grade pedestrian crossings along Macleod Trail.

Trade-offs:

- Stairs, ramps, and elevators are required to access Erlton LRT station.
- Slightly increased travel distance for vehicles travelling 25 Avenue S.
- Slower trains due to curved and elevated Red Line LRT tracks.
- Major disruptions to LRT service during construction.
- High construction costs.

3.2.2. Concept B – Median Flyover

This concept does not move the LRT station and tracks. The east leg of the Macleod Trail and 25 Avenue S.E. intersection is closed and people driving on 25 Avenue S. must use ramps for certain movements. *Figure 3-7* illustrates a 3D rendering of the preliminary concept with hypothetical future development. *Figure 3-8* is a movement diagram illustrating how movements from Macleod Trail and 25 Avenue S. can be made.

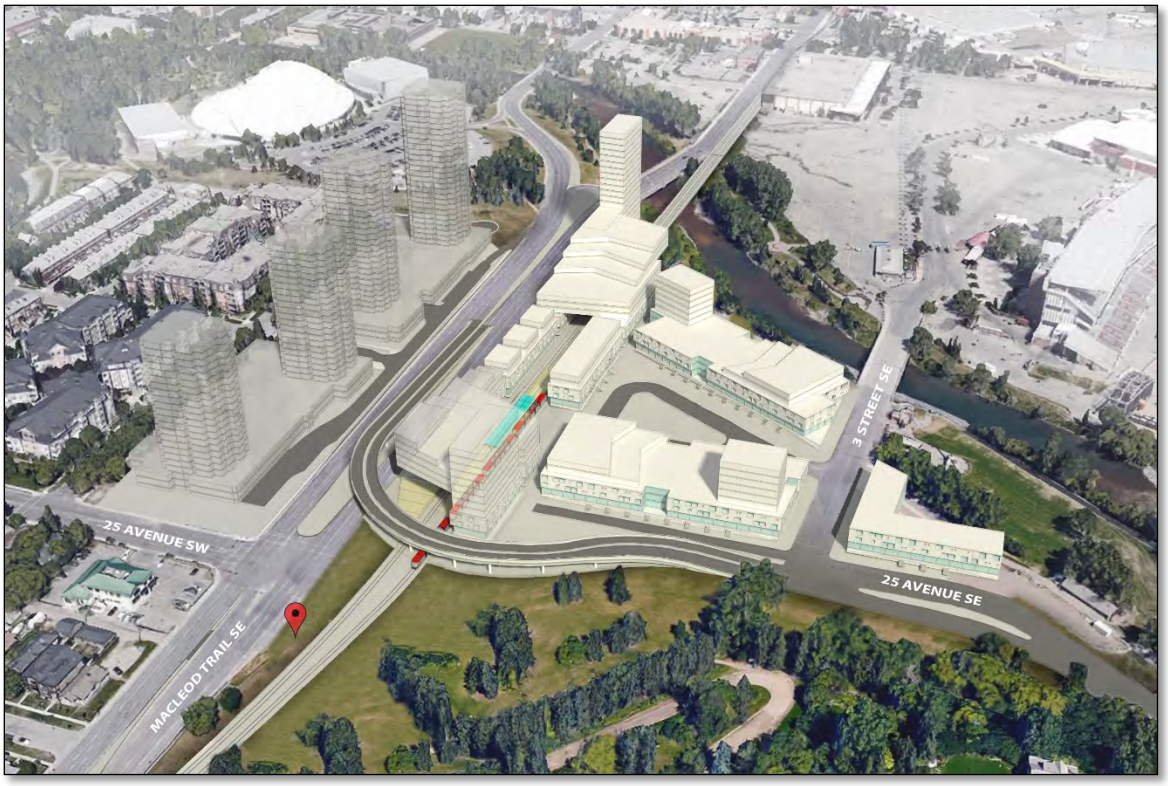


Figure 3-7: Concept B Aerial Rendering

Benefits:

- At-grade pedestrian crossing time is optimized.
- Pathway to connect the Elbow River Pathway to Reader Rock Garden.
- Removes the LRT/vehicle conflict on Macleod Trail and 25 Avenue S.E.
- Low construction cost.
- Can be constructed within the existing road right-of-way.

Trade-offs:

- Increased travel distance and convoluted paths for vehicular traffic along 25 Avenue S. relative to existing network.
- Ramps are inconsistent with the characteristics of Macleod Trail as an Urban Boulevard.
- Pedestrians cross the LRT tracks.

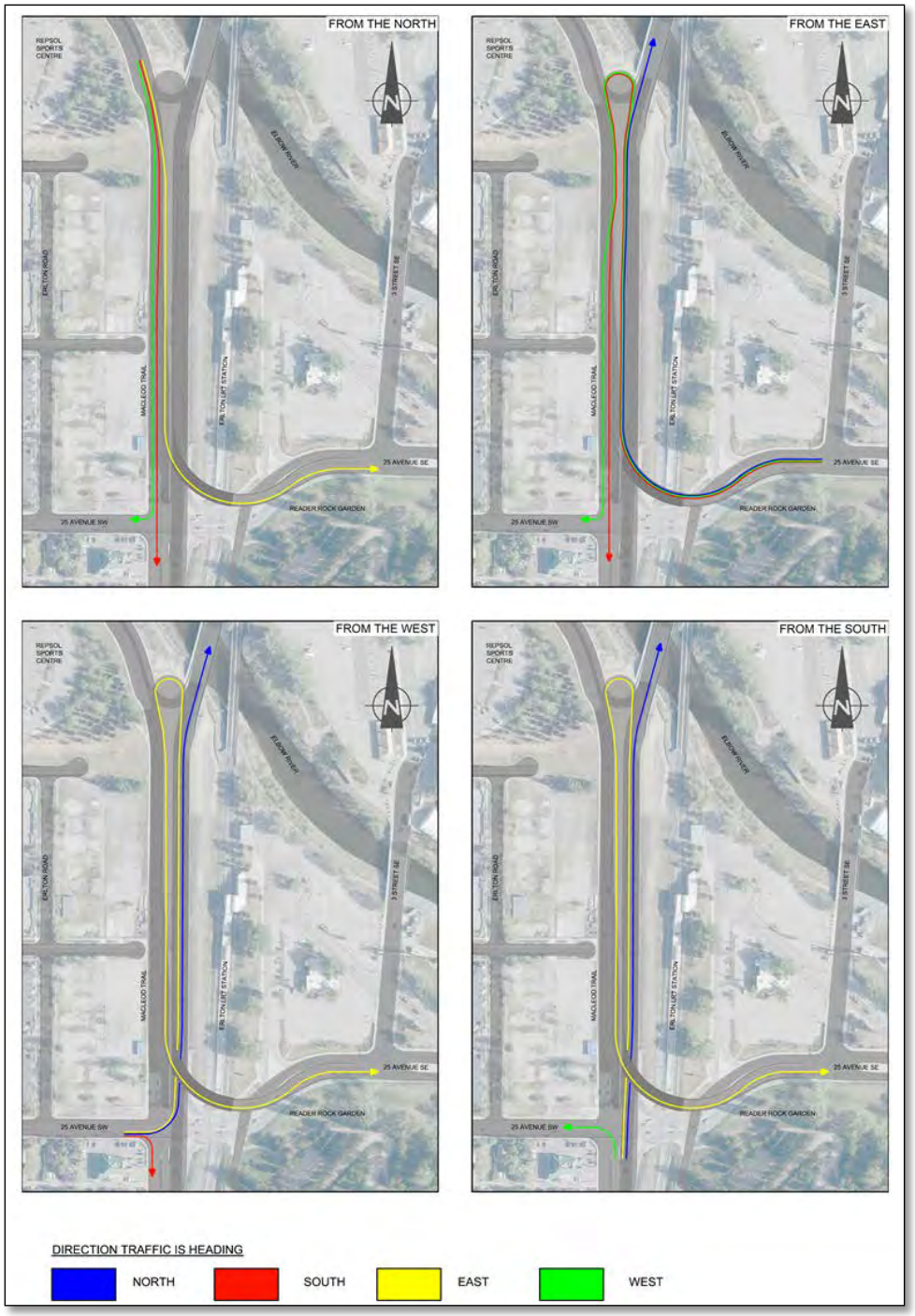


Figure 3-8: Concept B – Movement Diagram

3.2.3. Concept C – Relocated At-Grade LRT Crossing

This concept leaves the LRT alignment, station and surrounding roads generally at-grade. Relocating the LRT alignment to the east to a new level crossing of a re-aligned 25 Avenue S.E.

eliminates traffic signal delays due to the pre-emption at the existing 25 Avenue S.E. and Macleod Trail intersection.

For this concept, the east leg of 25 Avenue S. is relocated northward and a new re-aligned Erlton Station is located on the south side of the new road crossing, which is approximately 120m from the existing Macleod Trail. North of the crossing, a new LRT bridge over the Elbow River is required to join a new LRT right-of-way parallel to the river linking the alignment back to the existing right-of-way adjacent to the southwest corner of the Big Four building. The eastern re-alignment increases the LRT right-of-way length to 720m between tie-ins to existing tracks. *Figure 3-9* illustrates a 3D rendering of the preliminary concept with potential future development.

Figure 3-9: Concept C Aerial Rendering

Benefits:

- At-grade pedestrian crossing time is optimized.
- Pathway to connect the Elbow River Pathway to Reader Rock Garden.
- Removes the LRT/vehicle conflict on 25 Avenue S.E. and Macleod Trail.

Trade-offs:

- A vehicular and pedestrian at-grade LRT crossing on 25 Avenue S.E.
- Slower trains due to curved LRT tracks.
- Curved LRT tracks require more maintenance.
- Major disruptions to LRT service during construction.

- High construction cost.

3.3. Evaluation Criteria

The evaluation criteria were established by the project team based on the feedback received from the public and stakeholders during the initial engagement events, as well as input provided by The City of Calgary based on policies and guidelines, including:

- Calgary Transportation Plan (2009);
- Municipal Development Plan (2009);
- Complete Streets Guide (2014); and,
- Calgary Pathway and Bikeway Plan (2012).

Combining the feedback received from the public, as well as The City and project team's requirements, a total of eleven major criteria categories were identified. A summary of the selected evaluation criteria is provided in *Table 3-3,* along with descriptions of how each criterion was evaluated and scored.

The criteria include a mix of attributes that can be evaluated quantitatively and/or qualitatively:

- Quantitative: Criteria which can be measured (e.g. cost).
- Qualitative: Criteria which can be observed or described, but not measured (e.g. TOD potential).

Each concept was scored, on a scale of one to five, based on how well it achieves the objectives of each evaluation criteria. The following points were assigned based on how the concepts compared to base conditions in achieving the objectives of the criteria:

1. Considerably worse
2. Slightly worse
3. Acceptable
4. Slightly better
5. Considerably better

The scores for each criterion were combined and the highest scored option was selected as the recommended concept.

A 'do nothing' concept was also considered in the evaluation, as per direction outlined in the Transportation Corridor Policy.

Table 3-3: Evaluation Criteria and Description

Evaluation Criteria	Description
LRT Service	▪ Ability to increase train frequency ▪ Changes to LRT speed or travel time
Active Modes Accommodation	▪ Active modes opportunities to cross Macleod Trail ▪ Ease of access to the LRT station
Vehicle Operations	▪ The efficiency of vehicular travel within and through the area, including delays, travel distances, wayfinding, and maneuverability
Access Management	▪ Changes to existing property access (Calgary Stampede Grounds, Reader Rock Garden, Repsol Sport Centre) ▪ Changes to community access ▪ Future development access opportunities
TOD Potential	▪ The attractiveness of the developments given the surrounding area and infrastructure for leasing / resale, including land parcel sizes and orientation ▪ Land area available
Staging of Development	▪ The ease with which surrounding land can be utilized/developed in the short term
Safety	▪ Conflict points at intersections, vehicular maneuvering abilities, and geometric/operational issues ▪ Crossings of the LRT with pedestrian, cyclist or vehicular traffic
Disruption to Floodway	▪ Impacts to the flow of water during storm events
Construction Cost	▪ The total cost of construction & contingencies
LRT Service Disruption During Construction	▪ The disruption to LRT service and operations that construction will cause, including service interruptions, shut down/shuttle service, and extended delays
Traffic Disruption During Construction	▪ The disruption to traffic operations that construction will cause, including lane closures, detours, and extended delays

3.4. Evaluation of Concepts

3.4.1. Public Feedback

The three preliminary concepts were presented at an in-person open house held on May 24, 2017, as well as through an online survey that was available from May 24 through June 13, 2017, and at the Inglewood/Ramsay coordination project meetings. Participants were asked to evaluate each concept presented by completing the following sentence for each of the three concepts.

- 1. This concept meets the communities' priorities because…
- 2. This concept does not meet the communities' priorities because...
- 3. This concept meets my needs because…
- 4. This concept does not meet my needs because...

High-level themes and/or summary points that emerged for each of the concepts presented are highlighted in *Table 3-4*.

Table 3-4: Public Feedback on Preliminary Concepts

Concept A – Elevated LRT Station	
Theme	**Explanation**
Improved active mode connectivity	Citizen comments identified this option as providing good pedestrian and bicycle connections.
Improved traffic flow and vehicle travel times	Citizen comments identified this option as improving traffic flow and vehicle travel times by removing the LRT and signal disruption.
Opportunity for revitalization of the community	Citizen comments identified this option as providing good opportunity for redevelopment and revitalizing the community.
Concern regarding access for Ramsay/Mission residents	Citizen comments identified a concern for east – west travel and increasing the travel time for Ramsay/Mission residents.
Improved and safer access to public transit	Citizen comments identified this as improving pedestrian safety by removing the at-grade crossing and improving access to the LRT.
Concern regarding construction cos	Citizen comments identified a concern with the cost of constructing this project and that it was “too expensive”.
Concept B – Median Flyover	
Theme	**Explanation**
Concern with traffic flow and vehicle travel times	Citizen comments identified a concern with the flyover being a complicated or confusing route that doesn’t improve traffic flow or vehicle travel times.
Concern with aesthetics of a flyover	Citizens identified a concern that the flyover will take away from the “Urban Boulevard” feel and will be aesthetically displeasing.
Appreciation for lower-cost of construction	Citizen comments identified this option as favourable based on it being the lowest cost option of the three presented options.
Concern that it doesn’t allow for revitalization of the community	Citizen comments identified this option as not providing opportunity for redevelopment and not revitalizing the community.

Concept C – Relocated At-Grade LRT Crossing	
Theme	**Explanation**
Opportunity for revitalization of the community	Citizen comments identified this option as providing good opportunity for redevelopment and revitalizing the community.
Improved active mode connectivity	Citizen comments identified this option as providing good pedestrian and bicycle connections.
Concern with safety by still having an at-grade crossing	Citizen comments identified a concern that this option still provides an at-grade crossing, which still poses safety concerns.
Improved traffic flow and vehicle travel times for north – south travel	Citizen comments identified this option as improving traffic flow and vehicle travel times by removing the signal disruption on Macleod Trail. However, some concerns exist for travel east – west on 25 Avenue S.

3.4.2. LRT Service

One of the study objectives is to enhance transit/LRT service and allow for an increase in train frequency and/or an increase in the number of train cars. Calgary Transit also indicated that it is important to minimize any changes to the LRT speed or travel time. As such, the LRT services were evaluated, as detailed in *Table 3-5*, based on the ability to increase LRT frequency and any changes made to speed and travel time.

Table 3-5: LRT Service Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ The at-grade LRT/roadway crossing control at the intersection of 25 Avenue S.E. may impede increasing LRT frequency.	1.0
Concept A	▪ There is no impediment to increasing LRT frequency due to separation between the LRT and vehicular traffic. ▪ There is a slight increase in LRT travel time due to track elevation, possibly requiring the addition of another train to maintain frequency.	3.0
Concept B	▪ There is no impediment to increasing LRT frequency due to separation between the LRT and vehicular traffic. ▪ There are no changes to LRT travel time as there are no changes to existing Red Line LRT tracks.	5.0
Concept C	▪ The at-grade LRT/roadway crossing control at the intersection of 25 Avenue S.E. and 3 Street may impede increasing LRT frequency. ▪ There is a slight increase in LRT travel time due to track length and curvature, possibly requiring the addition of another train to maintain frequency.	2.0

3.4.3. Active Modes Accommodation

A key consideration in the development and evaluation of concept options was the accommodation of active modes. Given the priorities identified by stakeholders, as well as the nature of the surrounding neighbourhoods and TOD environment of the area, pedestrian and cyclist connections within and around the area were evaluated for each concept under consideration, as detailed in *Table 3-6*. In particular, opportunities for active modes to cross Macleod Trail, as well as access to and from the LRT station were assessed.

Table 3-6: Active Modes Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ There is a pedestrian overpass across Macleod Trail as well as one opportunity for an at-grade crossing of Macleod Trail. The at-grade crossing is severely impacted by the pre-emption causing significant delays to active modes travel. ▪ The existing station is at-grade and is easily accessible.	2.0
Concept A	▪ There is a pedestrian overpass across Macleod Trail as well as two opportunities for at-grade crossing of Macleod Trail. Improved east/west pedestrian permeability. ▪ Ramps, stairs, elevators, and/or escalators are necessary to access the elevated station.	4.0
Concept B	▪ There is a pedestrian overpass across Macleod Trail as well as one at-grade crossing of Macleod Trail. The Red Line LRT tracks and elevated 25 Avenue act as a barrier to east/west pedestrian permeability. ▪ The station remains at-grade and is easily accessible.	3.0
Concept C	▪ There is a pedestrian overpass across Macleod Trail as well as two opportunities for an at-grade crossing of Macleod Trail. Improved east/west pedestrian permeability. ▪ The new station is at-grade and is easily accessible.	5.0

3.4.4. Vehicle Operations & Access

Traffic operations at the 2038 horizon were tested for each of the concepts under consideration. The AM peak hour and PM pre-event peak hour traffic volumes were input into Vissim software to determine the overall capacity of the area network such that comparisons could be made between the different concepts.

Overall capacity was used as the key metric for comparison rather than the typical method of evaluating levels of service, as the saturated road network conditions resulted in most movements already being at or over capacity. As such, meaningful comparisons could be better drawn by determining the amount of traffic the network is able to serve for each concept; in other terms, the percentage of traffic assigned to the network that the network is actually able to process.

Detailed Vissim calibration and analysis results are included in Appendix A and summarized in *Table 3-7* and *Table 3-8*. The overall evaluation for vehicle operations for each concept developed, as well as the Do Nothing scenario, is provided in *Table 3-9*.

Table 3-7: AM Peak Capacity Analysis

		Do Nothing	Concept A	Concept B	Concept C
Overall Capacity		93%	99%	100%	97%
Movement Capacity	NB Total: 2990 veh/hr	90% 2699 veh/hr	100% 2981 veh/hr	101% 3033 veh/hr	99% 2955 veh/hr
	SB Total: 1893 veh/hr	100% 1895 veh/hr	98% 1852 veh/hr	98% 1862 veh/hr	96% 1816 veh/hr
	EB Total 816 veh/hr	80% 650 veh/hr	99% 810 veh/hr	100% 825 veh/hr	89% 723 veh/hr
	WB Total 515 veh/hr	99% 508 veh/hr	100% 516 veh/hr	101% 522 veh/hr	95% 489 veh/hr
Travel Time	NB	1m 36s	1m 39s	1m 20s	1m 42s
	SB	2m 04s	1m 37s	1m 30s	1m 37s
	EB	3m 42s	3m 46s	3m 05s	3m 52s
	WB	6m 52s	3m 32s	2m 41s	6m 18s

Table 3-8: PM Peak Capacity Analysis

		Do Nothing	Concept A	Concept B	Concept C
Overall Capacity		60%	83%	75%	78%
Movement Capacity	NB Total: 2276 veh/hr	68% 1765 veh/hr	87% 2272 veh/hr	81% 2099 veh/hr	89% 2312 veh/hr
	SB Total: 2531 veh/hr	62% 1724 veh/hr	84% 2342 veh/hr	76% 2112 veh/hr	77% 2153 veh/hr
	EB Total 583 veh/hr	56% 676 veh/hr	75% 914 veh/hr	68% 1048 veh/hr	66% 796 veh/hr
	WB Total 546 veh/hr	49% 556 veh/hr	55% 581 veh/hr	52% 659 veh/hr	43% 619 veh/hr
Travel Time	NB	1m 59s	2m 00s	2m 42s	1m 53s
	SB	3m 43s	4m 07s	3m 56s	2m 48s
	EB	6m 58s	5m 53s	7m 25s	5m 59s
	WB	8m 19s	10m 20s	9m 40s	11m 01s

Table 3-9: Traffic Operations Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ Percent of assigned vehicles processed: 93% in the AM peak hour, 60% in the PM peak hour ▪ Pre-emption creates high queues and travel times ▪ PM peak has significantly lower capacity than all other concepts	1.0
Concept A	▪ Percent of assigned vehicles processed: 99% in the AM peak hour, 83% in the PM peak hour ▪ Removal of pre-emption is highly beneficial ▪ EB / WB capacities are limited due to short storage between intersections	4.0
Concept B	▪ Percent of assigned vehicles processed: 100% in the AM peak hour, 75% in the PM peak hour ▪ AM has lowest overall travel time ▪ High NB to SB U-turn usage occasionally results in weaving area congestion and queues, increasing intersection delays ▪ Moderately high NB / SB capacity, although weaving near ramp entrance results in high Macleod Trail travel times and safety concerns	3.0
Concept C	▪ Percent of assigned vehicles processed: 97% in the AM peak hour, 78% in the PM peak hour ▪ Short spacing between intersections results in WB left-turn and EB left-turn queues often backing up into the intersections ▪ Limited WB and SB left-turn capacity due to train pre-emption and short storage. SB left-turn queueing blocks SB vehicles.	2.0

Each of the concepts under consideration was evaluated to assess the existing and future proposed access locations, and connectivity to the surrounding major road network. This included a review of changes to existing property accesses (including the Calgary Stampede Grounds, Reader Rock Garden, and Repsol Sport Centre), changes to community access, and future development access opportunities. A summary of the evaluation for each concept is provided in *Table 3-10*.

Table 3-10: Community & Property Access Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ Access remains unchanged. ▪ Through traffic on 25 Avenue is direct but impacted by the pre-emption. ▪ Development access is limited with a possible access on 25 Avenue S.E. as a right-in/right-out.	3.0
Concept A	▪ Access to Stampede Grounds and Repsol Sport Centre remains unchanged. Access to Reader Rock Garden is relocated to 3 Street S.E. ▪ Through traffic on 25 Avenue S.E. has a slightly longer distance to travel due to the two T-intersection configuration. ▪ There is a full access on Macleod Trail with a possible second access as a right-in/right-out. An access can be provided on 25 Avenue S.E. between Macleod Trail and 3 Street S.E. and also east of 3 Street.	4.0
Concept B	▪ Access to Stampede Grounds and Reader Rock Garden, as well as northbound egress from Repsol Sport Centre, are provided via a roundabout at 25 Avenue and 3 Street S.E. ▪ Through traffic on 25 Avenue S.E. and turning movements between the east leg of 25 Avenue and Macleod Trail have a longer distance to travel due to circuitous configuration. ▪ Development access can be provided on 3 Street S.E. Access to Macleod Trail is indirect.	2.0
Concept C	▪ Access to Stampede Grounds will be altered due to at-grade LRT/roadway crossing control at 3 Street S.E. Access to Repsol Sport Centre remains unchanged. Access to Reader Rock Garden is relocated to 3 Street S.E. ▪ Through traffic on 25 Avenue S.E. has a slightly longer distance to travel due to the two T-intersection configuration. ▪ There is a full access on Macleod Trail with a possible second access as a right-in/right-out. An access can be provided on 25 Avenue S.E. east of 3 Street S.E. with a possible second access as a right-in/right-out between Macleod Trail and 3 Street S.E.	3.0

3.4.5. TOD Potential & Staging

One of the primary study objectives is to encourage transit supportive development on lands east of Macleod Trail, adjacent to Erlton Station. However, based on the current provincial flood hazard map, most of this land falls within the floodway, as illustrated in *Figure 3-10*. Existing Land Use Bylaw (LUB) 1P2007, Part 3, Division 3 mandates that new buildings are not allowed in the floodway, thus reducing the land available for potential development.

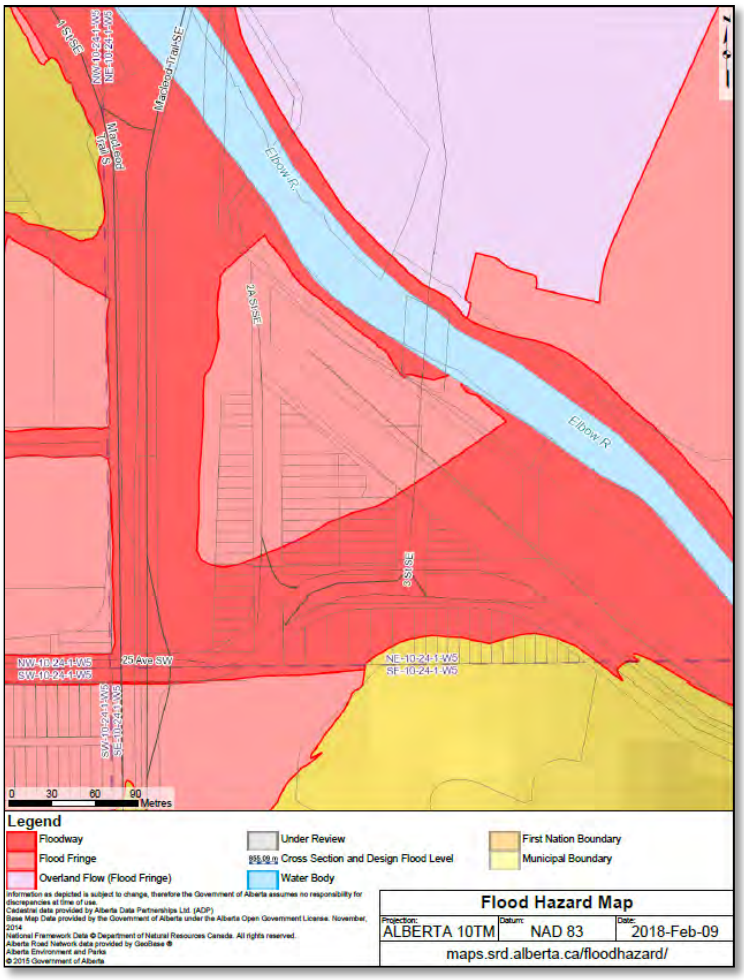


Figure 3-10: Flood Hazard Area Adjacent to Erlton Station

The evaluation of the TOD potential considered the attractiveness of the development for each concept given the surrounding area and infrastructure for leasing and/or resale, including land parcel sizes and orientation. Conservatively, the evaluation was conducted based on existing flood mapping and Land Use Bylaws, summarized in *Table 3-11*. The concepts with the floodway overlay are included in Appendix B.

Table 3-11: TOD Potential (Based on Existing Conditions) Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ Development parcels can be maximized with flexible configuration. ▪ Approximately 13,000 sqm of developable land available.	5.0
Concept A	▪ When built, concept will result in a reduction in developable parcels given the new LRT and road alignment goes through the triangle of developable land. ▪ Developable parcels may be less attractive to developers as some units will be facing the elevated guideway. ▪ Approximately 7,250 sqm of developable land available.	2.0
Concept B	▪ When built, concept will result in a slight reduction in developable parcels. ▪ Developable parcels may be less attractive to developers due to the visual impact of the elevated ramps. ▪ Approximately 12,750 sqm of developable land available.	4.0
Concept C	▪ When built, concept will result in a reduction in developable parcels given the new LRT and road alignment goes through the developable triangle. ▪ Approximately 11,550 sqm of developable land available.	3.0

It is expected that the upstream reservoirs, including the proposed Springbank Reservoir, and the new gates on the Glenmore Dam will be able to support a 2013-sized flood without overland flooding along the Elbow River. Until these mitigations are in place, it is unclear how the floodway zone and Land Use Bylaws would change to allow for development in this area. The maximum TOD potential would occur if buildings are allowed anywhere with a 30m setback of the Elbow River.

To assess the optimization of redevelopment opportunities, local developers and major landowners in the study area were invited in a workshop to provide their insights on the development implications of the preliminary concepts with a maximum land area, as summarized in *Table 3-12.* Potential development parcels were drawn up for each concept maintaining a minimum lot depth of 36m for development wherever possible. Parcels were also offset by a 30m buffer from the Elbow River. Development drawings can be found in Appendix C.

The actual land available for development in the future will likely be in between the two scenarios of conservative and maximum TOD potential presented here.

Table 3-12: TOD Potential (Based on Maximum Potential) Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ Development parcels are limited to east of the LRT tracks. Parcel configuration and layout is flexible. ▪ Approximately 25,000 sqm of developable land available.	3.0
Concept A	▪ If built, concept will result in increased density and developable land parcels. ▪ Developable parcels may be less attractive to developers as some units will be facing the elevated guideway. ▪ Approximately 30,000 sqm of developable land available.	4.0
Concept B	▪ If built, concept will likely not result in an increase in developable land parcels. Given the parcel depth of the land between the LRT tracks and Macleod Trail, it may not be feasible to develop. ▪ Developable parcels may be less attractive to developers due to the visual impact of the elevated ramps. ▪ Approximately 25,000 sqm of developable land available.	2.0
Concept C	▪ If built, concept will result in increased density and developable land parcels. ▪ Good parcel sizes and configuration would appeal to developers. ▪ The at-grade road and LRT track configuration is attractive to developers as it articulates good urban form. ▪ Approximately 35,000 sqm of developable land available.	5.0

The general agreement was that Concepts A and C would both facilitate redevelopment if the resulting parcels are deep enough to accommodate parkades. Each of these two concepts has some drawbacks, but overall, either would offer plausible redevelopment opportunities. Some key questions/ideas that arose from the developers during the workshop were:

- What is the main trigger: market readiness or roadway congestion?
- Does this plan anticipate shifting Macleod Trail to a retail orientation with walkability? It was recommended that retail should not go everywhere on the main levels.
- What are the urban design options (for any of the options)?
- The cross section of Macleod Trail will be critical to the redevelopment success.

- Successful TODs can't use current road standards. There would be a need to bring some of the innovative road standards to this area.

It was also important to evaluate the ability to stage development, in addition to evaluating the development potential in the study area. As shown in *Table 3-13*, some concepts allow high flexibility of when and how development can occur while others partially sterilize lands that could be developed until the ultimate concept is in place.

Table 3-13: Staging of Development Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ Development could move forward at any time.	5.0
Concept A	▪ Development parcels around the current and future LRT alignment are sterilized until the ultimate design is built. Some parcels east of the elevated guideway alignment can be developed prior to the ultimate design being built.	2.0
Concept B	▪ Development could move forward prior to the ultimate design being built. ▪ Elevating 25 Avenue S.E. will change and/or close development access.	4.0
Concept C	▪ Some of the development parcels are sterilized in the interim until the ultimate design is built. Parcel east of the proposed LRT alignment can be developed prior to the ultimate design being built.	3.0

3.4.6. Safety

Safety was a key consideration in the development and evaluation of the improvement concepts. Dr. John Morrall, with Canadian Highways Institute Ltd., conducted a high-level safety review of the concepts based on safety, conflicts, operations, and human factors, included in Appendix D. As illustrated in *Table 3-14*, the concepts were evaluated with respect to the conflict points arising from each intersection configuration proposed, vehicular maneuvering abilities, as well as any related geometric and operational issues. In addition, the safety risks associated with the crossings of the LRT tracks with pedestrian, cyclist, and vehicular traffic was evaluated.

Table 3-14: Safety Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ The 4-legged intersection has 36 conflict points with a complex and unpredictable signal operation. ▪ There is an at-grade pedestrian, cyclist and vehicle crossing of the LRT at 25 Avenue S.E.	1.0
Concept A	▪ The two T-intersections on Macleod Trail reduce the vehicular conflict points at each intersection. ▪ There are no crossings of the Red Line LRT tracks by other modes of transportation.	5.0
Concept B	▪ Single T-intersection on Macleod Trail significantly reduces the conflict points at the intersection, especially SB-EB conflicts with NB traffic. ▪ The SB traffic on Macleod Trail has multiple weaving and merging maneuvers. ▪ The closure of the east leg on 25 Avenue S.E. introduces unconventional travel patterns. ▪ There is an at-grade pedestrian and cyclist crossing of the LRT.	3.0
Concept C	▪ The two T-intersections on Macleod Trail reduce the vehicular conflict points at each intersection. ▪ EB traffic on 25 Avenue S.E. may spillback onto Macleod Trail due to at-grade LRT crossing. ▪ There is an at-grade pedestrian, cyclist and vehicle crossing of the LRT.	2.0

3.4.7. Impacts to Floodway

As the study area is situated within the floodway and flood fringe of the Elbow River, the impacts to the floodway associated with each concept were evaluated. The review included assessing the level of disruption to the area and the impacts to the flow of water during storm events. *Table 3-15* outlines the results of the evaluation for each concept.

Table 3-15: Impacts to Floodway Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ No disruption or change to the existing floodway.	5.0
Concept A	▪ Roads are at-grade and flood flow will not be obstructed. ▪ No impact on flood flows with elevated station. ▪ Flood route will be altered at the proposed new intersection (could improve flood flows) due to modification of the existing berm. Detailed hydrotechnical assessment will be conducted.	4.0
Concept B	▪ Road upgrade at Macleod Trail is at-grade and flood flow will not be obstructed. ▪ The proposed elevated ramp on the 25 Avenue S.E. is within the floodway obstructing flood flow.	2.0
Concept C	▪ Part of the relocated at-grade LRT station is located within the floodway obstructing flood flow.	3.0

3.4.8. Disruption During Construction

The level of disruption to area road network traffic operations and LRT service that the construction associated with each concept would incur was evaluated. The anticipated disruptions included lane closures, road detours, and partial or full closure of LRT operations at Erlton Station. A summary of the evaluation is provided in *Table 3-16* and *Table 3-17*.

Table 3-16: Traffic Disruption During Construction Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ There are no disruptions to traffic.	5.0
Concept A	▪ There are minimal disruptions to traffic on Macleod Trail and 25 Avenue S.E.	4.0
Concept B	▪ There are major disruptions to traffic due to lane closures on Macleod Trail and 25 Avenue S.E. during ramp construction.	2.0
Concept C	▪ There are some disruptions during the construction of the realigned LRT tracks due to a new 3 Street S.E. bridge and changes to the intersection of 25 Avenue S.E. and 3 Street.	3.0

Table 3-17: LRT Disruption During Construction Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ There is no disruption to LRT service.	5.0
Concept A	▪ Temporary periods of full closure of LRT service through the study area are required for construction of track and systems cut-overs to new alignment, testing of systems on new alignment and removal of existing level crossing systems. Construction of new elevated guideway and station will require protected temporary pedestrian and vehicle access routes to permit safe access to the existing station during entire construction period.	1.0
Concept B	▪ Disruption to LRT service can be minimized by using overnight or weekend LRT shut-down periods to permit erection of any protective screening required and installation of pre-fabricated roadway structure elements.	5.0
Concept C	▪ Temporary periods of full closure of LRT service through the study area are required for construction of track and systems cut-overs to new alignment, testing of systems on new alignment and removal of existing level crossing systems.	3.0

3.4.9. Costs

The total cost of construction, including contingencies, was evaluated for each concept. This allowed for a monetary comparison of the various infrastructure requirements such as elevated guideways, bridge and ramp structures, and roadway reconfiguration construction costs. *Table 3-18* details the results of the construction cost comparison.

Table 3-18: Construction Cost Evaluation & Scoring

Concept	Description	Score
Do Nothing	▪ $0	5.0
Concept A	▪ Approximately $129 million ▪ Costs include: new station, elevated guideway, LRT river bridge.	1.0
Concept B	▪ Approximately $42 million ▪ Costs include: ramp structure.	4.0
Concept C	▪ Approximately $111 million ▪ Costs include: new station, LRT river bridge, 3 Street S.E. bridge.	2.0

3.5. Evaluation Matrix

The primary objectives of the study were to provide better accommodations for all modes of transportation, improve transit service, and optimize redevelopment opportunities in the study area. These objectives aligned with what the community identified as top priorities, which were:

- Pedestrian accommodation, such as new or improved pedestrian infrastructure.
- Improved vehicle travel times, including reviewing signal timings and dedicated turn lanes.
- Bicycle accommodation, such as new infrastructure or improvements that enhance cycling.
- Improved public transit.
- Revitalization of the community.

Each criterion was prioritized based on its relative importance in achieving the project objectives and community priorities. Prioritization was assigned by giving each criterion a different weighting: the higher the weighting, the higher the priority. As such, active modes accommodation, safety, TOD potential, and LRT service were given higher weightings than the other criteria.

The completed evaluation matrix, including the weighting of each criterion and overall scores, can be found in *Table 3-19* and *Table 3-20*. As discussed in Section 3.4.5, the current potential for development in the study area is highly dependant on existing flood mapping and Land Use Bylaw. However, the flood mapping and Land Use Bylaw may change with the flood mitigation measures currently underway and/or planned. The overall evaluation of the concepts was undertaken for the two development scenarios: conservative TOD potential based on current bylaws, and maximum TOD potential assuming full development of the area can occur. All other criteria remain the same for the two scenarios.

Table 3-19: Concept Evaluation Matrix with Conservative TOD Potential

Evaluation Criteria	Weight	Do Nothing	Concept A	Concept B	Concept C
LRT Service	10.0	1.0	3.0	5.0	2.0
Safety	16.0	1.0	5.0	3.0	2.0
Pedestrian and Cyclist Accommodation	14.0	2.0	4.0	3.0	5.0
Vehicle Operations	8.0	1.0	4.0	3.0	2.0
Access Management	8.0	3.0	4.0	2.0	3.0
Staging of Development	6.0	5.0	2.0	4.0	3.0
TOD Potential	13.0	5.0	2.0	4.0	3.0
LRT Disruption During Construction	8.0	5.0	1.0	5.0	3.0
Traffic Disruption During Construction	4.0	5.0	4.0	2.0	3.0
Disruption to Floodway	5.0	5.0	4.0	2.0	3.0
Construction Cost	8.0	5.0	1.0	4.0	2.0
Total Score		38.0	34.0	37.0	31.0
Total Weighted Score		**306.0**	**320.0**	**346.0**	**286.0**

Table 3-20: Concept Evaluation Matrix with Maximum TOD Potential

Evaluation Criteria	Weight	Do Nothing	Concept A	Concept B	Concept C
LRT Service	10.0	1.0	3.0	5.0	2.0
Safety	16.0	1.0	5.0	3.0	2.0
Pedestrian and Cyclist Accommodation	14.0	2.0	4.0	3.0	5.0
Vehicle Operations	8.0	1.0	4.0	3.0	2.0
Access Management	8.0	3.0	4.0	2.0	3.0
Staging of Development	6.0	5.0	2.0	4.0	3.0
TOD Potential	13.0	3.0	4.0	2.0	5.0
LRT Disruption During Construction	8.0	5.0	1.0	5.0	3.0
Traffic Disruption During Construction	4.0	5.0	4.0	2.0	3.0
Disruption to Floodway	5.0	5.0	4.0	2.0	3.0
Construction Cost	8.0	5.0	1.0	4.0	2.0
Total Score		36.0	36.0	35.0	33.0
Total Weighted Score		**280.0**	**346.0**	**320.0**	**312.0**

Based on the evaluation, Concept B was the highest scored concept with conservative development, while Concept A scores highest with maximum development.

3.6. Other Considerations

The option of constructing a depressed LRT alignment beneath 25 Avenue S.E. was raised at various times during the study. Initial assessment of this concept presented several major difficulties in the constrained confines of the area between Cemetery Hill and the Elbow River.

The profile in *Figure 3-11* shows how the existing Red Line LRT tracks are on a steep downward as they approach the Cemetery Hill tunnel portal and then transition into an upward 3.7% gradient to cross 25 Avenue S.E.

Re-grading the LRT alignment to pass below the existing 25 Avenue S.E. would mean that the complete tunnel portal would have to be reconstructed. Alternatively, the east leg of 25 Avenue could be relocated farther north to provide some distance in which to depress the alignment below the roadway without major reconstruction of the tunnel portal. In order for the LRT to pass under a relocated 25 Avenue S.E. and then re-connect to the existing LRT bridge across the Elbow River, Erlton Station would have to be reconstructed on the maximum permitted 1.5% grade adjacent to a significant 4.5% approach grade north of the station. In addition, this re-alignment requires severe horizontal curvature resulting in less than desirable, sub-standard geometry for LRT operations.

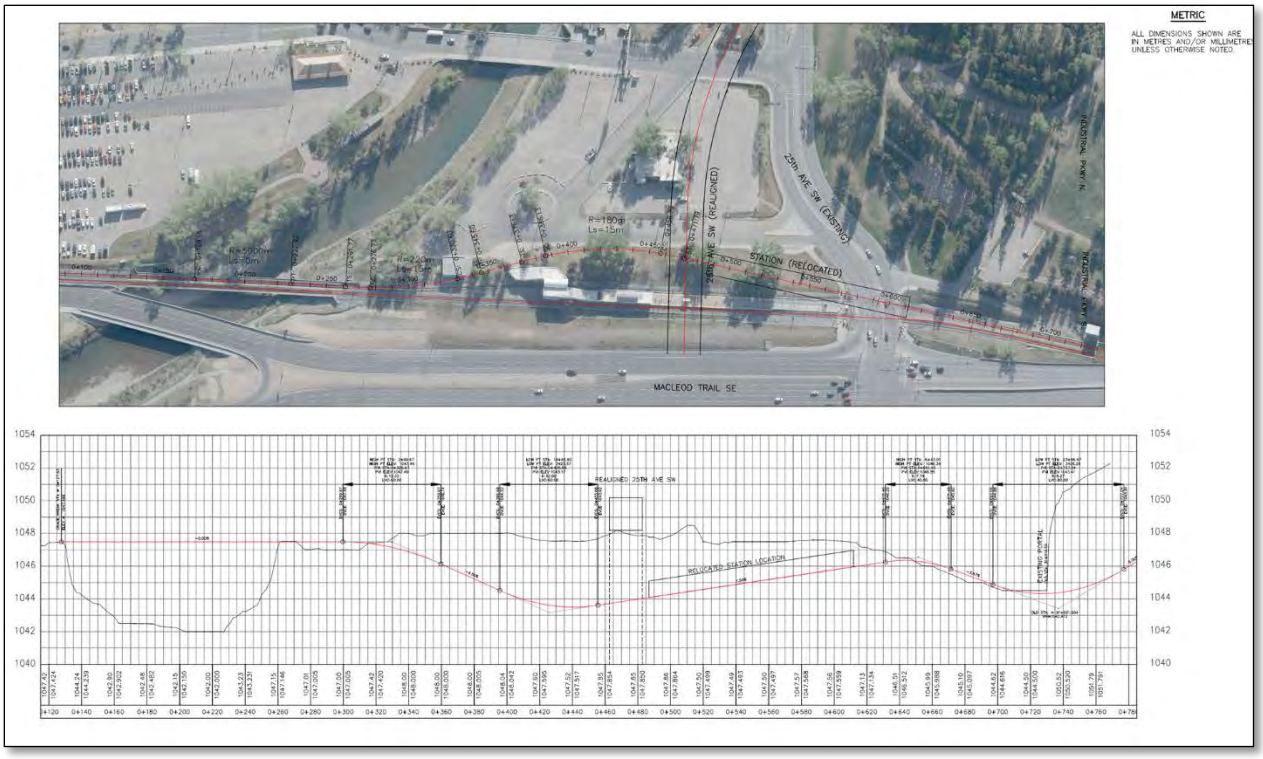


Figure 3-11: Depressed LRT Preliminary Profile

It should be noted that this concept plan and profile was prepared for illustration purposes only and did not make provision for the storage siding requirement that was subsequently identified. Accommodating the siding would make it impossible to reach the existing Elbow River bridge complicating the matter further by necessitating tunnelling beneath the river.

Construction of any form of below-grade LRT would shut down LRT service for an extended period and also impact the operation of adjacent roadways. Mitigating the impacts to ground water and flooding would also have to be considered in the design of the depressed station. The below-grade option south of the river would be much more disruptive to LRT service due to the required closure of Erlton Station and a temporary mainline diversion. In addition, this option would be more expensive to build and maintain than any of the at-grade or above-grade concepts investigated in this study.

The assessment did not identify any overall benefits of a below-grade alternative compared to the above-grade or at-grade options.

4. Concepts Refinement & Interim Improvements

4.1. Refined Concepts

Additional investigation was undertaken to determine how the three concepts could be further refined to incorporate stakeholder feedback and concerns, as well as incorporate access management and active modes accommodation.

Key considerations included in the refined concepts involved retaining adequate capacity for traffic entering and exiting the Stampede Grounds, provisions for transit vehicles servicing Erlton Station, providing access to Reader Rock Garden, and keeping maintenance access to the LRT tunnel portal. The proposed access in each concept provides a replacement U-turn route for traffic exiting from the Repsol Sport Centre that wishes to travel northbound on Macleod Trail. The road networks proposed also aim to provide access flexibility for future development proposals, however it should be noted that additional roads may be required.

Pedestrians and cyclists are accommodated through sidewalks or pathways along all new roadways and connections to existing facilities, including the Elbow River Pathway. Generally, a monolithic sidewalk has been included on all proposed roadways, with some additional pathway connections added between existing pathways. The proposed pedestrian overpass from the Anthem's Crosstown development was also incorporated in all concepts and modified where required. For instance, adjustments were required to the overpass ramp proposed on the east side of Macleod Trail, as it was not compatible as originally proposed with the concepts presented in this report. The provision of ramps or stairs to the overpass on the east side of Macleod Trail was considered but not thoroughly examined within the scope of this project.

Concurrently, an initiative to create a new access to the Stampede Grounds at Macleod Trail and 17 Avenue S.E. was being was being driven by the development planned on the Stampede Grounds through the Rivers District Master Plan. This resulted in a proposal to relocate the existing LRT siding track away from Victoria Park/Stampede Station. For operational reasons, the preferred location for this siding track is between Victoria Park/Stampede Station and the north end of the Cemetery Hill LRT tunnel. The purpose of this siding track is to provide a space to store trains to be brought into service, disabled trains, and maintenance vehicles. The siding needs to accommodate four-car trains in the short and medium term and be capable of extending

to accommodate five-car trains in the future. Direct access to the siding track is required from both inbound and outbound LRT tracks. This requirement determines the necessary geometry of track cross-over. The siding track only needs operator access to trains and does not require a passenger platform.

4.1.1. Siding Track Plans

Calgary Transit commissioned Hatch to develop alternative designs for the siding track and crossovers between the Big Four building and Erlton Station. A memo submitted by Hatch on January 17, 2018, included in Appendix E, recommended the siding track be located east of the mainline tracks on a separate bridge over the Elbow River, along with a single crossover south of the bridge.

4.1.2. Concept A Refinement

Refinements to the LRT horizontal and vertical alignment in Concept A are primarily due to the need to accommodate the siding track described above. As noted earlier in the report, the Concept A re-alignment requires the full length of the LRT right-of-way between the Big Four building's southwest corner and the north portal of the Cemetery Hill tunnel. If the siding track has been constructed over the new Elbow River bridge, this length is reduced considerably. Consequently, it is no longer possible to grade separate 25 Avenue S.E. while retaining Erlton Station by taking the LRT over or under the road between the southern limit of the siding track access and the tunnel entrance. As such, to achieve the Concept A grade separation, the existing mainline and bridge, and the interim siding track across the Elbow River become redundant for LRT use and could be removed or possibly re-purposed.

Alternative LRT track re-alignment configurations incorporating the siding track, Erlton Station, and the 25 Avenue S.E. grade separation were examined. Through the review, it was determined that the only feasible location for the replacement five-car siding track is between the inbound and outbound tracks at or near the horizontal tangent portion of the LRT track profile through the station. The tangent must also be of sufficient length to allow either equilateral or standard turnouts to be accommodated as cross-overs providing direct access to and from both inbound and outbound Red Line LRT tracks.

If the elevated Erlton Station is kept at near-desirable minimum grade (0.3%), the LRT profile requires grades of 5.5% and 6% for the station approaches to achieve the vertical clearance required over a re-aligned 25 Avenue S.E., assuming the roadway remains at or near the existing grade through Erlton Station. The constrained overall length of the re-alignment requires approach grades to be developed within the existing LRT right-of-way, resulting in longer periods of full service disruption to allow cut-over from existing to new elevated alignment. Also, the re-aligned horizontal alignment required within the constraints identified above imposes a 45km/h design speed limit on three of the four curves, with 50km/h on the northernmost fourth curve.

An alternative LRT vertical profile for the refined Concept A was subsequently developed with grades commencing outside of the existing right-of-way to reduce the service disruption period and improve track geometry. This entailed placing the Erlton Station on a 1.25% grade (within City design standards), which permitted grades of 3% and a short 6% on station approaches to achieve the required vertical clearance over a re-aligned 25 Avenue S.E. This alternative imposes a 45km/h design speed limit on the two curves entering the station with 50km/h on the northern and southernmost curves rejoining the existing alignment.

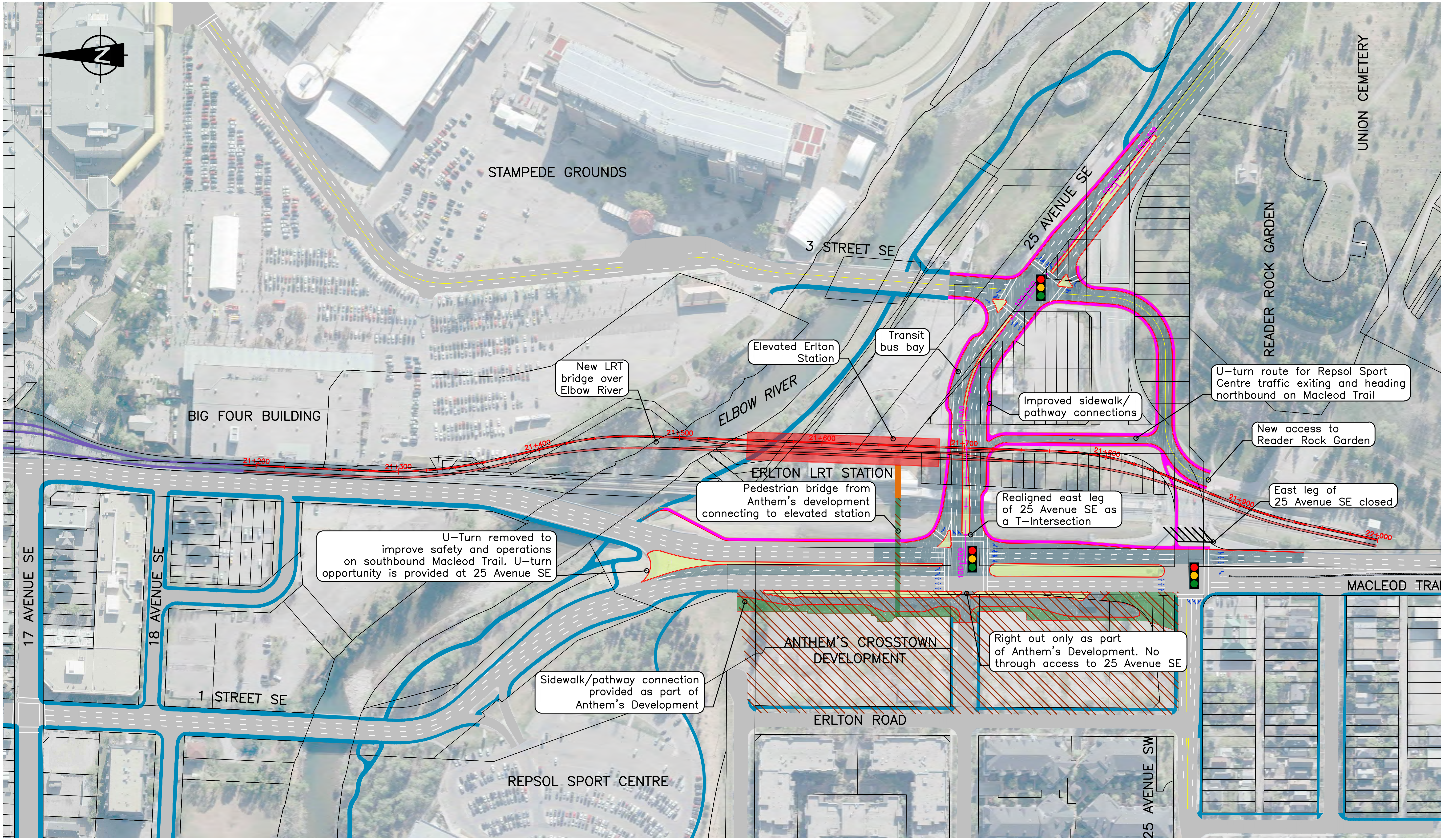
The investigation of refinements indicates that fitting the elevated trackwork, including a siding track, between the Cemetery Hill tunnel entrance and the Big Four building constrains the possible location of the elevated Erlton Station, resulting in less than desirable track geometry and likely a turnout configuration not favoured by Calgary Transit. However, if the area of the Big Four building becomes available prior to Concept A being implemented, then reconnecting the track further north would allow significant opportunity to improve operational geometry, siding track functionality, and overall constructability of the connection to existing track and systems.

In this concept, the utilities that will be affected are those that travel into the current Erlton Station. These are electrical, gas, sanitary, storm, and water facilities. It is expected that these would be dealt with as part of the new station design to ensure adequate servicing to the station is maintained. Roadwork has minimal surface impacts, and apart from potential protection measures during construction, no conflicts are expected.

The plan view, profile, and cross section for the refined Concept A are provided in *Figure 4-1, Figure 4-2,* and *Figure 4-3.*

Other refinements, in addition to the LRT refinement discussed above, include:

- Pathways and sidewalks added along all new roadways and to existing facilities to improve connections for people walking and cycling.
- Removal of the existing U-turn on Macleod Trail to create additional southbound left-turn storage length required.
- Bus pullouts on 25 Avenue S.E. to accommodate transit service and access to the station.
- New intersection on 25 Avenue S.E. to provide access to Reader Rock Garden and the LRT portal.
- Extension of the pedestrian overpass from Anthem's Crosstown development to the new elevated Erlton Station.



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- EXISTING PAVEMENT
- EXISTING PATHWAY
- EXISTING ERLTON STATION
- EXISTING LRT TRACKS
- ANTHEM'S PEDESTRIAN CONNECTIONS
- ANTHEM'S DEVELOPMENT
- NEW / ALTERED PAVEMENT
- PROPOSED STRUCTURE
- PROPOSED CONCRETE SURFACING
- PROPOSED PATHWAY/ SIDEWALK
- PROPOSED PEDESTRIAN OVERPASS
- FLOODWAY
- PROPOSED CURB & GUTTER
- PROPOSED CONCRETE BARRIER
- PROPOSED ERLTON STATION
- PROPOSED LRT TRACK
- 101+200 ROAD STATIONING
- 21+600 LRT STATIONING

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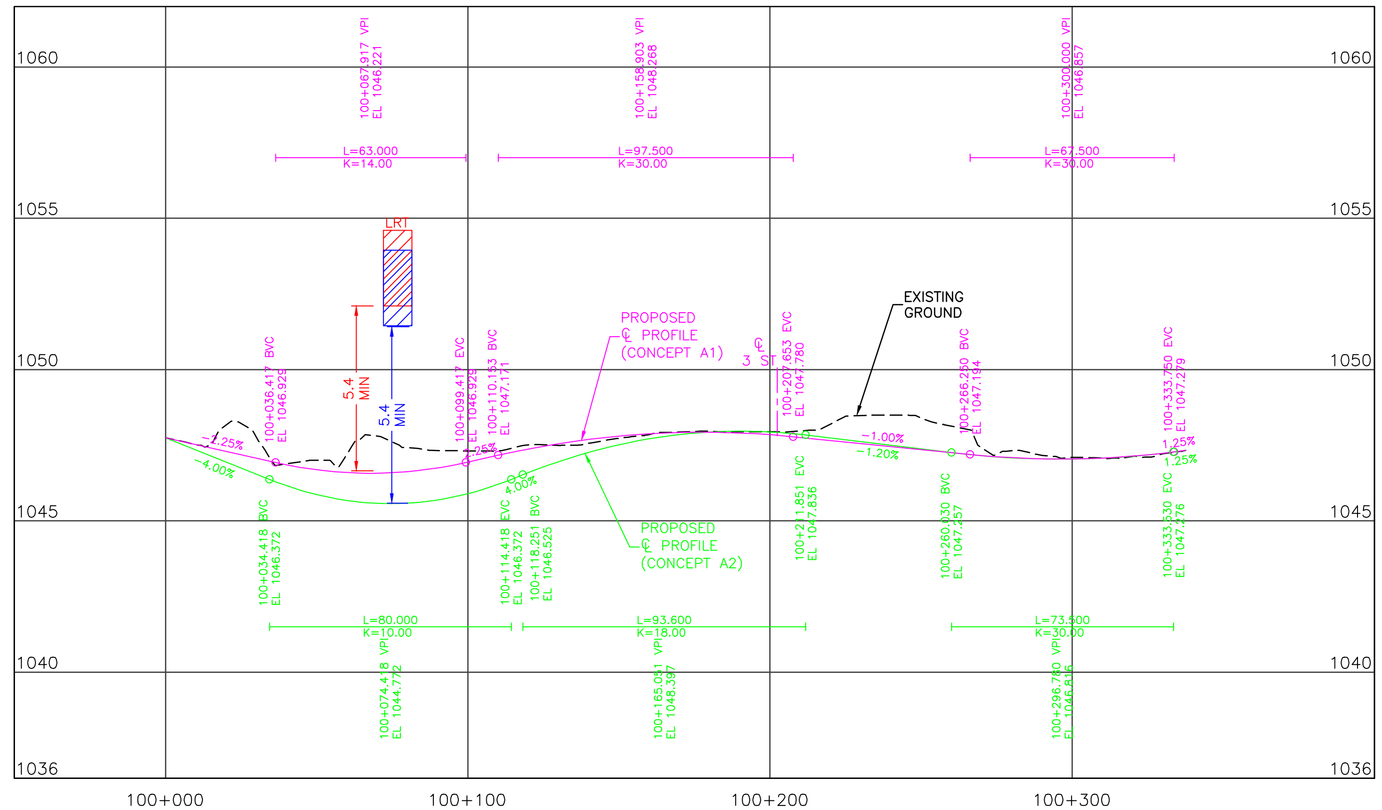
Refined Concept A
Elevated LRT Station

Plan

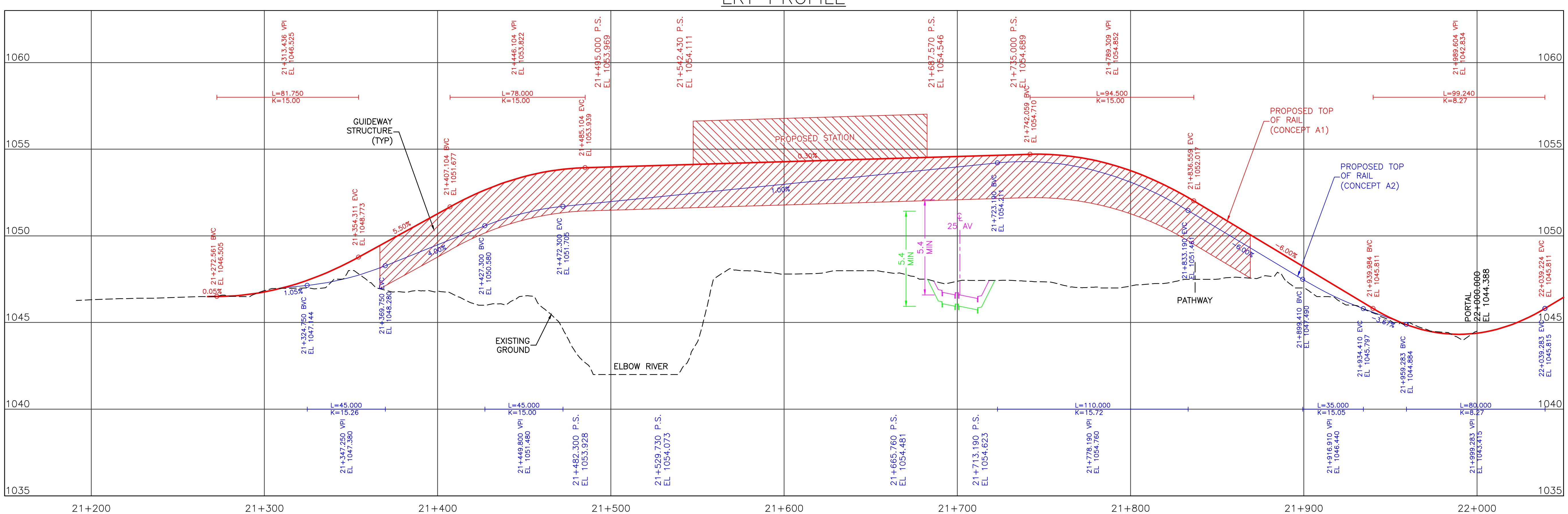
25 Avenue SE LRT Grade Separation Study

Fig. 4-1

ROADWAY PROFILE



LRT PROFILE



McElhanney

EXISTING GROUND
PROPOSED ROAD ℄ PROFILE
PROPOSED LRT PROFILE
STRUCTURE

25 0 50
1:2500

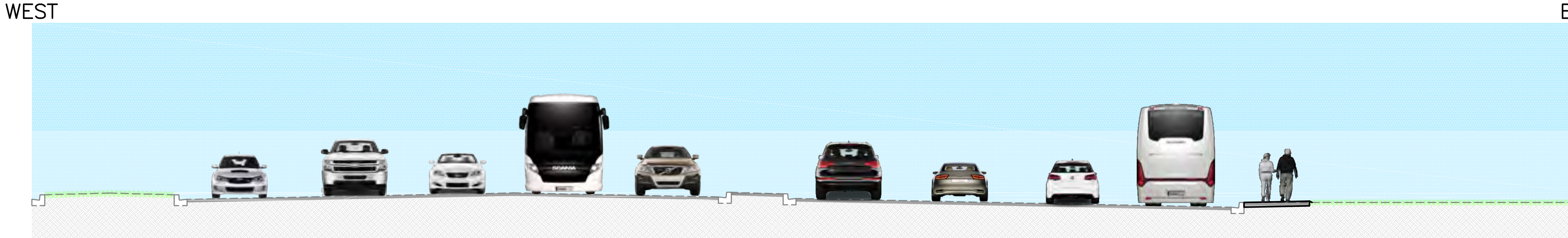
Refined Concept A
Elevated LRT Station

Profiles

25 Avenue SE LRT Grade Separation Study

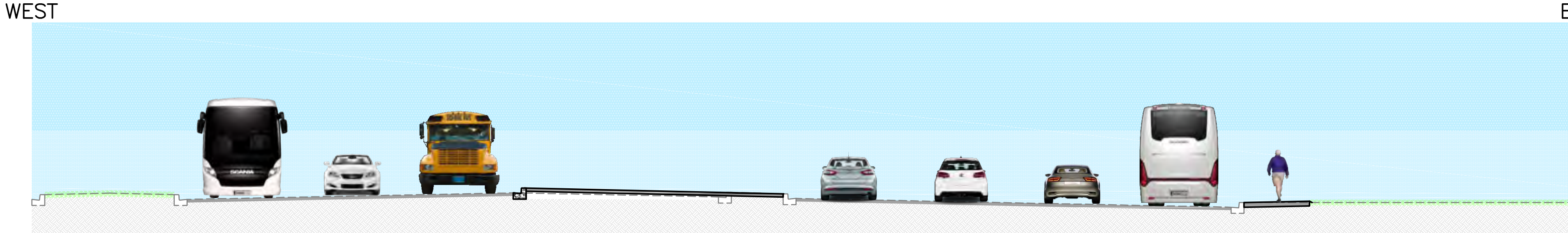
Fig. 4-2

MACLEOD TRAIL
NORTH OF 25 AVENUE



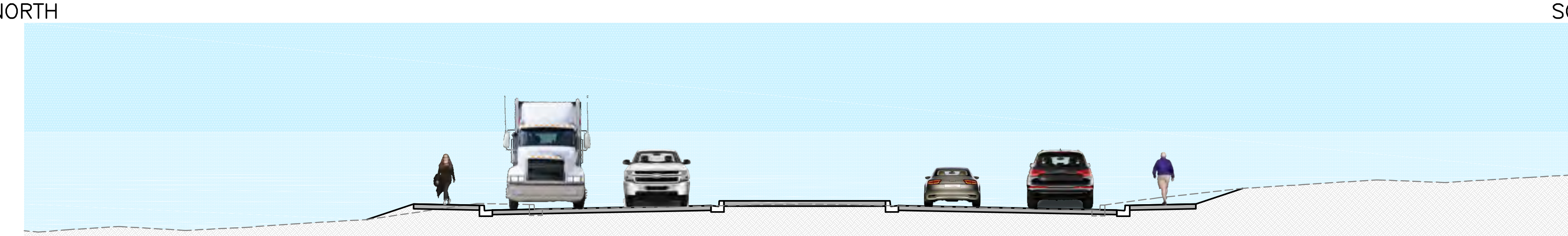
EXISTING DIMENSIONS	VARIES BLVD (ANTHEM)	3.50 LANE	3.50 LANE	3.50 LANE	3.30 LT LANE	3.30 LT LANE	2.50 MEDIAN	3.50 LANE	3.50 LANE	3.50 LANE	3.50 LANE		~30m TO LRT TRACK
PROPOSED DIMENSIONS	VARIES BLVD (ANTHEM)	3.50 LANE	3.50 LANE	3.50 LANE	3.30 LT LANE	3.30 LT LANE	2.50 MEDIAN	3.50 LANE	3.50 LANE	3.50 LANE	3.50 AUX LANE	2.53 MONOWALK	~55m TO LRT TRACK (ELEVATED)

MACLEOD TRAIL
SOUTH OF 25 AVENUE



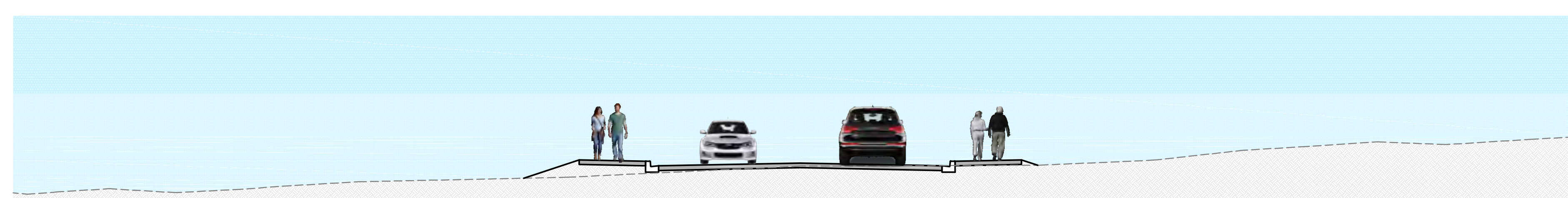
EXISTING DIMENSIONS	VARIES BLVD (ANTHEM)	3.50 LANE	3.50 LANE	3.50 LANE	3.30 LT LANE	3.30 LT LANE	2.50 MEDIAN	3.50 LANE	3.50 LANE	3.50 LANE	3.50 LANE		~18m TO LRT TRACK
PROPOSED DIMENSIONS	VARIES BLVD (ANTHEM)	3.50 LANE	3.50 LANE	3.50 LANE	9.10 MEDIAN			3.50 LANE	3.50 LANE	3.50 LANE	3.50 RT LANE	2.53 MONOWALK	~55m TO LRT TRACK (ELEVATED)

25 AVENUE



EXISTING DIMENSIONS	2.10 MONOWALK	3.70 LANE	3.70 LANE	2.00 PAINTED MEDIAN	4.00 LANE	4.20 LANE	
PROPOSED DIMENSIONS	2.53 MONOWALK	3.50 LANE	3.50 LANE	6.00 MEDIAN	3.50 LANE	3.50 LANE	2.53 MONOWALK NO WALKWAY EAST OF 3 STREET

LOCAL ACCESS ROAD



PROPOSED DIMENSIONS	2.53 MONOWALK	4.50 LANE	4.50 LANE	2.53 MONOWALK

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Refined Concept A
Elevated LRT Station

Typical Cross Sections

25 Avenue SE LRT Grade Separation Study | Fig. 4-3

4.1.3. Concept B Refinement

Several variations for Concept B were considered to address the weaving associated with the U-turn on Macleod Trail south of the Elbow River, as well as concerns identified by stakeholders, including aesthetics and access.

The first variation of Concept B was to convert 18 Avenue S.E. to a one-way street and use it as a U-turn instead of the originally proposed U-turn on Macleod Trail south of the river. This was meant to specifically address the weaving issues resulting from the high U-turn usage and the multiple maneuvering movements occurring over a short distance. Using 18 Avenue S.E. as the U-turn provided longer weaving distances for vehicle maneuvering, longer storage distance for turning vehicles, and slightly better overall operational capacity. However, vehicles had longer distances to travel to use 25 Avenue S.E., the eastbound vehicles on 18 Avenue S.E. would be required to take another route, and the westbound left-turning vehicles from 18 Avenue S.E. onto 1 Street S.E. required an added lane on 1 Street S.E. to make this a free movement. Given the drawbacks to this variation, it was not pursued further as a recommended refinement to Concept B.

The second variation of Concept B was to utilize the U-turn on Macleod Trail initially proposed south of the river as well as 18 Avenue S.E. to improve the weaving issues and accommodate the high U-turn usage. This variation allows a portion of the east leg of 25 Avenue S.E. to remain at-grade with a right-in/right-out, and a single southbound left lane ramp from the median of Macleod Trail that ties in to 25 Avenue S.E. Eastbound and westbound through movements would still not be allowed at the intersection to keep the signal operating without LRT pre-emption. The westbound vehicles on 25 Avenue S.E. could use the at-grade right-out, but would be prohibited from merging in with northbound Macleod Trail until north of the U-turn. Vissim analysis showed overall capacity improvements and a reduction in weaving issues. Maintaining some at-grade access for the east leg of 25 Avenue S.E. was also preferred by the Calgary Stampede, as it provides better connections in and out of the Stampede Grounds. This variation was carried forward as a possible refined Concept B2 and was evaluated in relation to Concept B, illustrated in *Table 4-1*, using the same evaluation criteria discussed in Section 3. Overall, Concept B2 has slightly better active modes accommodation, vehicle operations, and community/property access. However, traffic is no longer completely separated from the LRT, and gates would still be required at the LRT crossing. *Figure 4-4* is a movement diagram illustrating how movements from Macleod Trail and 25 Avenue S.E. can be made.

All variations of Concept B were tested with a roundabout at the intersection of 25 Avenue S.E. and 3 Street. A roundabout was selected as it offers significant advantages over a signalized intersection due to the alignment of the intersecting legs. The roundabout was designed at a high level and has not been specifically tested for large design vehicle travel paths, nor analyzed for fastest path. Based on recent experience, the 28m inscribed diameter and 5.0m wide circulatory travel lanes should provide adequate results for both aforementioned considerations. The currently shown hybrid laning of the roundabout could be altered to a full two-lane circulatory roadway should future operational analysis indicate it is needed. This would result in minimal changes to the overall roundabout design and footprint.

Table 4-1: Concept B2 Evaluation

Evaluation Criteria	Concept B		Refined Concept B2	
	Description	Score	Description	Score
LRT Service	▪ There is no impediment to increasing LRT frequency due to full separation between the LRT and vehicular traffic.	5.0	▪ There is no impediment to increasing LRT frequency but there is an at-grade LRT crossing that must be gate controlled.	4.0
Pedestrian and Cyclist Accommodation	▪ There is a pedestrian overpass across Macleod Trail, as well as one at-grade crossing of Macleod Trail. The Red Line LRT tracks and elevated 25 Avenue S.E. act as a barrier to east/west pedestrian permeability.	3.0	▪ 25 Avenue S.E. remains at-grade with a sidewalk/pathway provided along the roadway and no longer acts as a barrier to east/west pedestrian permeability.	4.0
Vehicle Operations	▪ Percent of assigned vehicles processed: 100% in the AM peak hour, 75% in the PM peak hour. ▪ High NB to SB U-turn volumes on Macleod Trail occasionally result in weaving area congestion and queues, increasing intersection delays.	3.0	▪ Percent of assigned vehicles processed: 100% in the AM peak hour, 89% in the PM peak hour. ▪ Increased weaving lengths and multiple U-turn locations.	5.0
Access Management	▪ Access to Stampede Grounds and Reader Rock Garden, as well as northbound egress from Repsol Sport Centre, are provided via a roundabout at 25 Avenue S.E. and 3 Street S.E. ▪ Development access can be provided on 3 Street S.E. Access to Macleod Trail is indirect.	2.0	▪ Access to Stampede Grounds and Reader Rock Garden are provided at grade with a right-in/right-out at 25 Avenue S.E. as well as via a roundabout at 25 Avenue and 3 Street S.E. ▪ Development access can be provided on 3 Street S.E. and on 25 Avenue S.E.	3.0

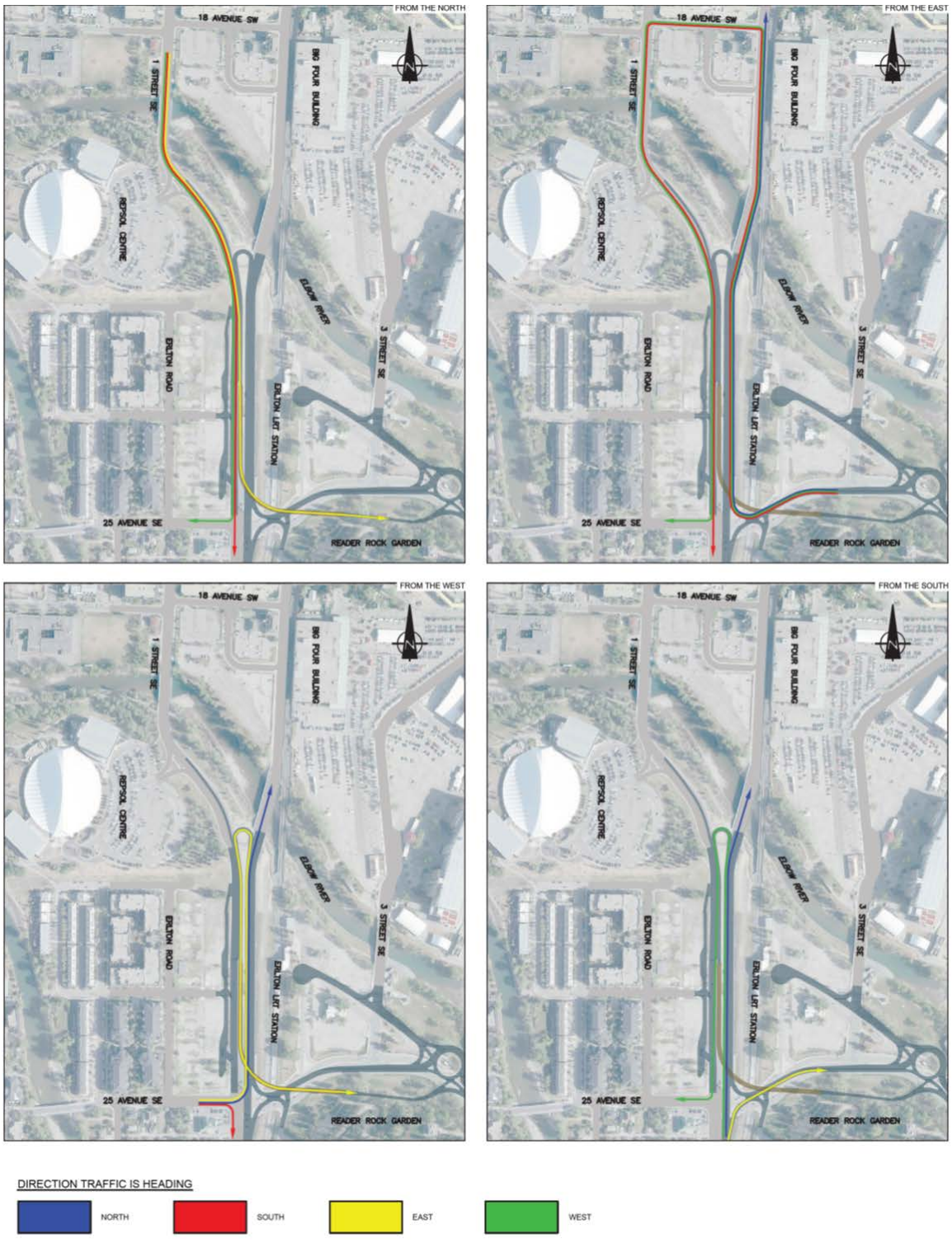

Figure 4-4: Concept B2 – Movement Diagram

Concept B has the most complicated road design due to the incorporation of a roundabout as well as very tight constraints for the flyover geometry.

The flyover is constrained both horizontally and vertically. At the northern limit, the ramp cannot appreciably be above current grade until it passes underneath the pedestrian overpass from Anthem's Crosstown development. It also cannot begin to curve over northbound Macleod Trail until it has reached at least the minimum vertical clearance. Horizontally, as it crosses above Macleod Trail, 25 Avenue S.E., and the Red Line LRT tracks, the alignment was selected to allow roughly equal span lengths and provide pier placement that did not conflict with the infrastructure underneath. Once the Red Line LRT tracks and 25 Avenue S.E. have been spanned, the ramp must then descend rapidly to meet existing grades and tie into the roundabout. Due to these constraints, a design speed of 40km/h was selected, corresponding with minimal vertical curves and a tight horizontal radius on the flyover. The drivable width of the ramp is 5.0m to improve horizontal sight distance and also provide room for emergency passage.

Steel trapezoidal box girders are recommended for the bridge structure as they provide the most flexibility for bridges with tight radii. Steel is preferred as horizontal and vertical curvature can be fabricated into the girder geometry to achieve grades while maintaining constant deck thickness and superelevation. Spans have been optimized to approximately 45m, as curved spans longer than this may impose design and fabrication difficulties. As well, 45m spans align well with available locations for pier placement, while minimizing the total number of spans required. The proposed deck would be cast-in-place concrete. Single column cast-in-place concrete piers are suggested with superstructure diaphragms at piers to be supported by a single bearing point. This consideration will alleviate the need for large pier caps that would traditionally be used. Aesthetically, this will give all piers the same appearance regardless of height.

From a constructability perspective, the box girders can be designed with bolted splices to reduce transportations needs and also reduce crane lifting capacity to facilitate easier erection. Pier and abutment construction should be fairly standard given the proposed alignment and expected pier locations.

No utility conflicts are expected for this concept. However, bridge pier foundation placement should be examined near the current 2A Street and 25 Avenue S.E. intersection to avoid potential impacts to sanitary, water, and storm systems.

The plan view, profile, and cross section for the refined Concept B and B2 are provided in *Figure 4-5, Figure 4-6, Figure 4-7,* and *Figure 4-8.* Other refinements in addition to the road configuration discussed above include:

- Pathways and sidewalks have been added along all new roadways and to existing facilities to improve connections for people walking and cycling.
- A cul-de-sac to allow Erlton Station traffic to turnaround.
- A roundabout at the intersection of 25 Avenue S.E. and 3 Street to facilitate multiple turning movements.

Roundabout facilitates multiple turning movements and provides access to Stampede Grounds. U–turn opportunity is provided for traffic exiting Repsol Sport Centre and heading Northbound on Macleod Trail

STAMPEDE GROUNDS

3 STREET SE

25 AVENUE SE

READER ROCK GARDEN

UNION CEMETERY

Siding track as proposed by the 17 Avenue S extension project

BIG FOUR BUILDING

ELBOW RIVER

Pedestrian bridge from Anthem's development connecting to existing station

Cul–de–sac to allow access to the station and turnaround

Elevated bi–directional ramp

New access to Reader Rock Garden

Existing LRT station remains as is

East leg of 25 Avenue SE closed

ERLTON LRT STATION

U–Turn reversed to accommodate intersection movements

200+200

200+300

200+400

MACLEOD TRAIL

17 AVENUE SE

18 AVENUE SE

ANTHEM'S CROSSTOWN DEVELOPMENT

Right out only as part of Anthem's Development

Sidewalk/pathway connection provided as part of Anthem's Development

1 STREET SE

ERLTON ROAD

25 AVENUE SW

REPSOL SPORT CENTRE

McElhanney

- EXISTING PAVEMENT
- EXISTING PATHWAY
- EXISTING ERLTON STATION
- EXISTING LRT TRACKS
- ANTHEM'S PEDESTRIAN CONNECTIONS
- ANTHEM'S DEVELOPMENT
- NEW / ALTERED PAVEMENT
- PROPOSED STRUCTURE
- PROPOSED CONCRETE SURFACING
- PROPOSED PATHWAY/ SIDEWALK
- PROPOSED PEDESTRIAN OVERPASS
- FLOODWAY
- PROPOSED CURB & GUTTER
- PROPOSED CONCRETE BARRIER
- PROPOSED ERLTON STATION
- PROPOSED LRT TRACK
- 101+200 ROAD STATIONING
- 21+600 LRT STATIONING

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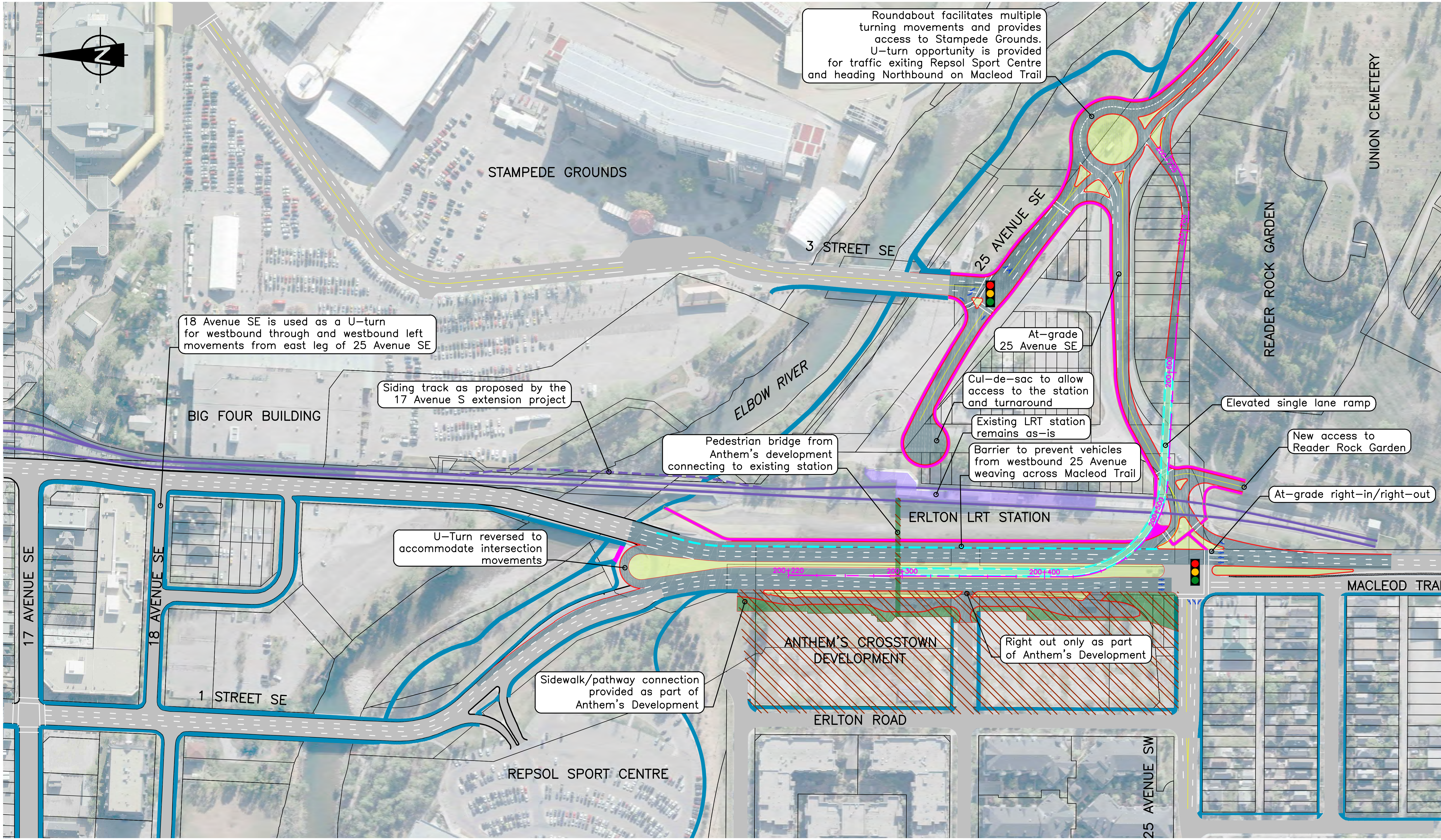
Refined Concept B
Bi-Directional Median Flyover

Plan

25 Avenue SE LRT Grade Separation Study | Fig. 4-5



Roundabout facilitates multiple turning movements and provides access to Stampede Grounds. U-turn opportunity is provided for traffic exiting Repsol Sport Centre and heading Northbound on Macleod Trail
UNION CEMETERY
STAMPEDE GROUNDS
25 AVENUE SE
3 STREET SE
READER ROCK GARDEN
At-grade 25 Avenue SE
18 Avenue SE is used as a U-turn for westbound through and westbound left movements from east leg of 25 Avenue SE
Cul-de-sac to allow access to the station and turnaround
ELBOW RIVER
Siding track as proposed by the 17 Avenue S extension project
Elevated single lane ramp
Existing LRT station remains as-is
BIG FOUR BUILDING
New access to Reader Rock Garden
Pedestrian bridge from Anthem's development connecting to existing station
Barrier to prevent vehicles from westbound 25 Avenue weaving across Macleod Trail
At-grade right-in/right-out
ERLTON LRT STATION
U-Turn reversed to accommodate intersection movements
200+220
200+300
200+400
200+500
200+600
MACLEOD TRAIL
17 AVENUE SE
18 AVENUE SE
ANTHEM'S CROSSTOWN DEVELOPMENT
Right out only as part of Anthem's Development
Sidewalk/pathway connection provided as part of Anthem's Development
1 STREET SE
ERLTON ROAD
REPSOL SPORT CENTRE
25 AVENUE SW

EXISTING PAVEMENT
EXISTING PATHWAY
EXISTING ERLTON STATION
EXISTING LRT TRACKS
ANTHEM'S PEDESTRIAN CONNECTIONS
ANTHEM'S DEVELOPMENT
NEW / ALTERED PAVEMENT
PROPOSED STRUCTURE
PROPOSED CONCRETE SURFACING
PROPOSED PATHWAY/ SIDEWALK
PROPOSED PEDESTRIAN OVERPASS
FLOODWAY
PROPOSED CURB & GUTTER
PROPOSED CONCRETE BARRIER
PROPOSED ERLTON STATION
PROPOSED LRT TRACK
101+200 ROAD STATIONING
21+600 LRT STATIONING

25 0 50
1:2500

McElhanney

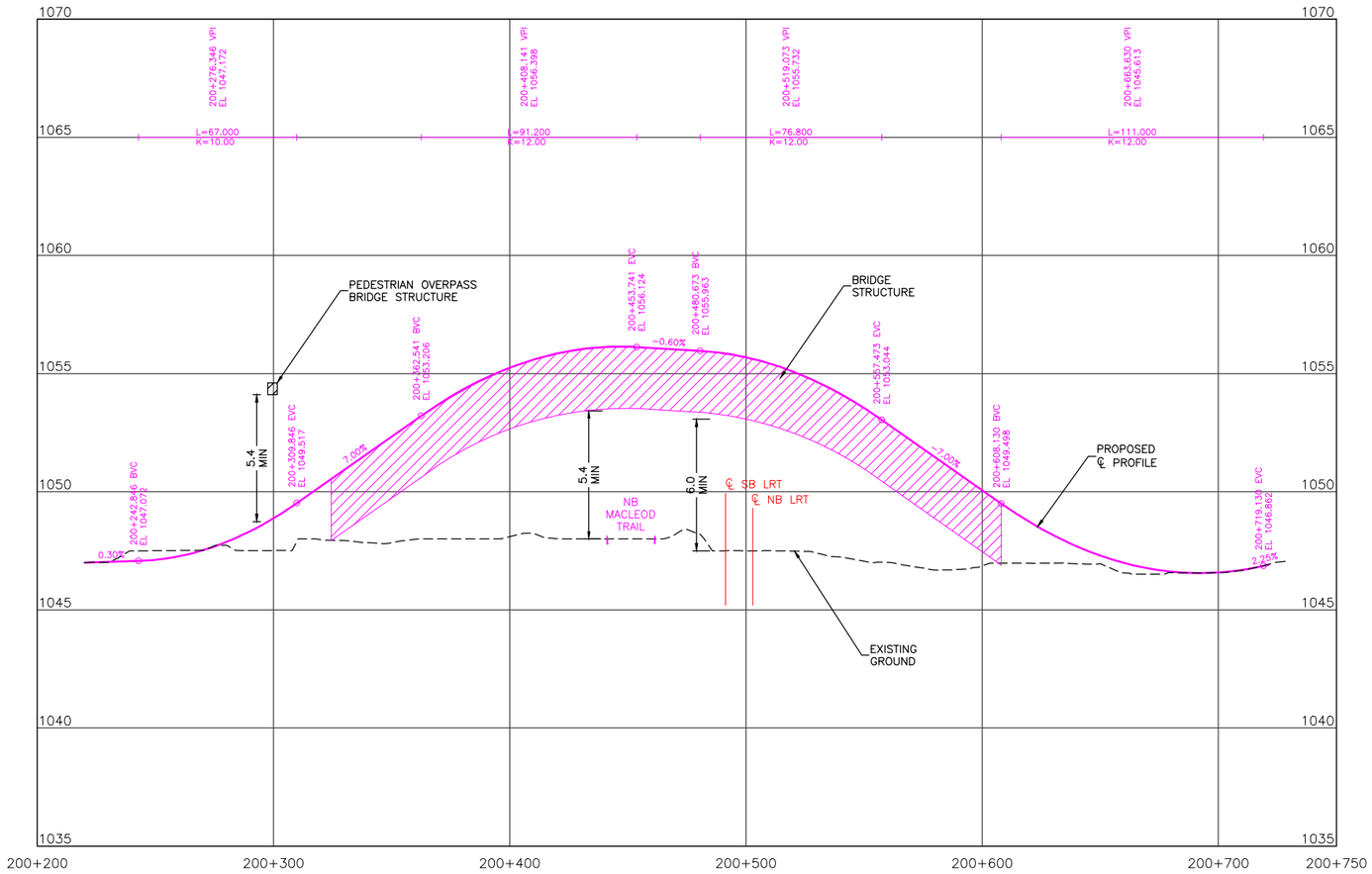
Refined Concept B2
Single Lane Median Flyover

Plan

25 Avenue SE LRT Grade Separation Study

Fig. 4-6

ROADWAY PROFILE



McElhanney

EXISTING GROUND
PROPOSED ROAD ℄ PROFILE
PROPOSED LRT PROFILE
STRUCTURE

25 0 50
1:2500

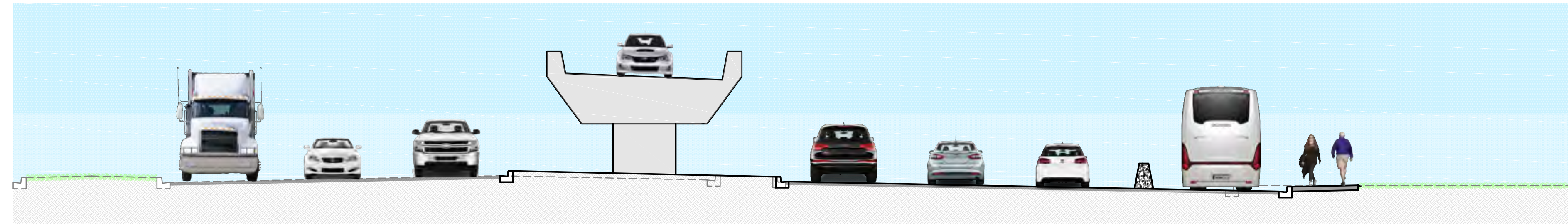
Refined Concepts B & B2
Median Flyovers
Profile

25 Avenue SE LRT Grade Separation Study

Fig. 4-7

MACLEOD TRAIL
UNIDIRECTIONAL FLYOVER

WEST — EAST

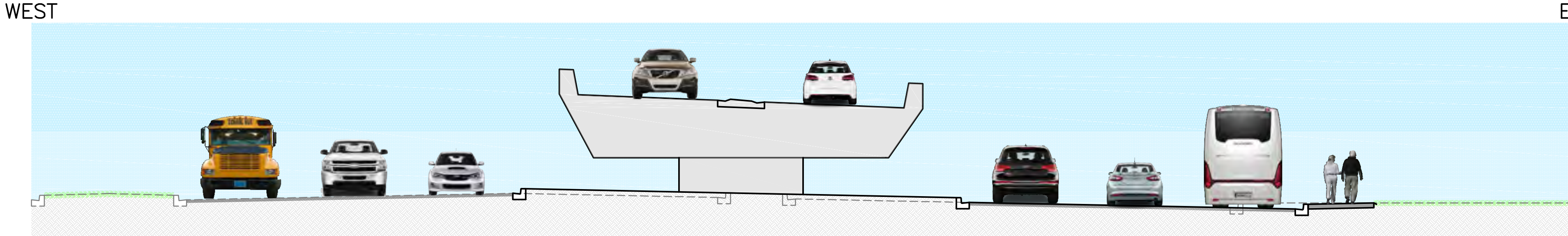


EXISTING DIMENSIONS: VARIES BLVD (ANTHEM) | 3.50 LANE | 3.50 LANE | 3.50 LANE | 3.30 LT LANE | 3.30 LT LANE | 2.50 MEDIAN | 3.50 LANE | 3.50 LANE | 3.50 LANE | 3.50 LANE | ~18m TO LRT TRACK

PROPOSED DIMENSIONS: VARIES BLVD (ANTHEM) | 3.50 LANE | 3.50 LANE | 3.50 LANE | 1.50 | 1.10 SHLD & BARRIER | 4.00 LANE | 1.10 SHLD & BARRIER | 1.50 | 3.50 LANE | 3.50 LANE | 3.50 LANE | 1.60 SHLD & BARRIER | 3.50 AUX LANE | 2.53 MONOWALK | ~13m TO LRT TRACK

MACLEOD TRAIL
BIDIRECTIONAL FLYOVER

WEST — EAST

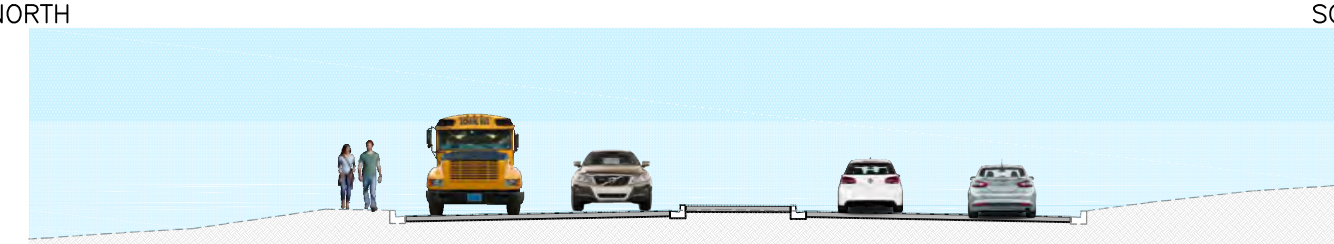


EXISTING DIMENSIONS: VARIES BLVD (ANTHEM) | 3.50 LANE | 3.50 LANE | 3.50 LANE | 3.30 LT LANE | 3.30 LT LANE | 2.50 MEDIAN | 3.50 LANE | 3.50 LANE | 3.50 LANE | 3.50 LANE | ~18m TO LRT TRACK

PROPOSED DIMENSIONS: VARIES BLVD (ANTHEM) | 3.50 LANE | 3.50 LANE | 3.50 LANE | 1.50 | 1.10 SHLD & BARRIER | 4.00 LANE | 1.50 MEDIAN | 4.00 LANE | 1.10 SHLD & BARRIER | 1.50 | 3.50 LANE | 3.50 LANE | 3.50 LANE | 2.53 MONOWALK | ~13m TO LRT TRACK

25 AVENUE
EAST OF ROUNDABOUT

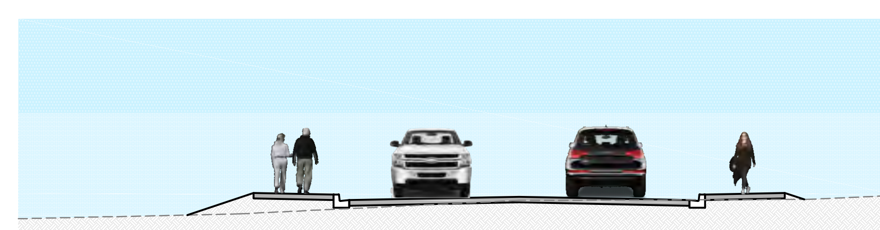
NORTH — SOUTH



EXISTING DIMENSIONS: 2.10 MONOWALK | 3.70 LANE | 3.70 LANE | 2.00 PAINTED MEDIAN | 4.00 LANE | 4.20 LANE

PROPOSED DIMENSIONS: 2.10 MONOWALK | 3.50 LANE | 3.50 LANE | 3.60 (VARIES) MEDIAN | 3.50 LANE | 3.50 LANE

LOCAL ACCESS ROAD



PROPOSED DIMENSIONS: 2.53 MONOWALK | 4.50 LANE | 4.50 LANE | 2.53 MONOWALK

McElhanney

Refined Concepts B & B2
Median Flyover

Typical Cross Sections

25 Avenue SE LRT Grade Separation Study

Fig. 4-8

4.1.4. Concept C Refinement

In Concept C, an initial refinement was to co-locate the LRT and 3 Street S.E. crossings of 25 Avenue as a single intersection. Traffic signals at this intersection would be pre-empted to give the LRT the right of way as a train approaches.

Secondly, a five-car capacity curved siding track would be accommodated between the Big Four building and the Elbow River on the east side of the inbound mainline within the re-alignment length for storage of trains. Access to this siding track from both mainlines will require reversal of the direction of the existing crossover adjacent to the Big Four building and installation of a second new single crossover south of the siding track. If reversal of the northern crossover on the DF track section is not feasible, the only alternative is inserting the siding track between the mainlines in the station tangent south of the new level crossing if sufficient tangent length can be developed during more detailed design.

Given that this concept assumes a relocated at-grade crossing of 25 Avenue S.E., the vertical alignment can largely follow existing grades. The profile of the re-aligned mainline can be kept near grade as it approaches the existing right-of-way, thus minimizing the time that disruption of LRT service is required to achieve the cut-over to the new easterly alignment.

The re-aligned horizontal LRT track alignment required within the constraints described earlier in Section 3.1 imposes a 45km/h design speed limit on the curve entering the station from the north with 50km/h on the northern and southernmost curves rejoining the existing alignment.

The roadway geometry is closely linked to the LRT track geometry in this option. To optimize transit and roadway operations, it is important to have the rail crossing as close to the intersection as possible so that the rail and traffic signals act as a single system. The rail was realigned as far east as practically possible prior to road design commencing. The south end of the existing 3 Street S.E. bridge was then used as the other physical limit for realignment.

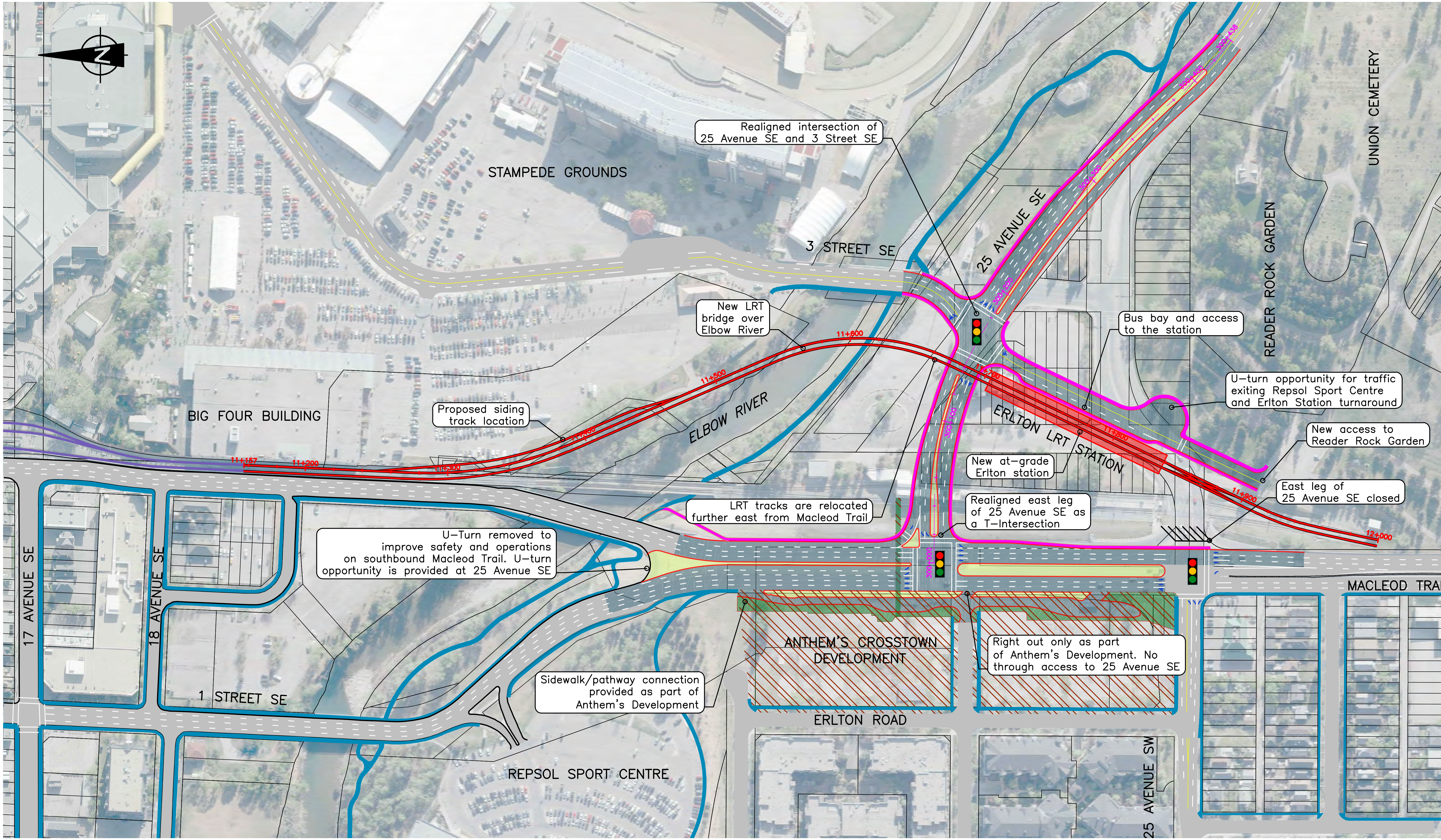
The cul-de-sac provided on the Erlton Station access road was incorporated to allow transit to exit, rather than presenting an additional road that could reconnect to 25 Avenue S.E. east of 3 Street. The option to provide an at-grade rail crossing and right-out exit onto Macleod Trail was also examined but rejected due to poor geometry and conflict with the proposed rail crossover.

In this concept, the utilities that will be affected are those that travel into the current Erlton Station. These are electrical, gas, sanitary, storm, and water facilities. It is expected that these would be dealt with as part of the new station design to ensure adequate servicing to the station is maintained. Roadwork has minimal surface impacts and apart from potential protection measures during construction, no conflicts are expected.

The plan view, profile, and cross section for the refined Concept C are provided in *Figure 4-9, Figure 4-10* and *Figure 4-11.*

Other refinements, in addition to the LRT refinement discussed above, include:

- Pathways and sidewalks have been added along all new roadways and to existing facilities to improve connections for people walking and cycling.
- Removal of the current U-turn on Macleod Trail to create additional southbound left-turn storage length required.
- Bus pullouts on 25 Avenue S.E. and the new road in front of Erlton Station.
- A cul-de-sac to allow station traffic to turnaround.
- Relocation of the 3 Street and 25 Avenue S.E. intersection.
- A ramp extension from the Anthem Crosstown development's pedestrian overpass to the relocated Erlton Station.



McElhanney

- EXISTING PAVEMENT
- EXISTING PATHWAY
- EXISTING ERLTON STATION
- EXISTING LRT TRACKS
- ANTHEM'S PEDESTRIAN CONNECTIONS
- ANTHEM'S DEVELOPMENT
- NEW / ALTERED PAVEMENT
- PROPOSED STRUCTURE
- PROPOSED CONCRETE SURFACING
- PROPOSED PATHWAY/ SIDEWALK
- PROPOSED PEDESTRIAN OVERPASS
- FLOODWAY
- PROPOSED CURB & GUTTER
- PROPOSED CONCRETE BARRIER
- PROPOSED ERLTON STATION
- PROPOSED LRT TRACK
- 101+200 ROAD STATIONING
- 21+600 LRT STATIONING

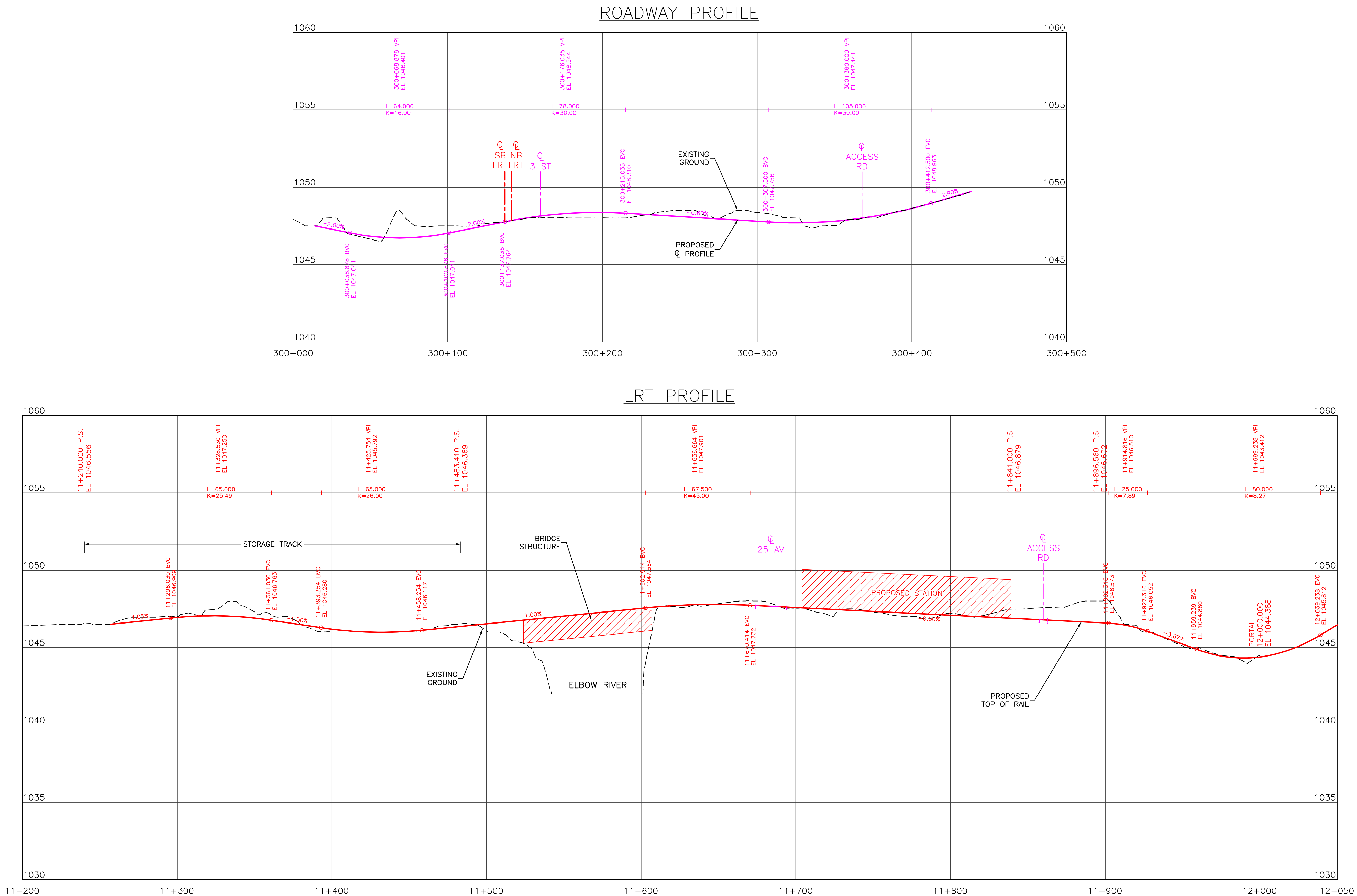
25 0 50
1:2500

Refined Concept C
Relocated At-Grade LRT Crossing

Plan

25 Avenue SE LRT Grade Separation Study

Fig. 4-9



McElhanney

- EXISTING GROUND
- PROPOSED ROAD ℄ PROFILE
- PROPOSED LRT PROFILE
- STRUCTURE

25 0 50
1:2500

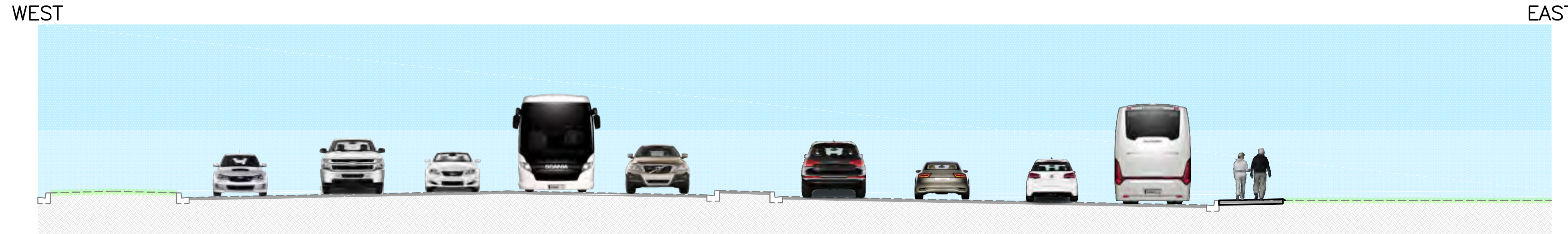
Refined Concept C
Relocated At-Grade LRT Crossing

Profiles

25 Avenue SE LRT Grade Separation Study

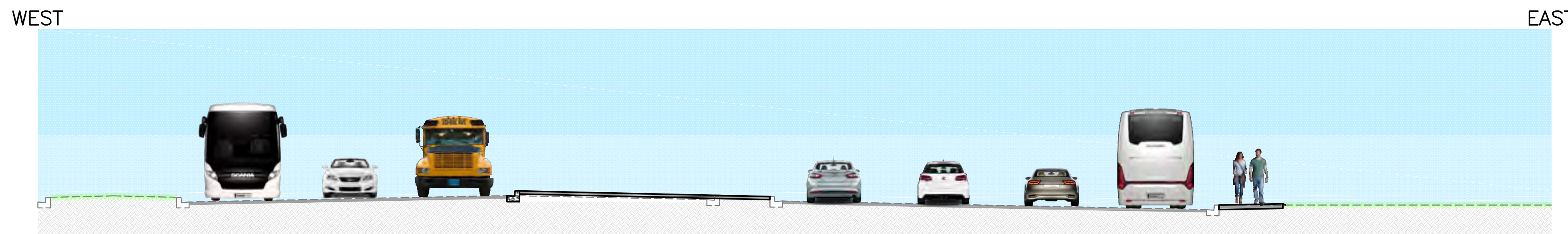
Fig. 4-10

MACLEOD TRAIL
NORTH OF 25 AVENUE



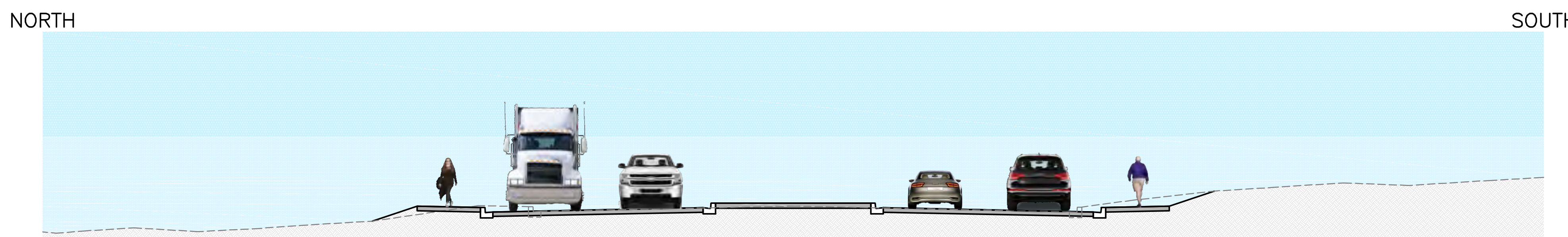
EXISTING DIMENSIONS	VARIES BLVD (ANTHEM)	3.50 LANE	3.50 LANE	3.50 LANE	3.30 LT LANE	3.30 LT LANE	2.50 MEDIAN	3.50 LANE	3.50 LANE	3.50 LANE	3.50 LANE		~30m TO LRT TRACK
PROPOSED DIMENSIONS	VARIES BLVD (ANTHEM)	3.50 LANE	3.50 LANE	3.50 LANE	3.30 LT LANE	3.30 LT LANE	2.50 MEDIAN	3.50 LANE	3.50 LANE	3.50 LANE	3.50 AUX LANE	2.53 MONOWALK	

MACLEOD TRAIL
SOUTH OF 25 AVENUE



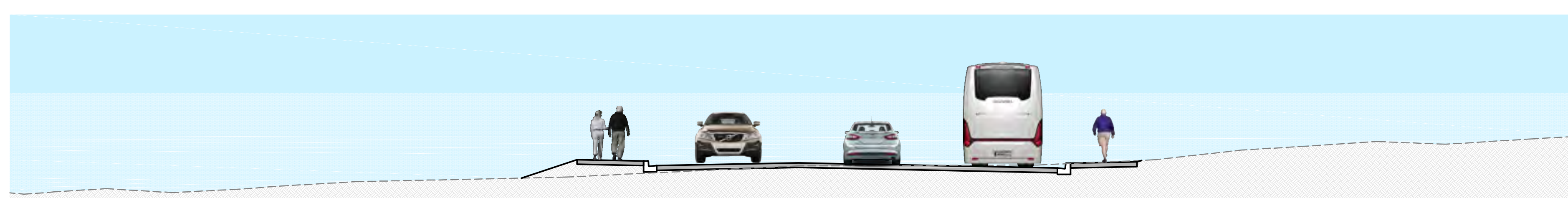
EXISTING DIMENSIONS	VARIES BLVD (ANTHEM)	3.50 LANE	3.50 LANE	3.50 LANE	3.30 LT LANE	3.30 LT LANE	2.50 MEDIAN	3.50 LANE	3.50 LANE	3.50 LANE	3.50 LANE		~18m TO LRT TRACK
PROPOSED DIMENSIONS	VARIES BLVD (ANTHEM)	3.50 LANE	3.50 LANE	3.50 LANE	9.10 MEDIAN			3.50 LANE	3.50 LANE	3.50 LANE	3.50 RT LANE	2.53 MONOWALK	

25 AVENUE



EXISTING DIMENSIONS	2.10 MONOWALK	3.70 LANE	3.70 LANE	2.00 PAINTED MEDIAN	4.00 LANE	4.20 LANE	
PROPOSED DIMENSIONS	2.53 MONOWALK	3.50 LANE	3.50 LANE	6.00 MEDIAN	3.50 LANE	3.50 LANE	2.53 MONOWALK NO WALKWAY EAST OF 3 STREET

LOCAL ACCESS ROAD



PROPOSED DIMENSIONS	2.53 MONOWALK	4.50 LANE	4.50 LANE	3.70 BUS BAY	2.53 MONOWALK

McElhanney

Refined Concept C
Relocated At-Grade LRT Crossing

Typical Cross Sections

25 Avenue SE LRT Grade Separation Study

Fig. 4-11

4.2. Evaluation of Refined Concepts

The completed evaluation matrix, including the weighting of each criteria and overall scores, can be found *Table 4-2* and *Table 4-3.* As discussed in Section 3.5, the overall evaluation of the concepts was undertaken for the two development scenarios: conservative TOD potential based on current bylaws, and maximum TOD potential assuming full development of the area can occur. All other criteria remain the same for the two scenarios. In addition, the evaluation criteria and the process for evaluating Concepts A, B, and C remain the same as in Section 3.5, with the addition of Concept B2.

Table 4-2: Refined Concept Evaluation Matrix with Conservative TOD Potential

Evaluation Criteria	Weight	Concept A	Concept B	Concept B2	Concept C
LRT Service	10.0	3.0	5.0	4.0	2.0
Pedestrian and Cyclist Accommodation	14.0	4.0	3.0	4.0	5.0
Vehicle Operations	8.0	4.0	3.0	4.0	2.0
Access Management	8.0	4.0	2.0	3.0	3.0
TOD Potential	13.0	2.0	4.0	4.0	3.0
Staging of Development	6.0	2.0	4.0	4.0	3.0
Safety	16.0	5.0	3.0	3.0	2.0
Disruption to Floodway	5.0	4.0	2.0	2.0	3.0
Construction Cost	8.0	1.0	4.0	4.0	2.0
LRT Service Disruption During Construction	8.0	1.0	5.0	5.0	3.0
Traffic Disruption During Construction	4.0	4.0	2.0	2.0	3.0
Total Score		34.0	37.0	39.0	31.0
Total Weighted Score		**320.0**	**346.0**	**366.0**	**286.0**

Table 4-3: Refined Concept Evaluation Matrix with Maximum TOD Potential

Evaluation Criteria	Weight	Concept A	Concept B	Concept B2	Concept C
LRT Service	10.0	3.0	5.0	4.0	2.0
Pedestrian and Cyclist Accommodation	14.0	4.0	3.0	4.0	5.0
Vehicle Operations	8.0	4.0	3.0	4.0	2.0
Access Management	8.0	4.0	2.0	3.0	3.0
TOD Potential	13.0	4.0	2.0	2.0	5.0
Staging of Development	6.0	2.0	4.0	4.0	3.0
Safety	16.0	5.0	3.0	3.0	2.0
Disruption to Floodway	5.0	4.0	2.0	2.0	3.0
Construction Cost	8.0	1.0	4.0	4.0	2.0
LRT Service Disruption During Construction	8.0	1.0	5.0	5.0	3.0
Traffic Disruption During Construction	4.0	4.0	2.0	2.0	3.0
Total Score		36.0	35.0	37.0	33.0
Total Weighted Score		**346.0**	**320.0**	**340.0**	**312.0**

Based on the evaluation, Concept C was the lowest scored concept for both development scenarios and should not be pursued further. Concept A and Concept B2 continue to have merits in meeting the study objectives and should be re-evaluated once the flood mitigation measures are in place and a new floodway zone has been identified, and when the TOD potential can be better determined with the actual developable land area.

4.3. Interim Improvements

In addition to the examination of Concepts A, B and C, consideration was given to potential interim improvements that could be beneficial to operations at the 25 Avenue S.E. and Macleod Trail intersection. The interim options include improvements to the signal control system of the 25 Avenue S.E. LRT crossing and the Macleod Trail intersection, as well as reconfiguration of the intersection to improve traffic flow.

4.3.1. Signal System Improvements

Previous studies by The City of Calgary indicate there may be an opportunity to replace the existing LMD signal controller at the intersection of 25 Avenue S.E. and Macleod Trail with an Intelight controller. The new Intelight controller offers advanced features and greater programmability, will allow better traffic signal programming for LRT pre-emptions.

Installation of an Intelight signal controller, along with a real time traffic-responsive control system, can improve intersection operations for vehicular traffic. The responsive system requires an array

of detectors installed in the field, as well as the use of specialized software. In addition to the stop-line detection cameras already in place at the intersection, advanced detection equipment would also be required. The procurement of advanced detection equipment and traffic-responsive control software can provide interim benefits to traffic operations at this intersection.

4.3.2. Intersection Reconfiguration Options

An option involving the of splitting of the existing four-leg intersection of 25 Avenue S.E. and Macleod Trail into two T-intersections was examined, as shown in *Figure 4-12*. With this option, the T-intersection of Macleod Trail with the west leg of 25 Avenue S. is expected to operate efficiently without disruptions due to LRT pre-emption, while the T-intersection of Macleod Trail with a realigned east leg of 25 Avenue S.E. would continue to operate with LRT pre-emption in place, however, fewer traffic movements would be affected.

To minimize disruption to LRT operations, the realigned east leg of 25 Avenue S.E. would cross the tracks in a clear space between Erlton Station and an electrical sub-station building that exists north of the station. This new alignment of 25 Avenue S.E. could be incorporated into Concepts A or C in the future.

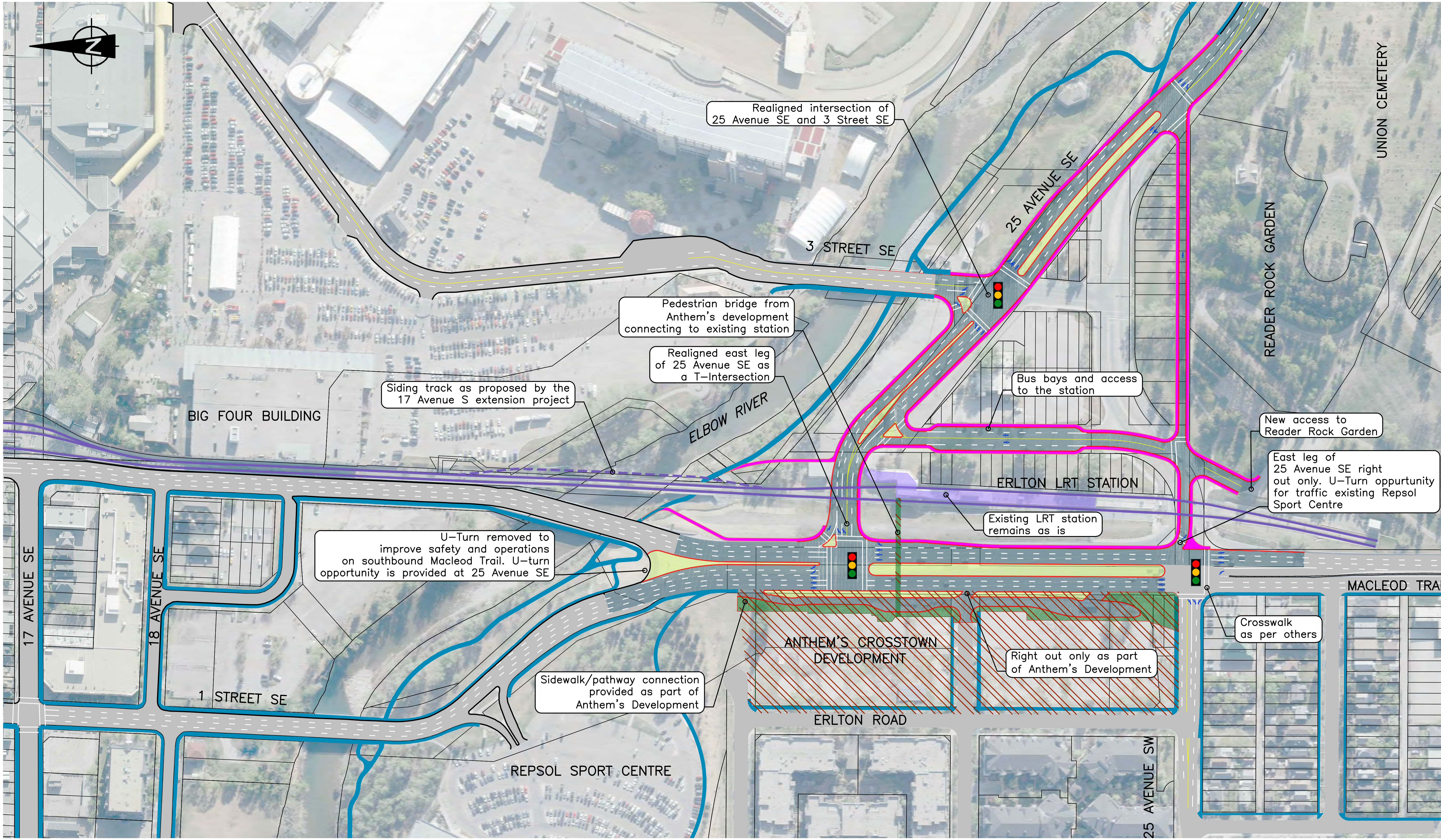
With the proposed new alignment, the east leg of 25 Avenue S.E. would be located on lands owned by Calgary Stampede. In discussions with representatives from Calgary Stampede, it was determined that such an alignment would be detrimental to the Calgary Stampede's operations for the foreseeable future. An alternative zig zag configuration for 25 Avenue S.E. using 2A Street S.E. was thus examined.

The Zig Zag Option makes use of existing roadway alignments and the 3 Street S.E. intersection. This provides an advantage over the other option as it reduces construction costs. However, the resulting roadway geometry is below minimal standards. Design speed would approximately be 20-30 km/h, for which guidelines are not published. The roadway has been widened appreciably through the corners to allow for truck off-tracking without encroachment into adjacent lanes. Also, a new access into Reader Rock Garden is required because allowing left turns on a 90-degree corner presents significant safety concerns. One other issue with this option is that the road provides a barrier for pedestrians connecting between the Stampede Grounds and Erlton Station. Providing midblock crossings along with already poor roadway geometry is not recommended. Based on walking direction and distances to adjacent intersections, if a midblock crossing is not provided, jaywalking is likely to be highly problematic. As a potential but high-cost solution, a pedestrian overpass has been indicated on the figure.

This new zig zag configuration with two ninety-degree bends, as shown in *Figure 4-13*, would not be compatible with any of the future concepts being considered. The estimated construction cost for this configuration would be under $10 million, which would be a throw away cost if any of Concepts A, B or C were implemented in the future.

The traffic analysis for these interim improvements confirmed that they could provide benefits to future traffic flow relative to a do-nothing approach. However, since realigning 25 Avenue S.E. to a configuration compatible with potential future Concepts A or C conflicts with current Stampede

Grounds operations, and the zig zag configuration incurs unwarranted throw away costs, neither interim option is recommended at this time.



G:\PROJECTS\2511 00827 00 25 AVE LRT GRADE SEPARATION FP...

McElhanney

EXISTING PAVEMENT
EXISTING PATHWAY
EXISTING ERLTON STATION
EXISTING LRT TRACKS
ANTHEM'S PEDESTRIAN CONNECTIONS
ANTHEM'S DEVELOPMENT
NEW / ALTERED PAVEMENT
PROPOSED STRUCTURE
PROPOSED CONCRETE SURFACING
PROPOSED PATHWAY/ SIDEWALK
PROPOSED PEDESTRIAN OVERPASS
FLOODWAY
PROPOSED CURB & GUTTER
PROPOSED CONCRETE BARRIER
PROPOSED ERLTON STATION
PROPOSED LRT TRACK
101+200 ROAD STATIONING
21+600 LRT STATIONING

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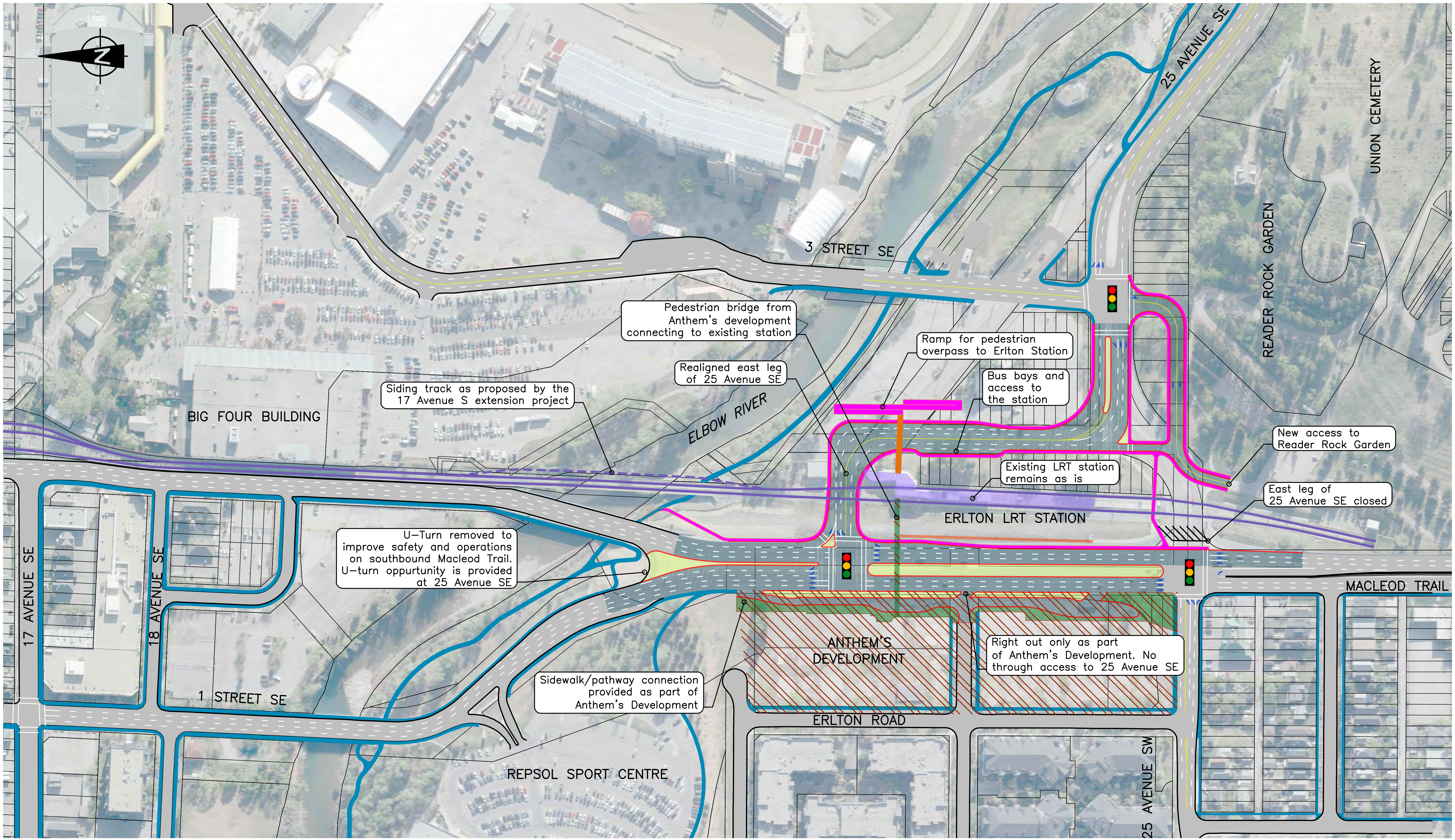
1:2500

Interim Stage Concept
Split T-Intersection

Plan

25 Avenue SE LRT Grade Separation Study

Fig. 4-12



McElhanney

- EXISTING PAVEMENT
- EXISTING PATHWAY
- EXISTING ERLTON STATION
- EXISTING LRT TRACKS
- ANTHEM'S PEDESTRIAN CONNECTIONS
- ANTHEM'S DEVELOPMENT
- NEW / ALTERED PAVEMENT
- PROPOSED STRUCTURE
- PROPOSED CONCRETE SURFACING
- PROPOSED PATHWAY/ SIDEWALK
- PROPOSED PEDESTRIAN OVERPASS
- FLOODWAY
- PROPOSED CURB & GUTTER
- PROPOSED CONCRETE BARRIER
- PROPOSED ERLTON STATION
- PROPOSED LRT TRACK
- 101+200 ROAD STATIONING
- 21+600 LRT STATIONING

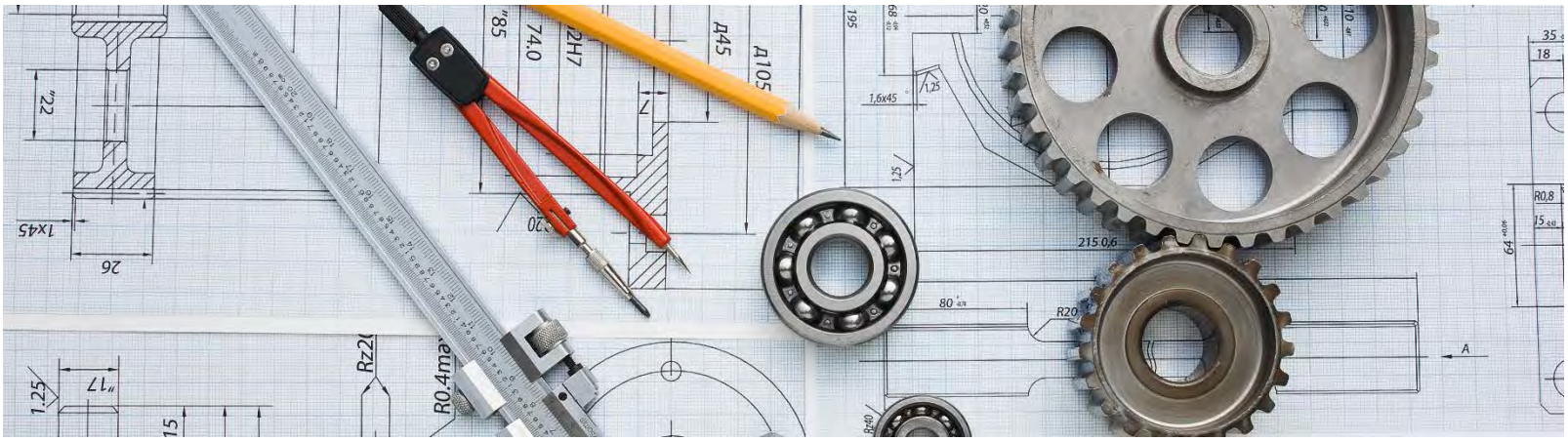
25 0 50
1:2500

Interim Stage Concept
Zig-Zag

Plan

25 Avenue SE LRT Grade Separation Study

Fig. 4-13



5. Cost Estimates

The cost estimation includes four basic types of costs; roadway, track, station, and structural costs. All costs were based on recent costs from similar projects. The costs are presented in 2017 dollars and have not been adjusted for inflation as timelines for this project are unknown.

Roadway

The roadway cost estimates are inclusive of most standard items, including removal of existing infrastructure and new items such as earthworks, pavement, curb and gutter, sidewalks, pathways and finishing. Where existing items will also be required in the future, the complete removal and subsequent replacement has been assumed. Other items such as signage, pavement markings, street side amenities, and streetlighting have not been quantified but are estimated as a percentage of other work.

Track

Track cost estimates include removals, earthworks, track, substrate, control and communication systems, and special trackwork such as turnouts. Track costs depend on whether they are at grade or on structures. In cases where the track is on a structure, structural costs have not been included independently.

Station Costs

Station costs have been determined at a very high level but include demolition of the existing station, construction of the new station, and an allowance for maintenance of transit service during track or station closures required during construction. They also include costs associated with utility relocations required for station servicing.

Structural Costs

Structural costs were really one of three different items, depending on the concept. Structural costs pertaining to elevated guideway for the track have been included under track costs. The other costs considered were for grade separation of the roadway, either a bridge structure, or a

tunnel structure. As any tunnelling options were ruled out early on, these costs are not relevant to the three concepts but have been included as a comparative tool.

Miscellaneous Costs

Miscellaneous costs that have also been included are traffic signals and utility relocations. Signal costs are reasonably straightforward and are based on the amount of work required to install new traffic signals or reconfigure existing signals. Any signal infrastructure relating to the LRT has been included under LRT costs. Most utilities within the project area will not be impacted but utility costs have been included as an allowance should unforeseen conflicts arise. To reflect this, the amount included for utility work has been kept consistent for each option. Utility costs relating to station servicing are included within the station costs.

Contingency (25%) and engineering costs (15%) have been added on to the construction sub totals to account for the high-level nature of this estimate and uncertain timelines.

Costs for Concept A, Concept B, Concept B2 and Concept C are included in *Table 5-1* to *Table 5-4.*

Table 5-1: Concept A Cost Estimate Breakdown

Description	Units	Quantity	Unit Rate	Total Cost
Roadway				
Removals & site preparation	m^2	36000	$50	$1,800,000
New roadway (paved area)	m^2	15000	$100	$1,500,000
New walkway (sidewalk/pathways)	m^2	2900	$225	$652,500
New roadway (concrete medians/islands)	m^2	3300	$150	$495,000
New roadway (storm system)	Lump sum	1	$200,000	$200,000
Subtotal				**$4,647,500**
LRT Track				
At-grade track (including earthworks)	Double track-m	260	$22,000	$5,720,000
Level crossing infrastructure	Each	0.2	$700,000	$140,000
Elevated track (including guideway structure)	Double track-m	120	$62,000	$7,440,000
At-grade track (including siding & all earthworks)	Triple track-m	300	$87,000	$26,100,000
Special trackwork (crossovers, turnouts etc.)	Lump sum	1	$2,400,000	$2,700,000
Traction power sub-station	Each	0.33	$3,000,000	$990,000
LRT systems (traction power, train control & communications)	Double track-m	680	$6,600	$4,488,000
Subtotal				**$47,578,000**
Station				
Demolition and removal of existing LRT track/station	Lump sum		$2,500,000	$2,500,000
Maintaining transit service during LRT closure	Lump sum	1	$3,000,000	$3,000,000
Elevated station infrastructure	Each		$33,000,000	$33,000,000
Subtotal				**$38,500,000**
Other Structures				
Subtotal				**$0**
Miscellaneous Costs				
Traffic signals	Each	2.5	$300,000	$750,000
Utility relocations	Lump sum	1	$1,000,000	$1,000,000
Subtotal				**$1,750,000**
Cost Summary				
Subtotal				**$92,475,500**
Contingency (25%)				**$23,118,875**
Engineering (15%)				**$13,871,325**
Total				**$129,465,700**

Table 5-2: Concept B Cost Estimate Breakdown

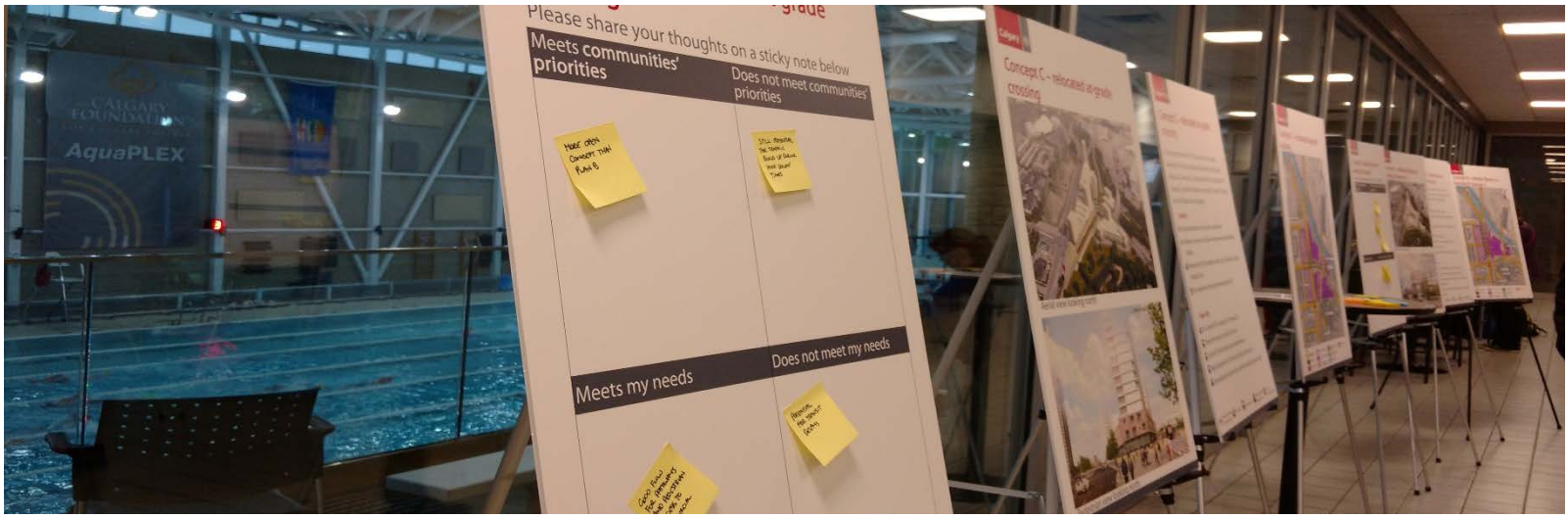
Description	Units	Quantity	Unit Rate	Total Cost
Roadway				
Removals & site preparation	m^2	36000	$50	$1,800,000
New roadway (paved area)	m^2	20450	$100	$2,045,000
New walkway(sidewalk/pathways)	m^2	2900	$225	$652,500
New roadway (concrete medians/islands)	m^2	4600	$150	$690,000
New roadway (barriers)	m	600	$300	$180,000
New roadway (storm system)	Lump sum	1	$100,000	$100,000
Subtotal				**$5,467,500**
LRT Track				
Subtotal				**$0**
Station				
Subtotal				**$0**
Other Structures				
Flyover structure	m^2	3600	$6,500	$23,400,000
Subtotal				**$23,400,000**
Miscellaneous Costs				
Traffic signals	Each	1	$300,000	$300,000
Utility relocations	Lump sum	1	$1,000,000	$1,000,000
Subtotal				**$1,300,000**
Cost Summary				
Subtotal				**$30,167,500**
Contingency (25%)				**$7,541,875**
Engineering (15%)				**$4,525,125**
Total				**$42,234,500**

Table 5-3: Concept B2 Cost Estimate Breakdown

Description	Units	Quantity	Unit Rate	Total Cost
Roadway				
Removals & site preparation	m^2	36000	$50	$1,800,000
New roadway (paved area)	m^2	23100	$100	$2,310,000
New walkway (sidewalk/pathways)	m^2	3100	$225	$697,500
New roadway (concrete medians/islands)	m^2	5000	$150	$750,000
New roadway (barriers)	m	975	$300	$292,500
New roadway (storm system)	Lump sum	1	$100,000	$100,000
Subtotal				**$5,950,000**
LRT Track				
Subtotal				**$0**
Station				
Subtotal				**$0**
Other Structures				
Flyover structure	m^2	1800	$6,000	$10,800,000
Subtotal				**$10,800,000**
Miscellaneous Costs				
Traffic signals	Each	1	$300,000	$300,000
Utility relocations	Lump sum	1	$1,000,000	$1,000,000
Subtotal				**$1,300,000**
Cost Summary				
Subtotal				**$18,050,000**
Contingency (25%)				**$4,512,500**
Engineering (15%)				**$2,707,500**
Total				**$25,270,000**

Table 5-4: Concept C Cost Estimate Breakdown

Description	Units	Quantity	Unit Rate	Total Cost
Roadway				
Removals & site preparation	m^2	36000	$50	$1,800,000
New roadway (paved area)	m^2	18800	$100	$1,800,000
New walkway (sidewalk/pathways)	m^2	3250	$225	$731,250
New roadway (concrete medians/islands)	m^2	3700	$150	$555,000
New roadway (storm system)	Lump sum	1	$200,000	$200,000
Subtotal				**$5,166,250**
LRT Track				
At-grade track (including earthworks)	Double track-m	465	$22,000	$10,230,000
Level crossing infrastructure	each	1.2	$700,000	$840,000
At-grade track (including siding & all earthworks)	Triple track-m	260	$87,000	$22,620,000
Special trackwork (crossovers, turnouts)	Lump sum	1	$2,400,000	$2,400,000
Traction power sub-station	Each	1	$3,000,000	$3,000,000
LRT systems (traction power, train control & communications)	Double track-m	725	$6,600	$4,785,000
Subtotal				**$43,875,000**
Station				
Demolition and removal of existing LRT track/station	Lump sum	1	$2,500,000	$2,500,000
Maintaining transit service during LRT closure	Lump sum	1	$2,000,000	$2,000,000
At-grade station infrastructure (including all systems)	Each	1	$18,000,000	$ 18,000,000
Subtotal				**$22,500,000**
Other Structures				
LRT river crossing bridge	Double track-m	90	$65,000	$5,850,000
Subtotal				**$5,850,000**
Miscellaneous Costs				
Traffic signals	Each	2.5	$300,000	$750,000
Utility relocations	Lump sum	1	$1,000,000	$1,000,000
Subtotal				**$1,750,000**
Cost Summary				
Subtotal				**$79,141,250**
Contingency (25%)				**$19,785,313**
Engineering (15%)				**$11,871,188**
Total				**$110,797,750**



6. Engagement & Communication Summary

6.1. Overall Engagement & Communication Process

The Engage Spectrum level for this project was 'Listen and Learn', which is defined as "We will listen to stakeholders and learn about their plans, views, issues, concerns, expectations and ideas." Feedback collected through the City-led engagement program will be used to help administration identify community priorities and inform proposed concepts for grade separation.

The City-led engagement strategy was developed to facilitate multiple touch points and ensure inclusivity for all who wanted to provide input and learn about the project by providing in-person and online opportunities for participating.

The objectives of the engagement program were to:

- Inform the community and key stakeholders of functional study.
- Identify the community priorities that will help inform the design options and final recommendation.
- Hear concerns and gather input to develop options for grade separation.
- Gather input into the proposed options for grade separations and have a recommended option.

The What We Heard Reports for each phase, with verbatim comments, can be found at the links below:

Phase One:
https://www.calgary.ca/engage/Documents/25_Ave_GradeSeparation/WWHR_Phase1_Final_25Ave.pdf

Phase Two:

https://www.calgary.ca/engage/Documents/25_Ave_GradeSeparation/WWHR_25AveGradeSeparationStudy_Phase2_FINAL.pdf

6.2. Phase 1 Engagement

An in-person open house was held on Tuesday, February 28, 2017, from 5:00 – 8:00 p.m. at Repsol Sport Centre. At this event and online, we shared project details, answered questions and asked citizens to provide us with their ideas and concerns regarding the project and to let us know how they want to be involved in the project moving forward.

An online survey was available from February 27 through March 13, 2017, at calgary.ca/25avestudy. Citizens were provided with the information shared at the in-person open house and were asked to provide their comments.

The project team also participated in the Inglewood/Ramsay project coordination events on March 9 and 11, 2017. They also met with the community associations adjacent to the study area to share project details.

In total, there were 263 participants and 511 ideas and comments received in this phase of engagement.

What we heard

Some of the main themes and priorities that emerged from the comments were:

- Pedestrian accommodation, such as new or improved pedestrian infrastructure.
- Improved vehicle travel times, including looking at the signal timing and dedicated turn lanes.
- Bicycle accommodation, such as new infrastructure or improvements that enhance cycling.
- Public transit is important.
- Revitalization of the community.

6.3. Phase 2 Engagement

An in-person open house was held on Wednesday, May 24, 2017, from 4:00 – 8:00 p.m. at Repsol Sport Centre. At this event and online, we shared the project details, what we learned in phase one of engagement, the three preliminary concepts and answered questions. We asked the public to evaluate each idea and tell us how they meet or do not meet their own needs and the needs of the community.

An online survey was available from May 24 through June 13 at calgary.ca/25avestudy. Citizens were provided with the information shared at the in-person open house and were asked to provide their comments.

The project team also participated in the Inglewood/Ramsay project coordination events on May 25 and 27, 2017. They also met with the community associations adjacent to the study area to share project details.

In total, there were 201 participants and 401 ideas and comments received.

What we heard

Some of the main themes and priorities that emerged through all of the comments for each of the concepts were:

Concept A – elevated LRT station

- Improves active mode connectivity
- Improves traffic flow and vehicle travel times
- Opportunity for revitalization of community
- Concern regarding access for residents of Ramsay and Mission
- Concern regarding construction cost

Concept B – median flyover to existing 25 Avenue S

- Concern with traffic flow and vehicle travel times
- Concern with aesthetics of a flyover
- Appreciation for lower-cost of construction
- Concern that it does not allow for revitalization of the community

Concept C – relocated at-grade crossing

- Opportunity for revitalization of the community
- Improved active mode connectivity
- Concern with safety by still having at-grade crossing
- Improved traffic flow and vehicle travel times for north-south travel

6.4. Phase 3 Engagement – Reporting back

Over the summer and fall of 2017 a technical review of the three concepts that were presented to the public took place. The concepts were also refined to make additional improvements for people walking, cycling, driving and taking transit.

The project team presented the refined concepts to the Lindsay Park, Erlton, and Mission/Cliff Bungalow community associations. In addition, the concepts were also presented in the Inglewood/Ramsay project coordination meeting. The project website was updated to include the refined concepts, recommendations, and short-term improvements.

6.5. Communications Overview

A comprehensive communications plan was developed to inform the community about the project and all of our engagement opportunities. On-going tactics employed throughout the life of the project have included:

- A project specific website (calgary.ca/25AveStudy) that shares information and background about the project. The website includes a summary of previous studies that have been

completed for this intersection, the current status of the project and information about how people can participate in engagement opportunities for the project. When engagement opportunities were available this information was provided on the web page.

- Sending emails to the 67 community members subscribed to our email list, sharing on-going project information and engagement details.
- Meetings with community associations adjacent to the study area in each phase of the project. They were provided with project updates and information about upcoming engagement opportunities. They were provided with information to share with their members.
- Meetings with and email updates to the Councillor's with communities adjacent to the study area. They were provided with project updates and information about upcoming engagement opportunities.
- Meetings with adjacent landowners to provide them with project updates and an opportunity for the project team to learn more about their long-term plans for their parcels.
- A script for 311 call center staff was updated during each phase of engagement, so that they could provide updates to people who called to inquire about the project.

The following communications tactics were employed to promote participation in our various engagement opportunities:

- Twitter and Facebook advertisement campaigns
- A letter mailed to surrounding area residents in the first phase of engagement
- Bold signs on 25 Avenue S.E., adjacent to Erlton Station
- Advertisements on the Repsol Sport Centre digital roadside sign
- Message on digital variable message sign on McLeod Trail northbound
- Notice boards on the Erlton Station platform advertising engagement opportunities
- Newsletter articles within the Roads department newsletter

External stakeholder groups that received project communications are:

- Residents who live adjacent to the study area
- Businesses located adjacent to the study area
- Landowners for properties adjacent to the study area
- Community associations for communities adjacent to the study area
- Transit users
- People who drive within the study area
- People who walk or cycle within the study area

7. Recommendations & Conclusions

The intersection of Macleod Trail and 25 Avenue S.E. will continue to play a key role in Calgary's transportation system. Traffic from the southern part of the city passes through the intersection to cross the Elbow River into and from Downtown. In addition, desired development along the Macleod Trail urban corridor will increase the importance of this area. Adjacent to the intersection, the Erlton Station on the Red Line LRT attracts pedestrians from the surrounding area and provides access to the Calgary Stampede Grounds. While changing vehicle technologies may increase the traffic carrying capability of our infrastructure, network nodes such as this are still expected to experience continued high use.

Fortunately, there are potential transportation solutions to improve pedestrian and cyclist accommodation and traffic flow in the area, while maintaining LRT operations and providing opportunities for development.

This study identified three alternative concepts worthy of consideration and has evaluated these concepts relative to The City's policies and objectives, as well as public and stakeholder priorities. The three concepts were:

- Concept A: elevated LRT and Erlton Station above realigned 25 Avenue S.E.
- Concept B: a median flyover from Macleod Trail to existing 25 Avenue S.E
- Concept C: relocated at-grade crossing further east from Macleod Trail

However, the lack of clarity regarding the relationship between the Elbow River Floodway and hypothetical redevelopment in the area poses a dilemma. The boundary of the floodway is under review by Alberta Environment and Parks and may be subject to further modification when upstream flood mitigation measures are implemented. It is expected that the upstream reservoirs, including the proposed Springbank Reservoir, and the new gates on the Glenmore Dam will be able to support a 2013-sized flood without overland flooding along the Elbow River. This area of the Elbow River is one of the most complex, and most important, flood areas in Calgary. Consequently, until these mitigations are in place, the area of land that may be developable under future Provincial and City flood mitigation policies is uncertain.

Nevertheless, it has been established that the plan labelled Concept B2 and shown in *Figure 4-6* would provide several improvements over the existing conditions and could be implemented at

City Council's discretion whenever deemed necessary. The plan labelled Concept A shown on *Figure 4-1* may also be a viable choice depending on the resolution of development/floodway issues.

Since there is neither funding allocated for grade separation of 25 Avenue and the Red Line LRT, nor new redevelopment proposals imminent in the area, it is recommended to defer a decision between Concept A and Concept B2 until the flooding/redevelopment matter is clarified. Once the mitigation measures are in place and a new floodway zone has been identified, a re-evaluation of the TOD potential can be undertaken at that stage with the actual developable land area.

In the interim, modest traffic improvements can be achieved by implementing improved signal control technology at the 25 Avenue and Macleod Trail S.E. intersection. Construction of a pathway along the east side of Macleod Trail would improve connectivity between the Elbow River Pathway and Reader Rock Garden. Re-grading this pathway area between Macleod Trail and the LRT line would improve floodwater conveyance in the area as well. Also, reduction of the posted speed limit on Macleod Trail to 50 km/hr in the study area would improve the pedestrian environment on both sides of the roadway.

A

Appendix A

VISSIM CALIBRATION AND ANALYSIS RESULTS

Memo

To:	Irini Akhnoukh	**Date:**	February 8, 2018
Company:	McElhanney	**Project #:**	02-17-0020
From:	Kristen Myers P.Eng. Lynn Machacek E.I.T.		
Subject:	25 Avenue Functional Planning Study VISSIM Analysis		

This memo summarizes the methodology and calibration of the VISSIM analysis conducted for the 25 Avenue Functional planning study.

1. METHODOLOGY

1.1 Model Software

Bunt & Associates created micro-simulation traffic models using PTV VISSIM 9 modelling software to analyze the street network. In addition to the base module designed for the simulation of vehicle traffic, the pedestrian simulation software VISWALK was also utilized to evaluate the pedestrian travel times and storage requirements.

VISSIM is a micro-simulation analysis tool used to model complex transportation networks. It is more adaptable, and can be more precise than Synchro software, which is used by transportation planners to establish volume to capacity ratios and Levels of Service using the procedures of the HCM. VISSIM software simulates the behaviour of individual drivers on the road network based on established mathematical car following models. Drivers, as well as pedestrians and cyclists, are subject to "rules" such as desired speeds, traffic signals, and lane restrictions. This is useful in assessing interactions between all types of vehicles and pedestrians, as well as looking at complex network effects. VISSIM allows for detailed assessment of queues, travel times, and other traffic parameters, and is capable of outputting more precise and more detailed results compared to Synchro.
Unlike traditional traffic software, VISSIM can also provide a better understanding of pedestrian interactions with vehicles and various types of traffic control, which cannot be modeled in Synchro, such as pedestrian signals.

VISSIM was chosen for this particular project to model pedestrian-pedestrian, vehicle-vehicle, vehicle-pedestrian and LRT pre-emption interactions, specifically at the intersection of Macleod Trail and 17 Avenue.

1.1 VISSIM Parameters

The VISSIM parameters approved for use in this study by the City of Calgary are shown in **Table 1.**

Table 1: Model Parameters

Parameter	Proposed Parameter
Model Run Length	60 minutes
Model Saturation Time	15 minutes
# Model Runs	5 initial runs, removing up to one outlier from the sample. The resulting performance metrics (delay, etc.) will be an average of the 4 remaining runs.
Heavy Vehicle Percentages	2% for all movements
Pedestrians	To be included at intersections with existing crossings. 17th Avenue, and the area directly adjacent to the Victoria Park / Stampede LRT Station will be modeled in VISWALK, and the remaining intersections be modeled using pedestrian link connections. Pedestrian volumes for the VISWALK network will be developed for Pre and Post event times, and existing pedestrian volumes will generally be used for all other intersections.
Peak Hour Factor	Peaking characteristics will be accounted for in the PM Post Event horizon. Event vehicles will be separated from background traffic, and vehicles will be modeled in 15-minute bins to represent the traditional peak hour factor. Peaking will be applied to the event vehicles based on the observed Stampede Ground access peak hour factors. Post-event pedestrians to be modeled using 5-minute bins to accurately represent post-event peaking characteristics
Public Transit	The Red Line LRT will be fully included in the analysis, including preemption at the 17th and 25th Avenue crossings. Buses are assumed to be included in the 2% heavy vehicle traffic. (4 car trains to be used at all horizons except 2048 which will include 5 car trains)
Model Calibration	The model will be initially calibrated using the GEH method to confirm that the assigned volumes are being processed. After this, individual intersections and movements will be calibrated to approximately match existing observed conditions and Synchro outputs (delays and queuing).
Driver Behavior	Wiedemann 74 (Urban Behaviour type) will be used on all study area links and roadways.
Internal Stamped Ground Access Lengths	The internal links will be made of sufficient length to capture internal queuing and delay without “losing” cars due to insufficient internal storage length.

Table 1: Model Parameters (Continued)

Parameter	Default Value	Proposed Values
Emergency Stop Distance	5m	Default unless adjustment required during calibration
Lane-Change Distance	200m	Default unless adjustment required during calibration
Average Standstill Distance	2.00m	Default
Additive Part of the Safety Distance	2.00m	Default
Multiplicity Part of the Safety Distance	3.00m	Default
Look Ahead Distance	Min. – 0m, Max – 250m, 4 observed vehicles	Default
Look Behind Distance	Min. – 0m, Max – 150m	Default
Minimum Headway	0.5m	1.0m as previously requested by the City of Calgary
Wait time before diffusion	60 seconds	60 seconds
Cooperative Lane Change	Not selected	Not selected as per default, but will report if parameter is used.
Advanced merging	Selected	Selected
Overtake Reduced Speed Areas	Not selected	Not selected because there are no lane dependent speed limits in the study network.

1.2 Peak Hour Definition

The following time periods were analyzed in the study models. A description of the vehicle and pedestrian volumes and travel patterns for each time period is provided below:

- AM - The peak observed *traffic* conditions on northbound Macleod Trail occur during the weekday AM peak period. At this time, pedestrian volumes crossing Macleod Trail to/from the station are not significant from a pedestrian modeling perspective. Most of the pedestrians accessing the station area and crossing Macleod Trail in this time period are transit users, with a small amount of employees destined to the Stampede Park and school students destined to St. Mary's High School.
- PM Pre Event - The peak *combined traffic/pedestrian* period is represented by the pre-game weekday PM peak hour. This overlaps the PM street peak traffic volumes with the peak pre-event inbound PM pedestrian volumes. It should be noted that to be conservative, Bunt combined these two volumes with no reductions to account for the fact that the two peak hours do not always fully overlap. The traffic volumes usually peak slightly earlier than the pedestrian volumes. The primary pedestrian pattern in this time period is inbound to the Stampede Park from the west side of Macleod Trail and from the train station. A small amount of non-event pedestrians routed to/from the train station and the west side of Macleod Trail were also included.
- PM Post Event - The peak observed *pedestrian* conditions occur during the post-event period, with nearly all pedestrian trips routed outbound from the Stampede Park, with approximately half of pedestrians destined to the LRT and half to the west side of Macleod Trail. Again a minor amount of non-event pedestrians to/from the station were also included. At this time the northbound traffic flows on Macleod Trail are relatively insignificant compared to the PM pre event period.

2. MODEL CALIBRATION

This section describes the calibration methodology that has been used to calibrate the base existing VISSIM model using balanced existing AM and PM peak hour volumes.

2.1 Initial Visual Debugging

The first step of the model calibration was an initial debugging, where the VISSIM network was run and observed, and deficiencies were noted such as disappearing cars and malfunctioning priority rules (colliding cars). The network priority rules and conflict areas were adjusted to remedy these issues before the next step of calibration began.

2.2 GEH Volume Calibration

The second step of calibration involved the utilization of the GEH (Geoffrey E. Havers) process. **Figure 1** presents the GEH formula which is used to compare traffic volumes processed by the model intersections with the input volumes, and is considered a more appropriate metric than a straight percentage comparison.

Figure 1: GEH Volume Calibration Formula

$$GEH = \sqrt{\frac{2(m-c)^2}{m+c}}$$

Notes:
m = output traffic volume from the simulation model (vph)
c = input traffic volume (vph)

The VISSIM model was run and the processed intersection volumes were compared with the input volumes (Balanced Exiting AM and PM volumes) and any GEH values over 5 were investigated. The model, and in particular the priority rules were adjusted until the all of the GEH values were below 5, i.e., the processed intersection volumes were approximately equal to what was observed in the field. **Table 2** shows the percent processed and GEH score for movements at the focus intersections.

Table 2: GEH Volume Calibration Results at Macleod Trail & 25 Avenue SE

Intersection	Movement	AM Peak Hour		PM Peak Hour	
		% Processed	GEH Score	% Processed	GEH Score
Macleod Trail & 25 Avenue	NBL	97%	0	95%	1
	NBT	99%	0	99%	1
	NBR	93%	0	98%	0
	SBL	96%	1	99%	0
	SBT	101%	0	101%	1
	SBR	109%	1	104%	1
	WBL	98%	0	86%	1
	WBT	96%	1	90%	2
	WBR	96%	1	92%	1
	EBL	92%	1	75%	2
	EBT	96%	1	104%	0
	EBR	99%	0	99%	0
Overall Intersection		99%	1	98%	1
Overall Network		101%	1	99%	2

All individual movement GEH score are less than 5, and the overall GEH score for the entire network is less than 5 for both peak hours.

2.3 Delay Calibration

After the model was calibrated so that the processed volumes were within 5 GEH, movement delays at all of the study intersections were reviewed. Any movements with delays that exceed 55s (LOS E for a signalized intersection) were inspected, and the delay and model operations were compared with Synchro to determine if the high levels of delay were in fact representative of the existing conditions. Delays that were deemed excessive were amended through the adjusting of various model parameters including link connections, priority rules and reduced speed areas, while high delays that were deemed realistic were left as is (for example, high delays at the intersection of Macleod Trail & 25th Avenue due to high volumes and LRT pre-emption).

2.4 Visual Calibration

The final calibration step was to again visually review the model operations, and in particular vehicle behaviours and queuing. In particular, static routing decisions for north and southbound movements were adjusted at a number of intersections on 1st Street SE and Macleod Trail in order replicate existing queuing behaviours on the corridor.

2.4.1 Event Traffic Calibration

Post-event traffic volumes at 3 Street were edited to establish a strong peaking profile, which reflects an event exit time of approximately 20 minutes. Video records were reviewed to replicate the approximate length of the southbound queue at 3 Street and the approximate number of cycles where significant queuing occurred within the analysis hour.

2.5 Calibrated VISSIM Model Parameters

The model parameters that resulted from the calibration process are attached. The vast majority of the parameters were left at their default values, and the emergency stopping distance was the primary behavioural parameter that was adjusted.

Included in the existing AM and PM model folders are excel sheets with results summaries including assigned volumes by movement and average processed volumes and delays.

The City of Calgary reviewed the calibrated AM and PM peak hour models and approved the model calibration.

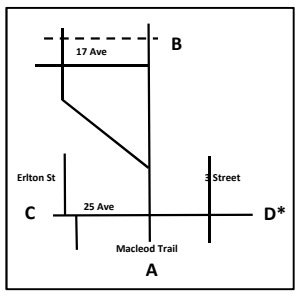
25 Avenue VISSIM Analysis Overview - UPDATED February 20, 2018

25 Avenue VISSIM Analysis - Detailed Results Comparison 5 runs

AM Peak Hour

Category		Assigned Values	Existing Network (Do Nothing)	Option A	Option B	Option C	Option B3	Option B4
Volume Set		2038	2038	2038	2038	2038		
Train Preemption (25th/3rd/No)		-	25th	No	No	3rd		
Performance Metrics								
Processed Screenline Percents (See evaluation locations on the right)	Overall (Full Network)	-	**93%**	**99%**	**100%**	**97%**		
	NB Macleod @ Point A (25 Ave)	-	87%	100%	101%	99%		
	NB Macleod @ Point B (17 Ave)	-	90%	100%	101%	99%		
	SB Macleod @ Point A (25 Ave)	-	100%	98%	98%	96%		
	SB Macleod @ Point B (17 Ave)	-	101%	99%	99%	99%		
	EB 25 Ave @ Point C (Erlton)	-	85%	98%	98%	91%		
	EB 25 Ave @ Point D (3 Street)	-	80%	99%	100%	89%		
	WB 25 Ave @ Point C (Erlton)	-	99%	100%	101%	95%		
	WB 25 Ave @ Point D (3 Street)	-	95%	100%	100%	90%		
Processed Screenline Volumes	Total of Below Movements	**10852**	**11535**	**12365**	**12430**	**12052**		
	NB Macleod @ Point A (25 Ave)	2751	2397	2749	2766	2736		
	NB Macleod @ Point B (17 Ave)	2990	2699	2981	3033	2955		
	SB Macleod @ Point A (25 Ave)	1893	1895	1852	1862	1816		
	SB Macleod @ Point B (17 Ave)	2185	2200	2164	2156	2156		
	EB 25 Ave @ Point C (Erlton)	518	440	508	508	470		
	EB 25 Ave @ Point D (3 Street)	816 / 828 for B/B3*	650	810	825	723		
	WB 25 Ave @ Point C (Erlton)	515	508	516	522	489		
	WB 25 Ave @ Point D (3 Street)	784 / 760 for B/B3*	746	785	758	707.6		
Average Travel Time (s) (See Figure to Right)	NB Macleod - A to B	-	96	99	80	102		
	SB Macleod - B to A	-	124	97	90	97		
	EB 25 Ave - C to D	-	223	206	185	232		
	WB 25 Ave - D to C	-	472	212	161	438		
Pedestrian Analysis Summary	# E-W Macleod Crossings	-	1	3	2	3		
	Avg. E-W Crossing Time	for all crossings	108	94	73	91		
	Avg. N-S Crossing Time	-	127	49	69	127		
Bay Lengths	25 Ave / Macleod - NBL	-	70	90	90	90		
	25 Ave / Macleod - NBR	-	20	170		80		
	25 Ave / Macleod - SBL	-	100	230	75	170		
	25 Ave / Macleod - EBL	-	50	55	55	55		
	25 Ave / Macleod - WBL	-	30	-	-	-		
	25 Ave / Macleod - WBR	-	30	100	-	120		
	25 Ave /3 Street - EBL	-	80	90	-	50		
	25 Ave/3 Street- WBR	-	55	30	-	70		
95th Percentile Queues	25 Ave / Macleod - NBL	-	590**	58	60	61		
	25 Ave / Macleod - NBR	-	8	-	-	135**		
	25 Ave / Macleod - SBL	-	124**	71	-	103		
	25 Ave / Macleod - SBTR	-	201	-	-	-		
	25 Ave / Macleod - EBL	-	341**	-	-	-		
	25 Ave / Macleod - EBTR	-	354	-	-	-		
	25 Ave / Macleod - EBLR	-	-	111**	93**	177**		
	25 Ave / Macleod - WBL	-	39**	59	-	114		
	25 Ave / Macleod - WBR	-	24	11	-	61		
	25 Ave / Macleod - NB U Turn	-	-	-	0	-		
	25 Ave / Macleod - SB Ramp	-	-	-	28	-		
	25/3 - SB	-	8	8	-	6		
	25/3 - EBL	-	4	15	-	15		
	25/3 - WBR	-	9	8	-	255**		
Commentary		-	Insufficient NB capacity, due in part to preemption and higher conflicting movements	EB/WB capacities are limited due to short storage between intersections	High NB to SB u-turn usage occasionally results in weaving area congestion	Limited WB and SBL capacity due to train preemption at 3 Street		
		-	Preemption creates high queues and travel times for westbound movement	Second lowest travel times overall	Lowest overall travel times	Short spacing between intersections results in WBL and EBL queues often backing up into the intersections		
		-						

Evaluation Locations



PM Peak Hour

Category		Assigned Values	Existing Network (Do Nothing)	Option A	Option B	Option C	Option B3	Option C w/ 3 min headways
Volume Set		2038	2038	2038	2038	2038	2038	2038
Train Preemption (25th/3rd/No)		-	25th	No	No	3rd	No	3rd
Performance Metrics								
Processed Screenline Percents (See evaluation locations on the right)	Overall (Full Network)	-	**60%**	**83%**	**75%**	**78%**	**89%**	**71%**
	NB Macleod @ Point A (25 Ave)	-	63%	100%	87%	99%	100%	99%
	NB Macleod @ Point B (17 Ave)	-	68%	87%	81%	89%	99%	87%
	SB Macleod @ Point A (25 Ave)	-	62%	84%	76%	77%	73%	65%
	SB Macleod @ Point B (17 Ave)	-	63%	87%	80%	80%	70%	64%
	EB 25 Ave @ Point C (Erlton)	-	51%	64%	78%	57%	97%	64%
	EB 25 Ave @ Point D (3 Street)	-	56%	75%	68%	66%	104%	60%
	WB 25 Ave @ Point C (Erlton)	-	67%	70%	79%	75%	100%	71%
	WB 25 Ave @ Point D (3 Street)	-	49%	55%	52%	43%	95%	44%
Processed Screenline Volumes	Total of Below Movements	**13047**	**9721**	**12204**	**11546**	**11689**	**12495**	**10684**
	NB Macleod @ Point A (25 Ave)	2671	1680	2667	2336	2651	2676	2643
	NB Macleod @ Point B (17 Ave)	2600	1765	2272	2099	2312	2572	2258
	SB Macleod @ Point A (25 Ave)	2796	1724	2342	2112	2153	2046	1817
	SB Macleod @ Point B (17 Ave)	3404	2153	2952	2713	2736	2388	2174
	EB 25 Ave @ Point C (Erlton)	747	378	476	579	423	728	479
	EB 25 Ave @ Point D (3 Street)	1213 / 1551 for B/B3	676	914	1048	796	1256	722
	WB 25 Ave @ Point C (Erlton)	829	556	581	659	619	830.6	593
	WB 25 Ave @ Point D (3 Street)	1610 / 1102 for B/B3	789	892	576	692	1044	702
Average Travel Time (s)	NB Macleod - A to B	-	118	120	162	113	92	128
	SB Macleod - B to A	-	223	247	236	168	203	256
	EB 25 Ave - C to D	-	418	353	445	359	213	418
	WB 25 Ave - D to C	-	499	620	580	661	464	519
Pedestrian Analysis Summary	# E-W Macleod Crossings	-	1	3	2	3	2	3
	Avg. E-W Crossing Time	for all crossings	101	98	85	81	83	84
	Avg. N-S Crossing Time	-	180	54	70	108	72	173
Bay Lengths	25 Ave / Macleod - NBL	-	70	90	90	90		
	25 Ave / Macleod - NBR	-	20	170		80		
	25 Ave / Macleod - SBL	-	100	230	75	170		
	25 Ave / Macleod - EBL	-	50	55	55	55		
	25 Ave / Macleod - WBL	-	30	-	-	-		
	25 Ave / Macleod - WBR	-	30	100	-	120		
	25 Ave /3 Street - EBL	-	80	90	-	50		
	25 Ave/3 Street- WBR	-	55	30	-	70		
95th Percentile Queues	25 Ave / Macleod - NBL	-	509**	174**	148**	163**		
	25 Ave / Macleod - NBR	-	-	198**	-	150**		
	25 Ave / Macleod - SBL	-	508**	131	-	561**		
	25 Ave / Macleod - EBL	-	287**	-	-	-		
	25 Ave / Macleod - EBL/R	-	-	102**	330**	289**		
	25 Ave / Macleod - WBL	-	43**	198	-	124		
	25 Ave / Macleod - WBR	-	17	5	-	27		
	25 Ave / Macleod - NB U Turn	-	-	-	505**	-		
	25 Ave / Macleod - SB Ramp	-	-	-	576**	-		
	25/3 - SB	-	22	32	-	51		
	25/3 - EBL	-	107**	91**	-	110**		
	25/3 - WBR	-	451**	470**	-	239**		
Commentary		Long queues obstruct through NB/SB movements and lower processing capacity compared to the existing volume scenario	Limited SBL capacity due to train preemption and short storage. SBL queueing blocks SBT vehicles	Moderately high NB / SB capacity, although weaving near ramp entrance results in high Macleod travel times and safety concerns	Limited SBL capacity due to train preemption and short storage. SBL queueing blocks SB vehicles.	Improved WB capacity (over Interim 2T), reduces NB/SB capacity on Macleod Trail	Significant (14%) improvement over the base Option B.	Significantly reduced EB/WB capacity on 25 Avenue due to increased # of trains
		Significantly lower capacity than all other future options	Relatively high WB capacity due to train crossing location	Low EB and WB capacity and high travel times due to queueing caused by weaving area	SB and EB capacities are marginally better than the Interim option	Improved EB and WB storage on 25 Avenue east of Macleod Trail	The increase in processesed U-turn traffic reduces how many SB vehicles are processed	An overall reducing in processing capacity of 7% compared to Option C
		Train preemption and 4 legs limits improvement potential at intersection	Low EB capacity and high travel time due to train preemption			Removal of NB channelized right onto 25 Avenue reduces EB capacity		

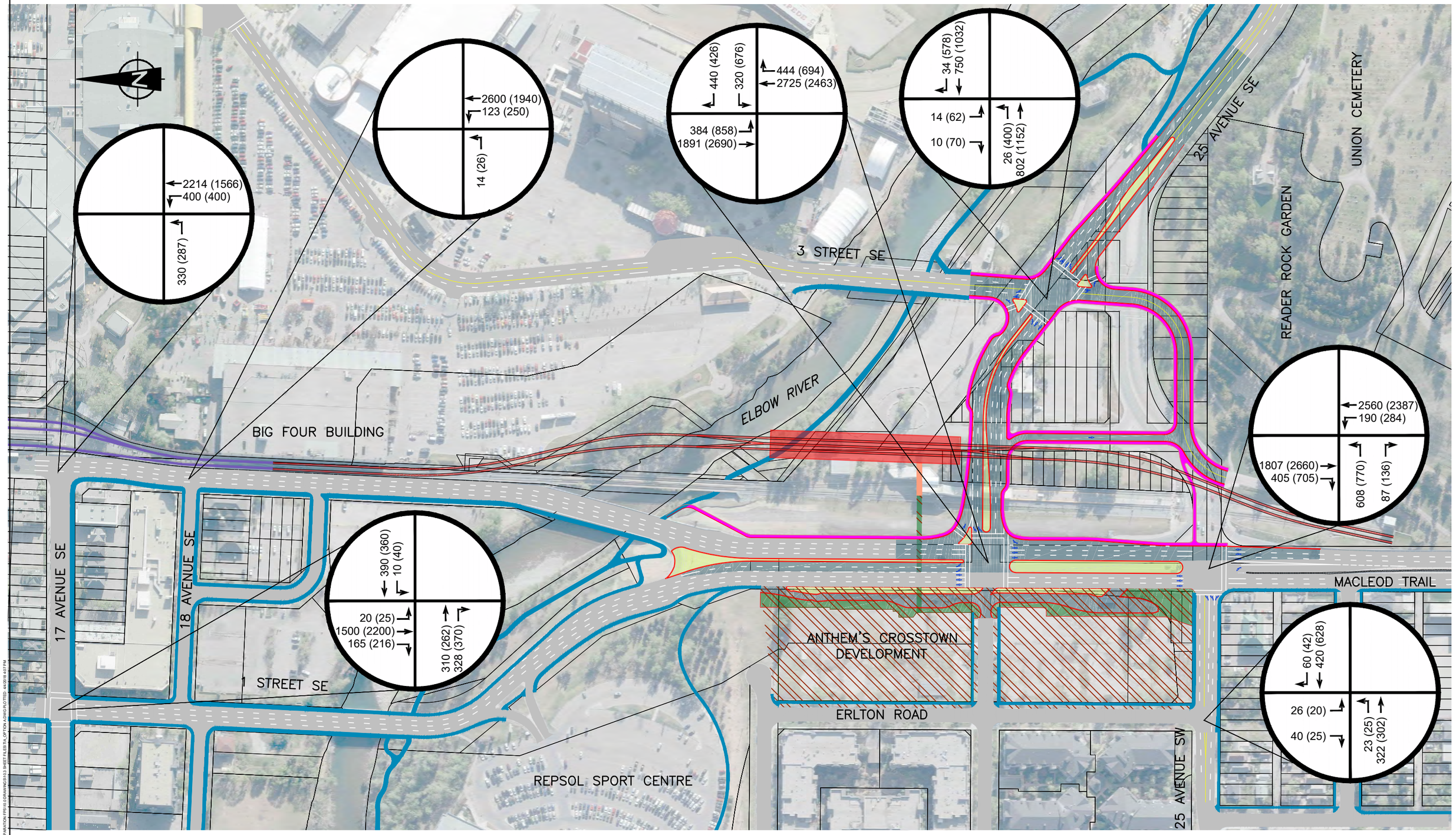
PM Post Event Peak Hour

Category		Existing Network (Do Nothing)	Option A	Option B	Option C
Volume Set		2038	2038	2038	2038
Train Preemption (25th/3rd/No)		25th	No	No	3rd
Performance Metrics					
Overall Processed (Full Network)		**100%**	**100%**	**101%**	**99%**
Overall Average Delay (25 Avenue & 3 Street / Macleod Intersections)		**32**	**22**	**11**	**22**
25 Avenue / Macleod Trail	NBL	67	61	44	61
	NBT	1	7	11	7
	NBR	38	1	NA	2
	SBL	46	59	0	66
	SBT	28	7	15	8
	SBR	25	16	15	15
	EBL	**66**	**60**	**25**	**51**
	EBT	70	NA	NA	NA
	EBR	23	6	5	6
	WBL	63	56	NA	45
	WBT	59	NA	NA	NA
	WBR	12	1	NA	3
25 Avenue / 3 Street SE	SBL	30	43	NA	41
	SBR	22	26	NA	41
	EBL	35	35	NA	40
	EBT	12	9	NA	19
	WBT	35	18	NA	52
	WBR	19	10	NA	11
	SB Average Queue	83	106	NA	128
	SB 95th Queue	218	260	NA	306
Average Travel Time (s)	NB Macleod - B to A	96	79	67	77
	SB Macleod - A to B	87	85	75	82
	EB 25 Ave - C to D	128	128	144	136
	WB 25 Ave - D to C	151	153	137	191
Pedestrian Analysis Summary	# E-W Macleod Crossings	1	3	2	3
	Avg. E-W Crossing Time	95	92	62	78
	Avg. N-S Crossing Time	117	47	51	62
Commentary		All options can accommodate the forecasted PM Post Event traffic, and the delays and travel times shown may be reflective of how the options will operate during the non-peak hours. Considering the SB movement at the intersection of 25 Avenue and 3 Street, the only option that has materially different results compared to the existing (do nothing) scenario is Option C. This is because the LRT tracks pass throught the west side of the intersection in this option, and the train blocks the SBR movement. Besides this, the average Post Event delays and queues for the other options are o f the same magnitude.			
		Highest overall delay	Second highest overall delay, but low east-west travel times	Lowest overall delay and generally lowest travel times	Highest delay and queue for vehicles exiting the Stampede Grounds

Notes

* - The models for the B options do not included the intersection of 25 Avenue and 3 Street, and so the EB/WB volumes east of Macleod Trail are slightly different

** - Queue exceeds available storage



205 (220) PEAK HOUR VOLUME - AM (PM)

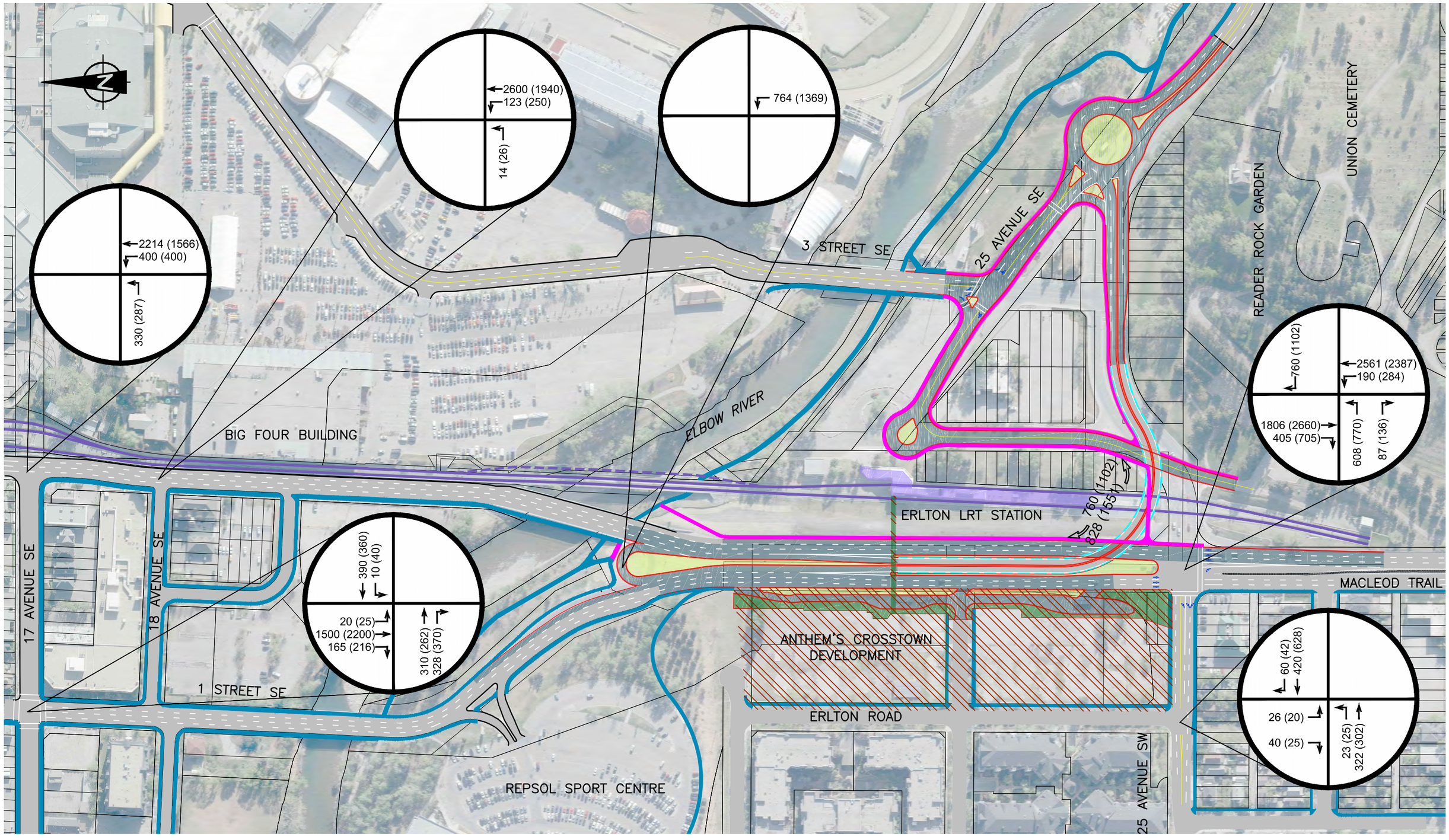
MOVEMENT DIRECTION

25 0 50
1:2500

Refined Concept A
Elevated LRT Station

Design Traffic Volumes

25 Avenue SE LRT Grade Separation Study | App. A-1



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205 (220) PEAK HOUR VOLUME - AM (PM)
MOVEMENT DIRECTION

770 (1441) PEAK HOUR VOLUME - AM (PM)

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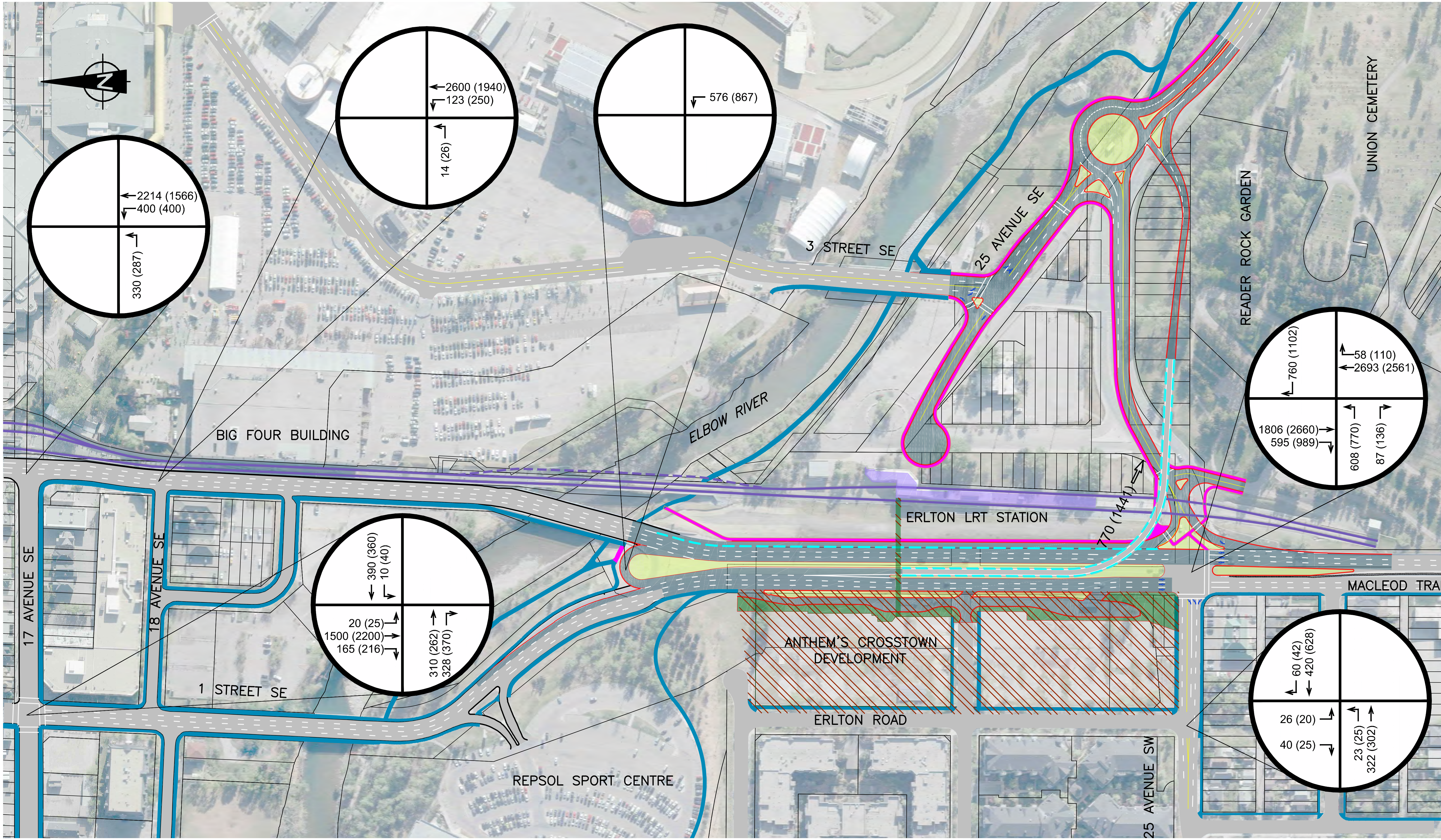
1:2500

Refined Concept B
Bi-Directional Median Flyover

Design Traffic Volumes

25 Avenue SE LRT Grade Separation Study | App. A-2



McElhanney

205 (220) PEAK HOUR VOLUME - AM (PM)

MOVEMENT DIRECTION

770 (1441) ⇒ PEAK HOUR VOLUME - AM (PM)

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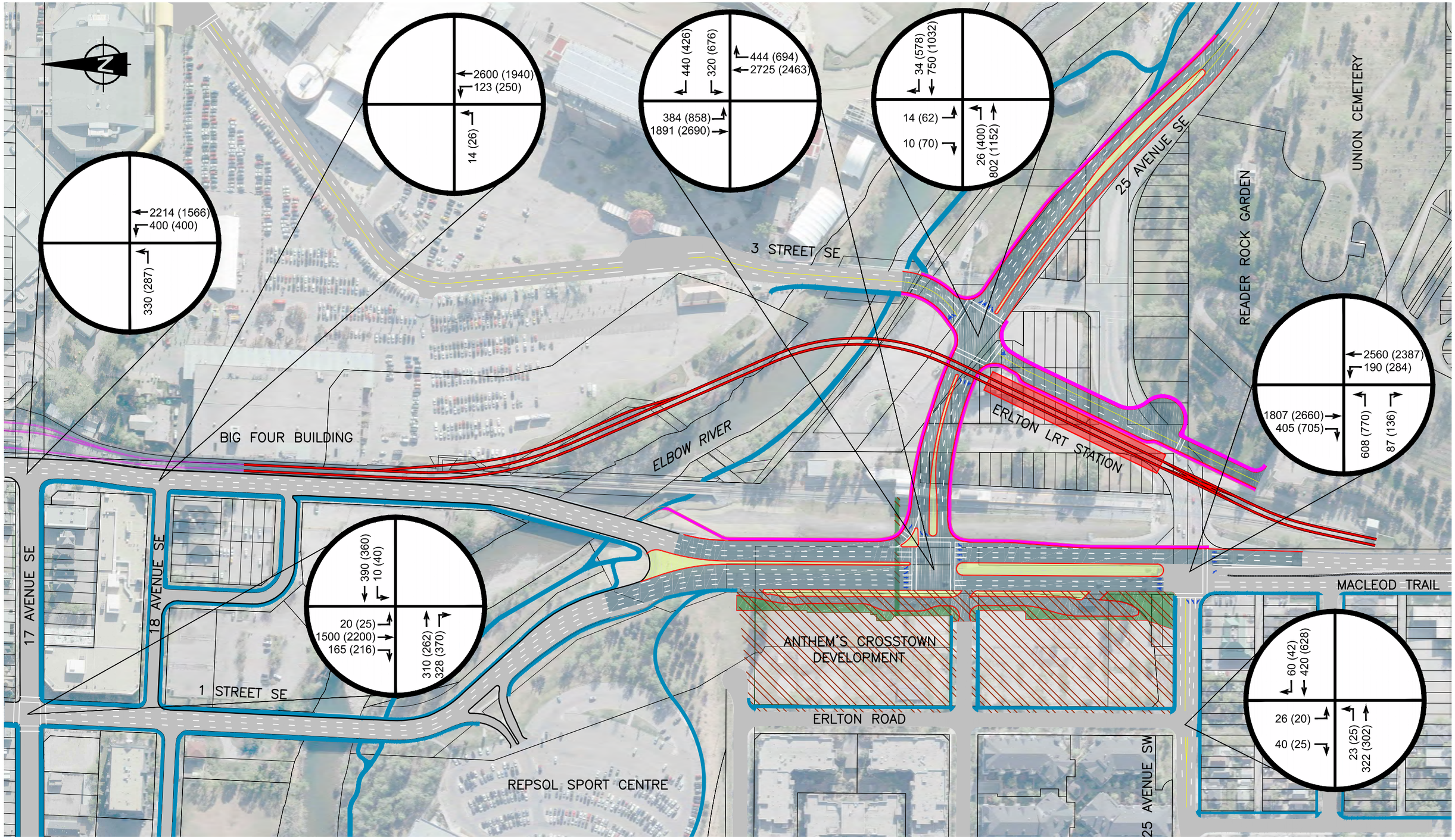
1:2500

Refined Concept B2
Single Lane Median Flyover

Design Traffic Volumes

25 Avenue SE LRT Grade Separation Study | App. A-3



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205 (220) PEAK HOUR VOLUME - AM (PM)

MOVEMENT DIRECTION

25 0 50
1:2500

Refined Concept C
Relocated At-Grade LRT Crossing

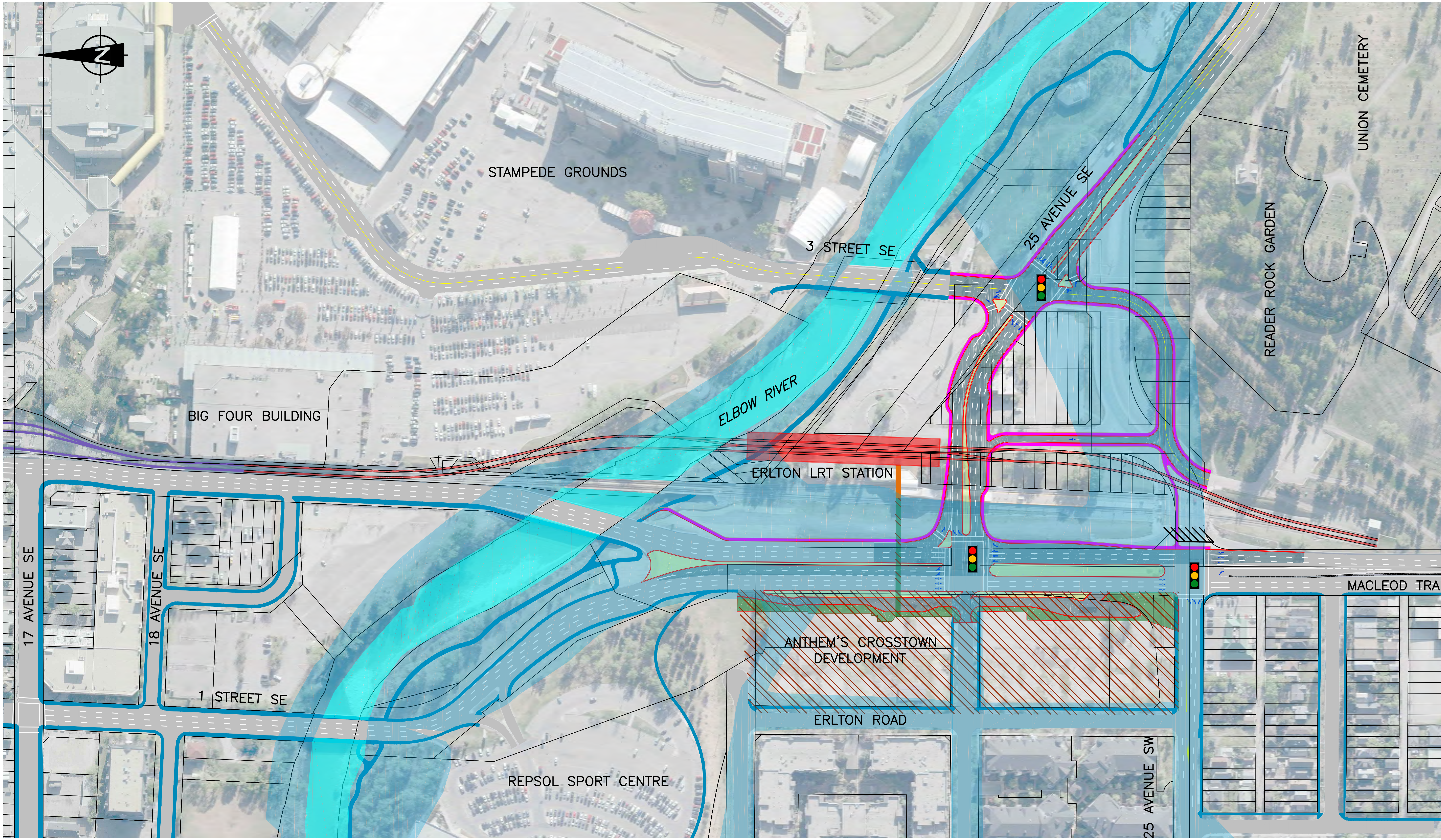
Design Traffic Volumes

25 Avenue SE LRT Grade Separation Study | App. A-4

B

Appendix B

CONCEPTS WITH FLOODWAY OVERLAY



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- EXISTING PAVEMENT
- EXISTING PATHWAY
- EXISTING ERLTON STATION
- EXISTING LRT TRACKS
- ANTHEM'S PEDESTRIAN CONNECTIONS
- ANTHEM'S DEVELOPMENT
- NEW / ALTERED PAVEMENT
- PROPOSED STRUCTURE
- PROPOSED CONCRETE SURFACING
- PROPOSED PATHWAY/ SIDEWALK
- PROPOSED PEDESTRIAN OVERPASS
- FLOODWAY
- PROPOSED CURB & GUTTER
- PROPOSED CONCRETE BARRIER
- PROPOSED ERLTON STATION
- PROPOSED LRT TRACK
- 101+200 ROAD STATIONING
- 21+600 LRT STATIONING

25 0 50
1:2500

Refined Concept A
Elevated LRT Station

Floodway Mapping

25 Avenue SE LRT Grade Separation Study

App. B-1

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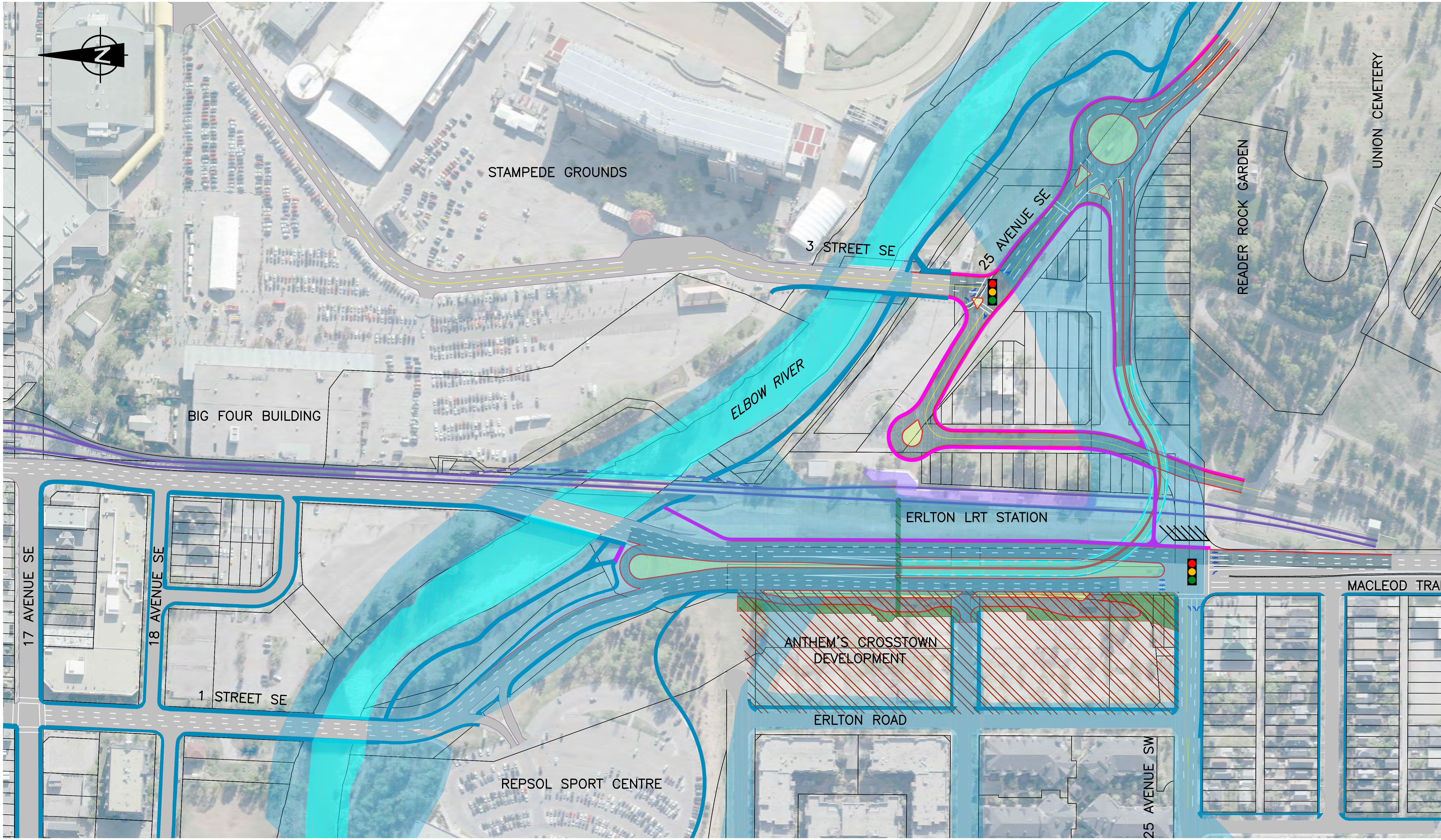

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EXISTING LRT TRACKS
ANTHEM'S PEDESTRIAN CONNECTIONS
ANTHEM'S DEVELOPMENT
NEW / ALTERED PAVEMENT
PROPOSED STRUCTURE
PROPOSED CONCRETE SURFACING
PROPOSED PATHWAY/ SIDEWALK
PROPOSED PEDESTRIAN OVERPASS
FLOODWAY
PROPOSED CURB & GUTTER
PROPOSED CONCRETE BARRIER
PROPOSED ERLTON STATION
PROPOSED LRT TRACK
101+200 ROAD STATIONING
21+600 LRT STATIONING

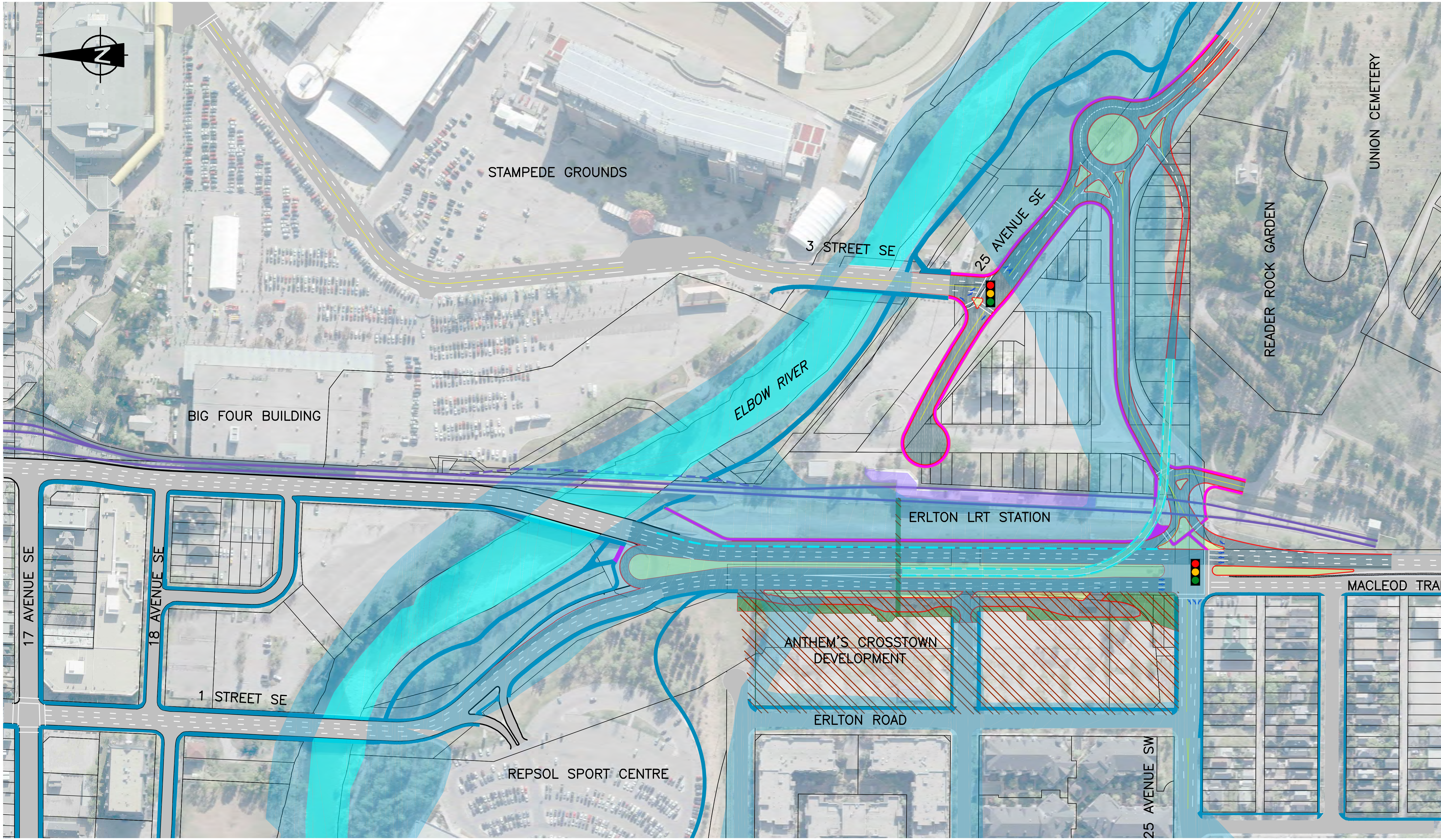
25 0 50
1:2500

Refined Concept B
Bi-Directional Median Flyover

Floodway Mapping

25 Avenue SE LRT Grade Separation Study

App. B-2



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EXISTING PATHWAY
EXISTING ERLTON STATION
EXISTING LRT TRACKS
ANTHEM'S PEDESTRIAN CONNECTIONS
ANTHEM'S DEVELOPMENT

NEW / ALTERED PAVEMENT
PROPOSED STRUCTURE
PROPOSED CONCRETE SURFACING
PROPOSED PATHWAY/ SIDEWALK
PROPOSED PEDESTRIAN OVERPASS
FLOODWAY

PROPOSED CURB & GUTTER
PROPOSED CONCRETE BARRIER
PROPOSED ERLTON STATION
PROPOSED LRT TRACK
101+200 ROAD STATIONING
21+600 LRT STATIONING

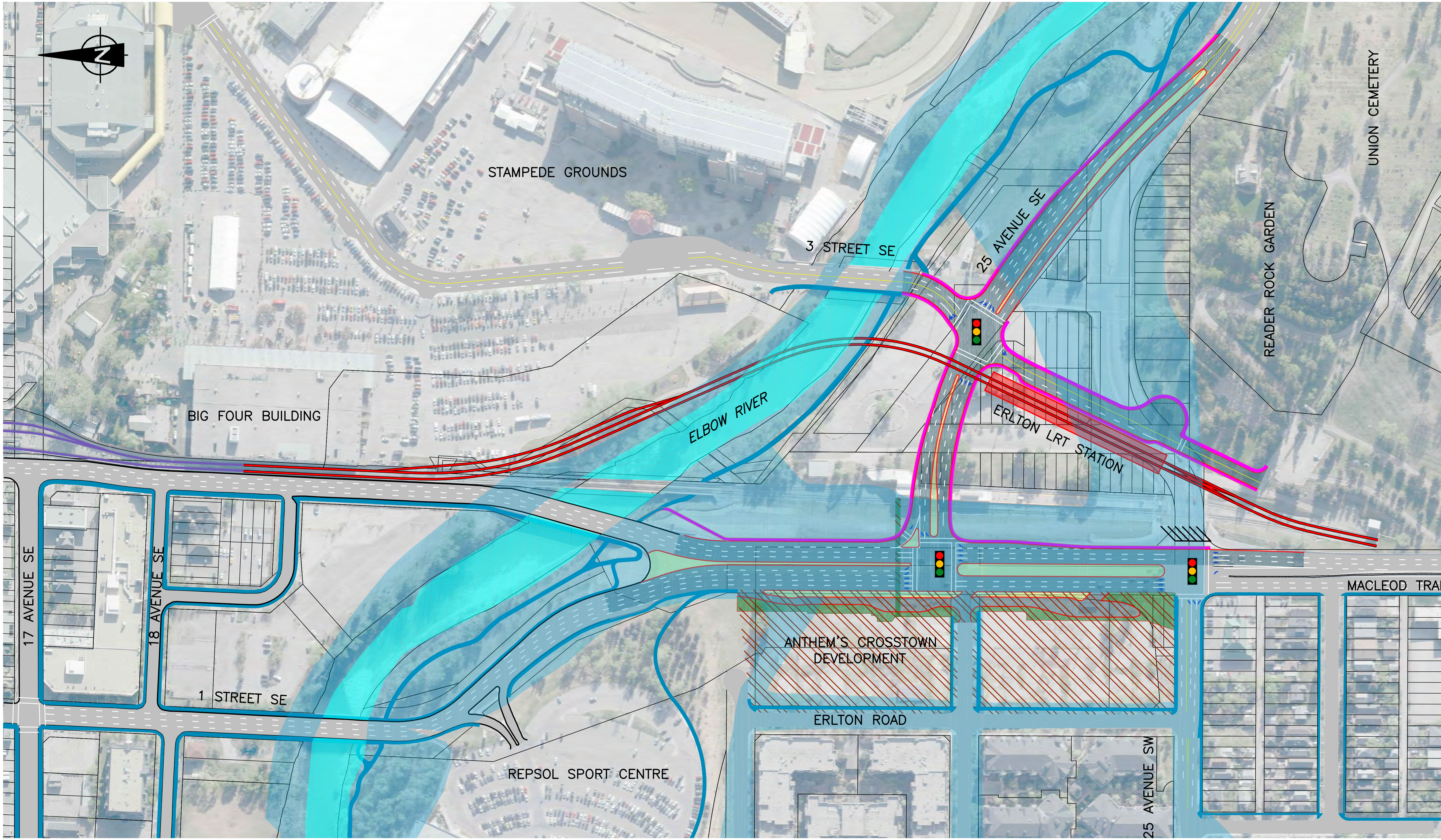
25 0 50
1:2500

Refined Concept B2
Single Lane Median Flyover

Floodway Mapping

25 Avenue SE LRT Grade Separation Study

App. B-3



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EXISTING PAVEMENT
EXISTING PATHWAY
EXISTING ERLTON STATION
EXISTING LRT TRACKS
ANTHEM'S PEDESTRIAN CONNECTIONS
ANTHEM'S DEVELOPMENT
NEW / ALTERED PAVEMENT
PROPOSED STRUCTURE
PROPOSED CONCRETE SURFACING
PROPOSED PATHWAY/ SIDEWALK
PROPOSED PEDESTRIAN OVERPASS
FLOODWAY
PROPOSED CURB & GUTTER
PROPOSED CONCRETE BARRIER
PROPOSED ERLTON STATION
PROPOSED LRT TRACK
101+200 ROAD STATIONING
21+600 LRT STATIONING

25 0 50
1:2500

Refined Concept C
Relocated At-Grade LRT Crossing

Floodway Mapping

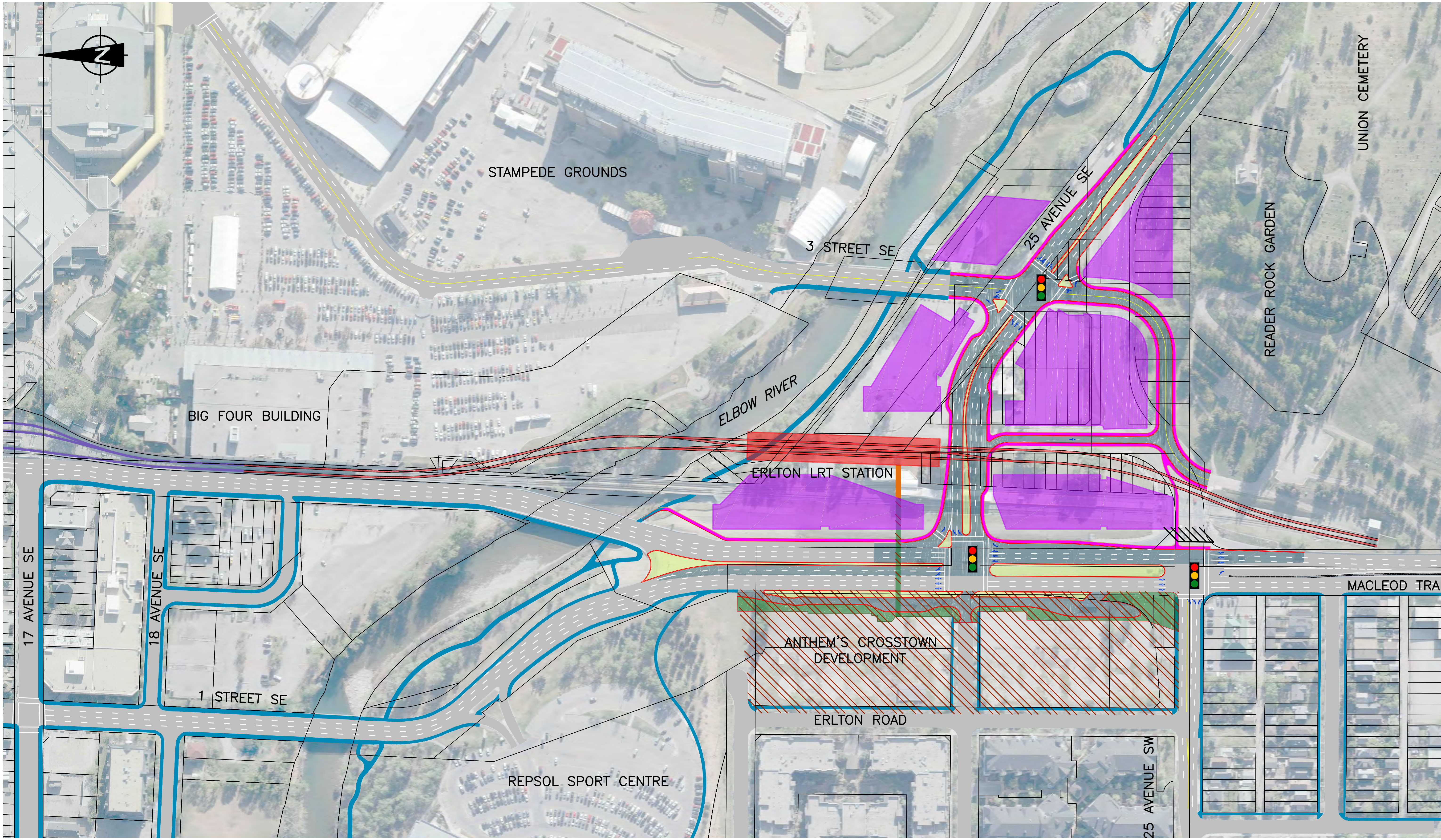
25 Avenue SE LRT Grade Separation Study

App. B-4

C

Appendix C

MAXIMUM POTENTIAL DEVELOPMENT PARCELS FOR EACH CONCEPT



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EXISTING LRT TRACKS
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ANTHEM'S DEVELOPMENT
NEW / ALTERED PAVEMENT
PROPOSED STRUCTURE
PROPOSED CONCRETE SURFACING
PROPOSED PATHWAY/ SIDEWALK
PROPOSED PEDESTRIAN OVERPASS
FLOODWAY
PROPOSED CURB & GUTTER
PROPOSED CONCRETE BARRIER
PROPOSED ERLTON STATION
PROPOSED LRT TRACK
101+200 ROAD STATIONING
21+600 LRT STATIONING

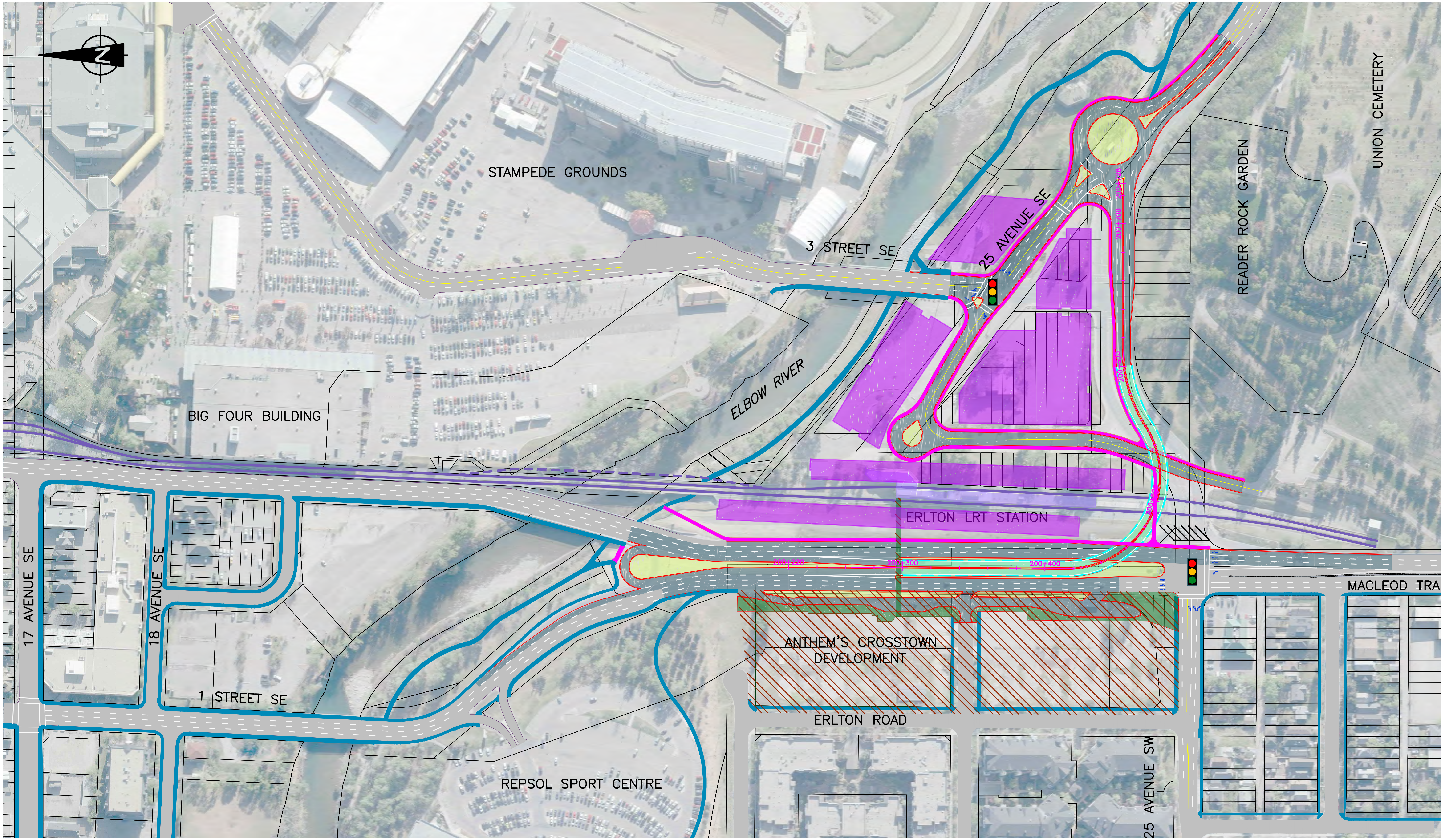
25 0 50
1:2500

Refined Concept A
Elevated LRT Station

Potential Development

25 Avenue SE LRT Grade Separation Study

App. C-1



EXISTING PAVEMENT	NEW / ALTERED PAVEMENT
EXISTING PATHWAY	PROPOSED STRUCTURE
EXISTING ERLTON STATION	PROPOSED CONCRETE SURFACING
EXISTING LRT TRACKS	PROPOSED PATHWAY/ SIDEWALK
ANTHEM'S PEDESTRIAN CONNECTIONS	PROPOSED PEDESTRIAN OVERPASS
ANTHEM'S DEVELOPMENT	FLOODWAY

PROPOSED CURB & GUTTER
PROPOSED CONCRETE BARRIER
PROPOSED ERLTON STATION
PROPOSED LRT TRACK
101+200 ROAD STATIONING
21+600 LRT STATIONING

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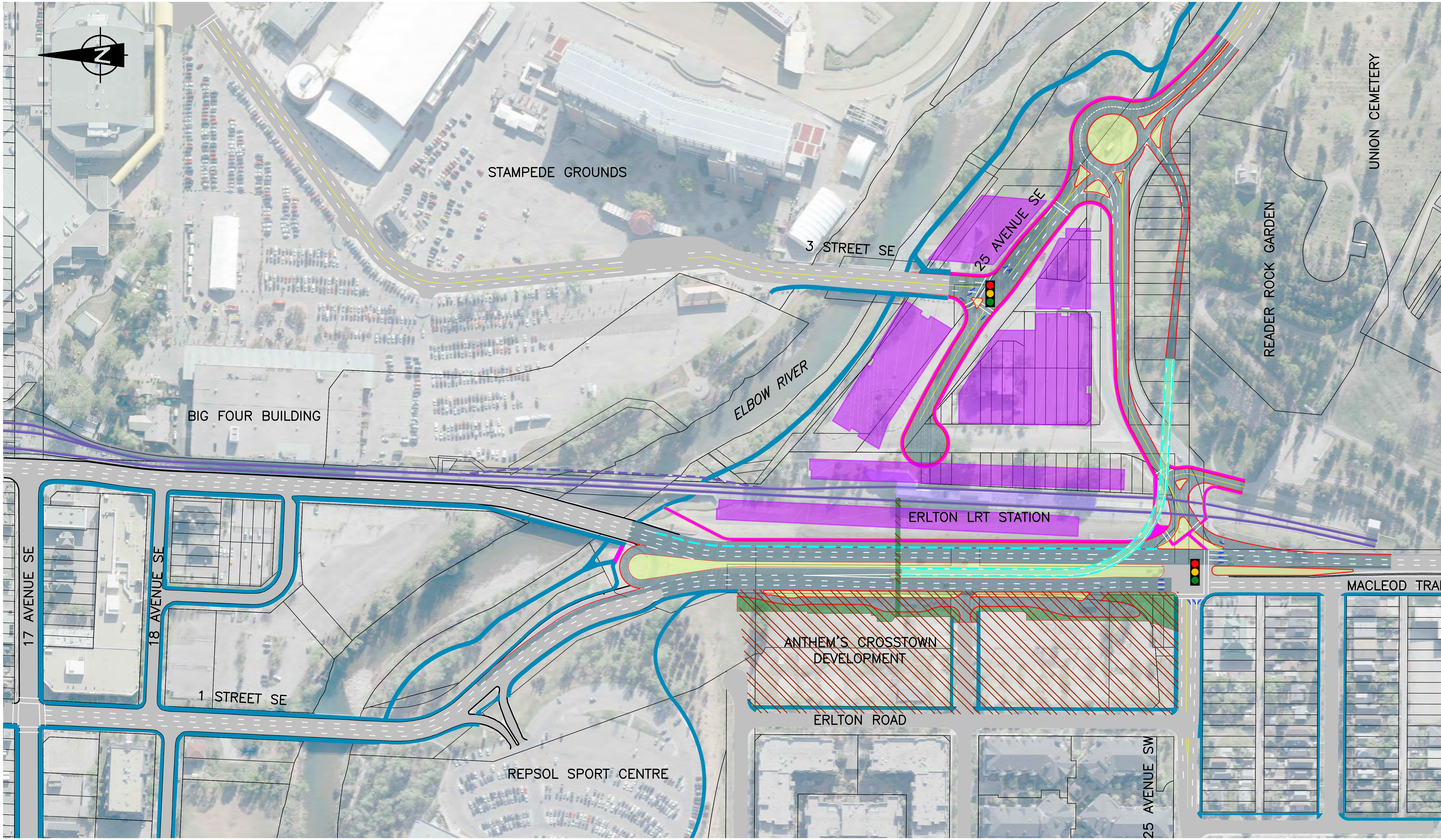
1:2500

Refined Concept B
Bi-Directional Median Flyover

Potential Development

25 Avenue SE LRT Grade Separation Study

App. C-2



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- EXISTING PAVEMENT
- EXISTING PATHWAY
- EXISTING ERLTON STATION
- EXISTING LRT TRACKS
- ANTHEM'S PEDESTRIAN CONNECTIONS
- ANTHEM'S DEVELOPMENT
- NEW / ALTERED PAVEMENT
- PROPOSED STRUCTURE
- PROPOSED CONCRETE SURFACING
- PROPOSED PATHWAY/ SIDEWALK
- PROPOSED PEDESTRIAN OVERPASS
- FLOODWAY
- PROPOSED CURB & GUTTER
- PROPOSED CONCRETE BARRIER
- PROPOSED ERLTON STATION
- PROPOSED LRT TRACK
- 101+200 ROAD STATIONING
- 21+600 LRT STATIONING

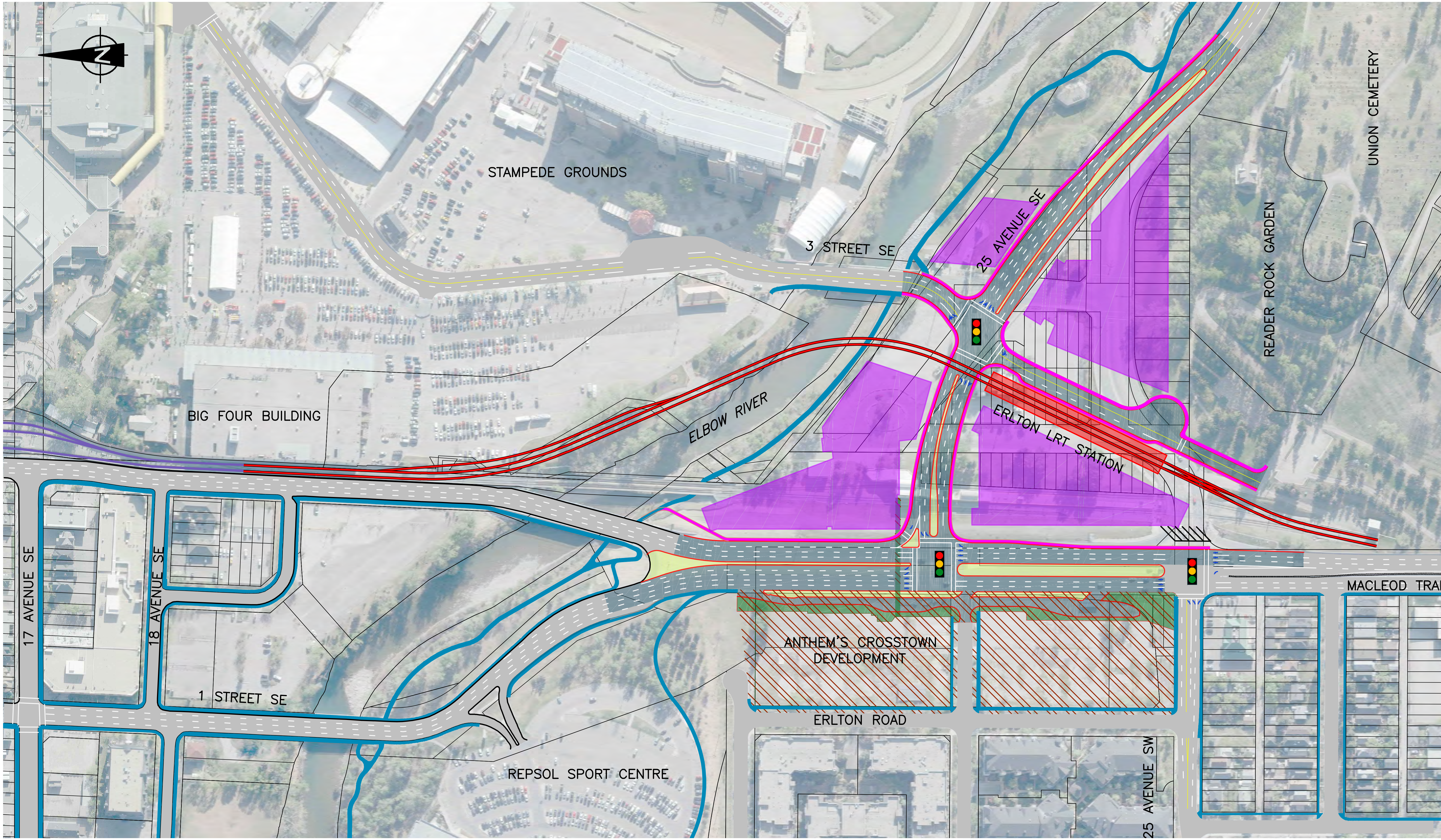
25 0 50
1:2500

Refined Concept B2
Single Lane Median Flyover

Potential Development

25 Avenue SE LRT Grade Separation Study

App. C-3



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EXISTING ERLTON STATION
EXISTING LRT TRACKS
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ANTHEM'S DEVELOPMENT
NEW / ALTERED PAVEMENT
PROPOSED STRUCTURE
PROPOSED CONCRETE SURFACING
PROPOSED PATHWAY/ SIDEWALK
PROPOSED PEDESTRIAN OVERPASS
FLOODWAY
PROPOSED CURB & GUTTER
PROPOSED CONCRETE BARRIER
PROPOSED ERLTON STATION
PROPOSED LRT TRACK
101+200 ROAD STATIONING
21+600 LRT STATIONING

25 0 50
1:2500

Refined Concept C
Relocated At-Grade LRT Crossing

Potential Development

25 Avenue SE LRT Grade Separation Study

App. C-4

D

Appendix D

SAFETY REVIEWS OF CONCEPTS

25 AVENUE & LRT GRADE SEPARATION EVALUATION OF OPTIONS

BASED ON

- SAFETY
- CONFLICTS
- OPERATIONS
- HUMAN FACTORS

PREPARED FOR

McElhanney Consulting Services Ltd

PREPARED BY

JOHN MORRALL

February 13, 2018

25 AVENUE S.E./LRT GRADE SEPARATION STUDY

1.0 BACKGROUND

The purpose of this report is to evaluate the finalized concepts of the 25 Avenue S.E./LRT Grade Separation Study, from a safety perspective. The initial 3 concepts were evaluated in October 2017 and are shown in Appendix A.

2.0 FINALIZED CONCEPTS

The finalized concepts are as follows:

Concept A: Elevated LRT
Concept B: Median Flyover to 25 Avenue S.E.
Concept B2: SB Left Flyover/Right turns at Grade
Concept C: Relocated At-Grade Crossing

Two interim options were submitted, but not evaluated as they were rejected in the initial screening process by the Calgary Stampede Board.

These were: 1) Split-T intersection and 2) zig-zag

All Concepts/Options including the “Do-Nothing” Option are shown in Appendix B.

The focus of this evaluation is on:

- Safety
- Conflicts
- Operations
- Human Factors

The evaluation does not include capital or operating costs; land acquisition; constructability and impacts during construction; and environmental impacts.

The ranking system is:

5 - Best
1 - Do Nothing (existing condition

3.0 CONCEPT A

This concept shows an elevated Erlton Station north of the relocated east leg of 25 Avenue S.E. The original concept had the LRT station elevated as well, but spanning 25 Avenue S.E. Macleod Trail and the intersections with the east and west legs of 25 Avenue S.E. are signalized.

Advantages

- At-Grade crossings with LRT are eliminated
- VRU and vehicular conflicts with LRT are eliminated
- Delays to VRU and vehicular traffic caused by LRT operations are eliminated
- The pedestrian overpass connecting the Anthem Development to the Erlton LRT Station provides a safe and direct connection

Disadvantages

- Park-and-ride and kiss-and-ride transit users will have to cross four lanes to reach the station. It is noted the original concept spanned 25 Avenue S. and did not have this disadvantage.

Summary

This concept is ranked a 5 out of 5 as it is considered the safer of the 4 concepts as all potential conflicts between VRUs and vehicular traffic are eliminated by elevating the station and LRT tracks.

Suggestion for Fig. A-1

It is suggested that Fig. A-1 would be enhanced with connections between the station and park-and-ride and kiss-and-ride. Directional arrows on all lanes are also suggested.

Show signals at Macleod Trail and the east and west legs of 25 Avenue S.E. As well show the east leg of 25 Avenue S.E. as closed as well as the west leg of 24 Avenue (it is closed, but looks open in Fig. A-1).

Access to the park-and-ride is unclear. If the kiss-and-ride drop-offs are the laybys, they should be clearly marked as such.

4.0 CONCEPT B

This concept retains the existing Erlton LRT Station and tracks as is. The existing intersection at 25 Avenue S.E.., east leg is closed. Access to/from 25 Avenue S.E. is via a two-lane, two-way elevated ramp from Macleod Trail. Macleod Trail and 25 Avenue S.E. is signalized.

Advantages

- The elevated ramp eliminates delays to vehicular traffic (e.g. SB-EB) crossing Macleod Trail and the LRT tracks as well as potential conflicts.
- The roundabout allows drivers to make return movements
- Similar to Concept A, the pedestrian overpass form Anthem Development provides a direct link to the Erlton LRT Station.

Disadvantages

- The elevated two-lane, two-way ramp may experience operational problems during inclement weather (ice and snow).
- Drivers using the ramp must make a left-hand exit. This is a violation of driver expectations, but commuters will get used to it over time. Unfamiliar drivers, however, may be confused, thus the importance of adequate advanced signing warning drivers to get into the left-lane if SB drivers are going to the ramp or if NB drivers are going to the turnaround.
- The NB-EB movement via the turnaround may appear to be counterintuitive to some drivers as it replaces the existing right turn NB-EB at the intersection.
- There is a potential weaving issue between WB-NB ramp traffic and NB traffic heading to the turnaround. The weaving distance appears to be short (approximately 50m).
- Pedestrians cross the LRT tracks at grade.

Summary

The main advantage of Concept B is the elimination of delays (and conflicts) caused by LRT operations. However, as the disadvantages outweigh the advantages, this concept is ranked 3 out of 5.

Suggestions for Fig. B-1

It is suggested that Fig. B-1 would be enhanced with directional arrows on all lanes. Movements would be enhanced by showing each route, including the use of 18 Avenue S.E. if a driver misses the turnaround (due to the short weave) or the left-hand exit to get to the LRT Station or 25 Avenue S.E., EB. The location and length of the weave should be shown, as it is unclear in Fig. B-1.

Show signals at Macleod Trail and 25 Avenue S.E. as well east leg of 25 Avenue S.E. as closed.

Access to the park-and-ride is unclear. Is the cul-de-sac the kiss-and-ride drop-off area?

5.0 CONCEPT B-2

Concept B-2 is a refinement of Concept B. The elevated ramp is one-way (SB-EB). The east leg of 25 Avenue S.E. is right-in/right-out. There is a barrier separating the NB curb lane from adjacent lanes preventing WB-NB drivers from weaving across all lanes to access the turnaround. Drivers WB-NB on the right-out who wish to go SB must travel NB to 18 Avenue S.E. to travel SB.

Advantages

- Concept B-2 eliminates the NB weaving conflict.
- The other advantages of B-2 are similar to Concept B

Disadvantages

- The disadvantages of Concept B-2 are similar to Concept B except that the NB weaving conflicts are eliminated.
- The WB-SB is more circuitous for Concept B-2 than Concept B, and will require more signing.

Summary

While Concept B-2 eliminates the weaving conflicts of Concept B. The WB-SB movements is more circuitous, which negates the benefits of eliminating the weaving conflicts. Consequently, this concept is ranked 3.5 out of 5.

Suggestions for Fig. B-2

It is suggested that Fig. B-2 would be enhanced with directional arrows on each lane. Each movement to and from the Erlton LRT Station should be shown with a route line. For example, SB-EB; WB-SB via 18 Avenue S.E.; NB-EB; and WB-NB.

Show signals at Macleod and 25 Avenue S.E.

Access to park-and-ride is unclear. Is the cul-de-sac the kiss-and-ride drop off?

6.0 CONCEPT C

Concept C relocates the LRT at-grade crossing to the east. The existing east leg of 25 Avenue S.E. is closed. The west leg and relocated east leg of 25 Avenue S.E. is signalized at Macleod Trail. The at-grade LRT crossing has flashing lights, bells, and gates. The Elbow River Pathway underpasses the LRT tracks, which bridges the Elbow River. A pedestrian ramp connects the Macleod Trail overpass from Anthem Development with the sidewalk on the closed east leg of 25 Avenue S.E.

Advantages

- The relocated LRT at-grade crossing should remove the LRT and vehicle conflicts on 25 Avenue S.E. and Macleod Trail.
- The pedestrian overpass on Macleod Trail provides a safe and direct connection between the Anthem Development and the Erlton LRT Station.

Disadvantages

- The at-grade LRT crossing means that there will be conflicts between cyclists and pedestrians on both east legs of 25 Avenue S.E.
- The pedestrian route (while grade-separated) from the Anthem Development to the Erlton LRT Station is fairly circuitous.

Summary

Concept C offers few advantages over the “do-nothing” option. Consequently, it is ranked 1.5 out of 5.

Suggestions for Fig. C-1

Show the signalized intersection as well as the closures with the usual symbols.

Access to park-and-ride is unclear. Locations of kiss-and-ride drop-off should be clearly marked if it is the layby by the LRT Station.

7.0 SUMMARY

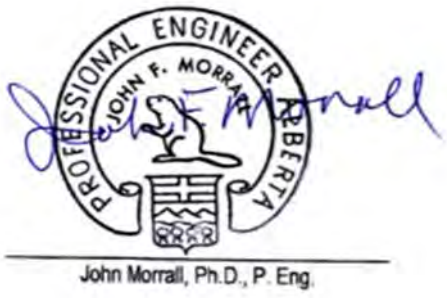
The rankings with respect to safety, conflicts, operations and human factors are as follows:

CONCEPT	RANKING
A	5.0
B	3.0
B-2	3.5
C	1.5
Do-Nothing	1.0

Concept A offers the most advantages with the least disadvantages. While Concepts B and B-2 offer some advantages over the existing conditions, both have a number of disadvantages including circuitous routing, which will require clear advance signing. In addition, elevated ramps can have operational issues during inclement weather.

Concept B-2 is marginally better than Concept B.

Concept C offers very marginal advantages over existing conditions and thus was ranked last.



APPENDIX A

Evaluation of Three Options

October 20, 2017

EVALUATION CRITERIA	OPTIONS A ELEVATED STATION (SPLIT T)	B MEDIAN FLYOVER (OR UNDERPASS)	C RELOCATED STATION AT GRADE
SAFETY VRU	(5) • Pedway over Macleod Trail • No at-grade crossing of LRT	(1) • Crosswalk on 6 lanes + 1 cut-off (Pedway conflicts with fly over) • VRUs cross LRT at-grade	(1) • Crosswalk on 6 lanes + 1 cut-off • VRUs cross LRT at-grade
SAFETY VEHICULAR TRAFFIC	(5) • No vehicle LRT conflict on 25 Avenue • Roundabout with 3 Street	(2) • SB-EB conflict with NB traffic eliminated • Roundabout with 3 Street	(1) • At-grade LRT crossing • LRT & 3 Street crossing very close
SAFETY LRT	(5) • No conflict with traffic on 25 Avenue	(5) • No conflict with traffic on 25 Avenue connection	(1) • At-grade LRT crossing on 25 Avenue
RANKING	15	8	3

EVALUATION CRITERIA	OPTIONS A ELEVATED STATION (SPLIT T)	B MEDIAN FLYOVER (OR UNDERPASS)	C RELOCATED STATION AT GRADE
CONFLICTS VRU	(5) No VRU conflicts with LRT or Macleod traffic	(2) VRU Conflicts with Macleod traffic. No LRT conflicts, except at platform	(1) VRU Conflicts with Macleod traffic & LRT
CONFLICTS VEHICULAR TRAFFIC	(3) Conflicts at signalized intersection	(4) No SB-EB conflicts with NB traffic	(1) Conflicts with signalized intersection & LRT/3 Street
CONFLICTS LRT	(5) No conflicts	(5) No conflicts	(1) Conflicts with LRT
RANKING	13	11	3

EVALUATION CRITERIA	OPTIONS A ELEVATED STATION (SPLIT T)	B MEDIAN FLYOVER (OR UNDERPASS)	C RELOCATED STATION AT GRADE
OPERATIONS VRU	(4) Direct connection to pedway via LRT station & elevated crosswalk	(1) Delays crossing Macleod & LRT	(1) Delays crossing Macleod & LRT
OPERATIONS VEHICULAR TRAFFIC	(4) Delays at signalized intersection	(5) Least delays	(1) Most Delays
OPERATIONS LRT	(5) No Delays	(5) No delays	(2) Most delays & more travel time due to longer track & curves
RANKING	13	11	4

EVALUATION CRITERIA	OPTIONS A ELEVATED STATION (SPLIT T)	B MEDIAN FLYOVER (OR UNDERPASS)	C RELOCATED STATION AT GRADE
HUMAN FACTORS VRU	(5) Pedway connects to elevated station	(1) Most circuitous route	(2) Longer pedestrian walk
HUMAN FACTORS VEHICULAR TRAFFIC	(5) Lowest driver workload	(1) Driver workload on flyover or tunnel – 8% grades & sharp curves Turnaround loop -stressful	(3) High driver workload – LRT & intersection
HUMAN FACTORS LRT	(5) Grade separated	(5) Grade separated	(1) At-grade LRT crossing
RANKING	15	7	6
OVERALL RANKING	56	37	16

- **HUMAN FACTORS INCLUDE: USER EXPECTATIONS; WORKLOAD & LOS/DELAY/EFFORT**

NOTES

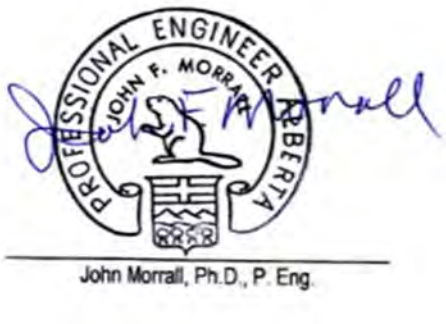
1. Costs & constructability not included in evaluation.

2. The pedway with the direct connection to the elevated station would attract the most pedestrians.

3. The pedway & the relocated station would attract the least number of users. Pedestrians do not favour pedways when they can use a crosswalk.

4. The median flyover would block a pedway over Macleod Trail.

5. The median flyover option would violate driver expectations for EB through; NB-EB & WB-SB turning movements and result in high driver workload as the routing is counter-intuitive.



John Morrall, Ph.D., P. Eng.

APPENDIX B

25 AVENUE SE & LRT CONCEPTS

E

Appendix E

TECHNICAL MEMORANDUM BY HATCH

Memo

To: Chris Knobel, P.Eng.

Company: City of Calgary

From: Jason Huck

Project Number: H-355369

Project Title: 17 Ave SE & Stampede Station (17SX)

Document: H-355369-MEM-TS-RW-001

Date: January 17, 2018

Subject: Siding Options

1 Background

Calgary Transit (CT) provided a siding track concept for Hatch's review and inclusion in the limited preliminary design and risk based estimate. See Figure 1 – CT Siding Concept. The siding is located between the Big 4 building and Erlton LRT Station, and includes a crossover on the direct fixation beside the Big 4 and another just north of Erlton. During the review process Hatch determined that the concept was likely not feasible with regards to constructability and uninterrupted operations:

- The proposed single crossover at the Big 4 is located on direct fixation (DF), on which there is an existing single crossover running the opposite direction. Hatch was informed during the concept phase that this concrete slab also is attached to deep piles due to the area's soil conditions. It is likely that LRT operations would have to be interrupted for more than one weekend to detach the existing slab from the piles and build a new track section. Simply modifying the plinths and rail to install a new crossover is also not feasible as there is a vertical curve in this section of track

- The proposed south end of siding was designed with the turnout on the existing bridge, which then ties into the siding on a new bridge. There are constructability concerns with this, but it also would add a risk of differential settlement between the bridges, affecting track stability. The existing bridge can be widened to mitigate this concern, but accommodating for a 5-LRV siding locates the turnout for the north end of siding at the Big 4 building & DF, leaving no room for a crossover.

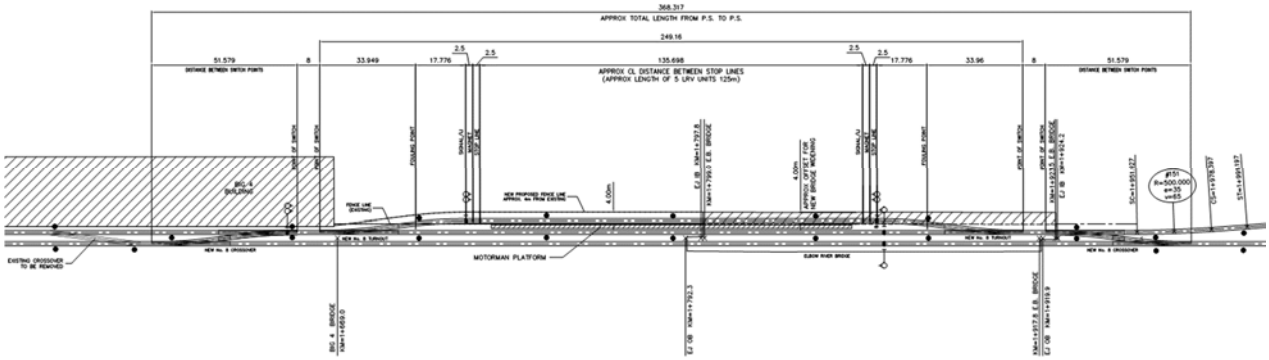


Figure 1 – CT Siding Concept

Hatch was requested to develop alternative designs for the siding and crossovers. CT evaluated the four options that Hatch developed, and subsequently confirmed that they prefer two of them (1b and 4b), but requested that Hatch describing each option and recommend one of them. Figures included in this memo have been reduced. The same figures are reproduced at full size in Appendix A.

The following are comments provided by CT (Operations, Track and Rail Systems) regarding this request:

- *Track says that Option 1b is more traditional but they don't mind either way.*
- *Rail Systems prefers Option 1b as the OCS appears to be less complex, less costly to build and less costly to maintain.*
- *Operations prefers Option 4b as it allows direct access to both mainline tracks. However, if you can fit the single crossover just south of the Big 4, Option 1b is no longer such a big concern for them.*
- *The 25th Ave Grade Separation prefers Option 1b as it appears to provide more clearance for a 4-lane t-Link roadway to Macleod Trail between the Erlton TPSS and the Erlton Station head entrance. They also mentioned that Option 1b shows an on-bridge track spacing for the siding. Can you please review that to ensure the new siding will be on its own bridge?*
- *Please show the additional crossover south of the Big 4 for Option 1b in future drawings.*

In response to the last comment above, Option 1b was revised to include a crossover south of the Big 4. This new design is labelled Option 1c and will be used for this Memo's purpose. See Figure 2 – Siding Option 1c.

2 Purpose

The purpose of this document is to describe the two preferred siding options and recommend one based on Hatch's assessment.

3 Assumptions and Track Design Parameters

- The siding track must accommodate a 5-car train. This is approximately 125m for a 5-LRV train, plus room for signals equipment and adequate space between the clearance and fouling points.
- Turnouts for the siding or crossovers can be No. 6, No. 8 or No. 12.
- Turnouts should not be located on vertical or horizontal curves, and require a minimal amount of tangent track in advance of the point of switch per the Design Guidelines.
- Track geometry should not be designed to significantly affect LRT run times if possible.
- A turnout should be located either entirely on one bridge structure/DF, or entirely off a bridge structure/DF. A turnout cannot be located partially on or off a structure, or separate structures.
- It is preferred that the crossovers for accessing the siding track are near the siding switches to mitigate excessive mainline track occupancy times and to reduce the number of interlockings.
- It is assumed that further analysis of constructing a new bridge, or expanding the existing bridge, will need to be completed after this stage of the project.
- It is assumed that the risks indicated below relating to the vertical curves north or Erlton Station can be modified per the proposed siding designs.

- It is assumed that OCS poles can be located in the fence line between Macleod Trail and the LRT ROW in a similar manner that exists currently near the Big 4 building.
- CT will be collecting survey for the Erlton area, but has indicated that Hatch is to assume the vertical geometry is acceptable for proposed special trackwork installation
- There are sliding rails, or expansion joints (EJ), directly north and south of the existing bridges. They will remain in the track and unmodified, or re-instated.
- The plan and profile information is based on the available as-builts or DAS, and is assumed to be sufficient until the next design phase.

4 Preferred Siding Options

4.1 Siding Option 1c

Summary

This siding track is east of the mainline tracks on a separate bridge. No. 6 turnouts provide access to the siding track. A No. 8 single crossover south of the Big 4 from the OB to IB track and a combination No. 6 and No. 12 single crossover north of Erlton station from the OB to IB track are provided for siding access. A mainline IB train move from Erlton will travel through the reverse side of a No. 12 switch, restricting train speed to 40km/h. This option will reduce LRT speeds in both directions at Erlton due to the vertical curve revision (20km/h), but increases to the run times will not be significant as the restrictions are situated close to Erlton station. Trains accessing the siding from the OB track are required to occupy the IB track also. A single OCS tension section will suffice for the siding and turnouts.

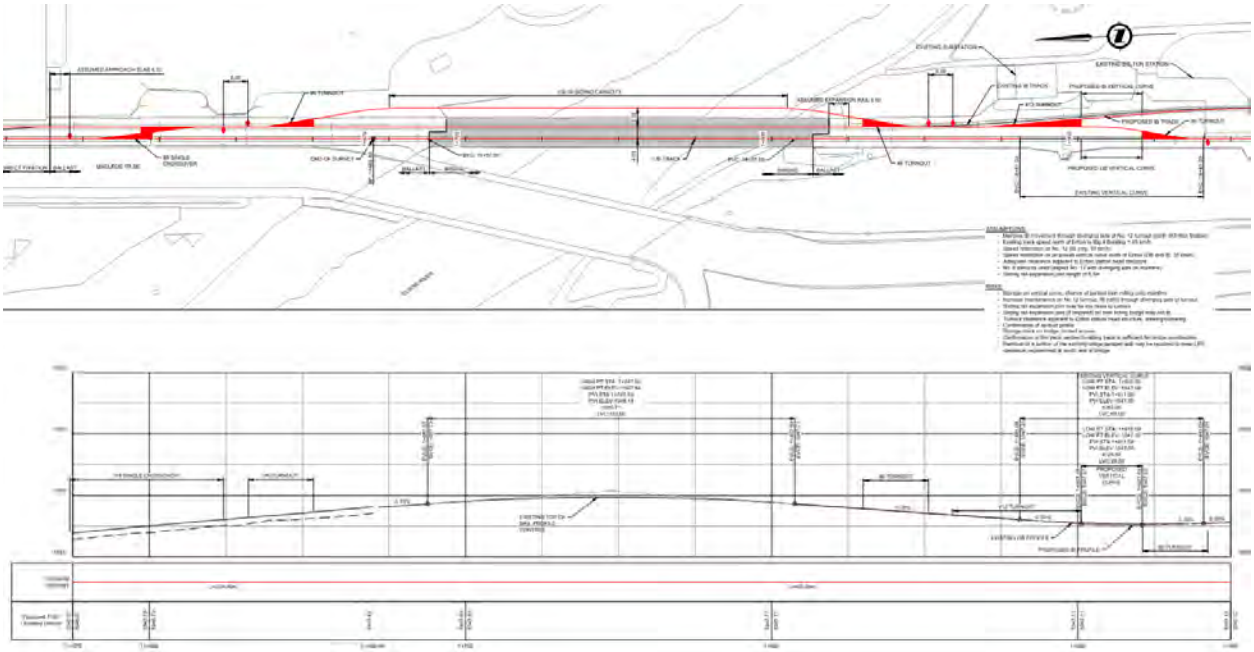


Figure 2 – Siding Option 1c

Risks

- Clearance adjacent to Erlton station head structure requires further analysis.
- It is assumed that the design of the new bridge will remove the risk of differential settlement. Further investigation of the design for the south bridge abutment is required.
- Modifications may be required to the existing IB track bridge structure (the wall on the south end) to accommodate the dynamic envelope of the train entering the siding. However, the curve in the turnout can likely be projected further (similar to O'Neil) to provide more clearance to mitigate this issue. This would provide more clearance for the new bridge construction also.
- A mainline OCS transition is situated between the bridge and Erlton, creating a potential 3-wire catenary zone due to the addition of the siding wires. An analysis of relocating the mainline transition further south to mitigate this scenario is required.
- Storage track is likely on a concave vertical curve.
- Increase maintenance on No. 12 turnout with normal movement over reverse leg.
- Sliding rail is near the turnout, and further analysis may be required.
- Confirmation of as-built plan and profile information is required for next phase.

Benefits

- All new switches/interlockings are south of the Big 4.
- Traditional siding design, with siding access from both IB and OB tracks
- Minimal re-alignment of existing tracks.
- Potential for motorman's platform to be safe distance from mainline.
- Constructability (assuming bridge structures' construction is compatible).
- Mainline track speeds south of the Big 4 are not affected.

4.2 Siding Option 4b

Summary

This siding is located on the existing IB track, and a new mainline IB track is built to the east of it on a new bridge. The new IB mainline extends the tangent track alignment in the Erlton station area, diverging back onto the existing IB track at the Big 4 via a No. 12 turnout (40km/h). The turnout to the siding from Erlton IB track is a No. 6, while both crossovers from the OB track to the siding utilize No. 8's. The vertical curve north of Erlton (on the OB track only) will have to be reduced to allow for this option. Trains accessing the siding from the OB track will not affect the IB track occupancy, and accessing it from the IB track will not affect the OB track occupancy. Maintenance access to the siding is more restrictive in this option.

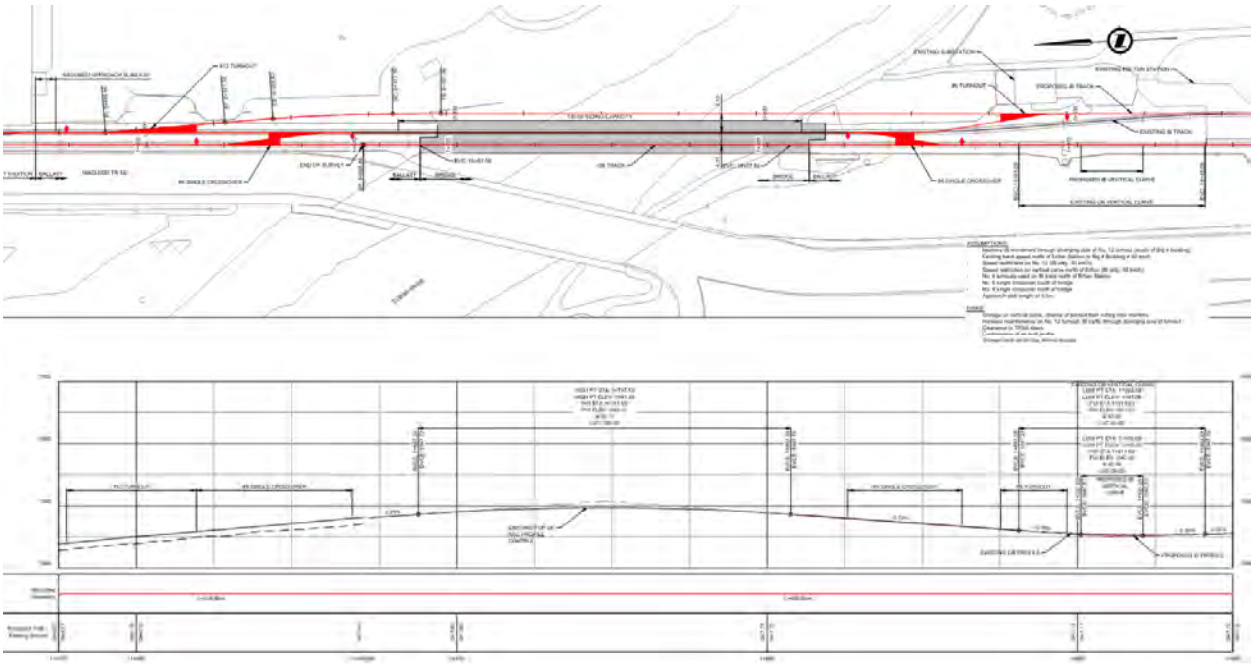


Figure 3 – Siding Option 4b

Risks

- Confirmation of clearance to the TPSS building is required. This can likely be mitigated via track geometry adjustments north and south of the IB No. 8 turnout to provide clearance, but affecting run times.
- The existing OCS poles IB39 and OBB 39 between the bridge and Erlton are feeder poles, and IB39 has balance weights. Relocating them for this siding option requires new feeder ducts and further analysis relating to the balance weights.
- This option requires a more tension sections than option 1c.
- Storage is on an existing vertical concave curve.
- Increased maintenance on No. 12 turnout.
- Confirmation of as-built plan and profile information is required for next phase.
- Motorman's platform could be situated directly beside a mainline track.
- This option requires a more tension sections than option 1c.

Benefits

- All new switches/interlockings are south of the Big 4.
- Segregated siding access from both IB and OB tracks.
- Minimal re-alignment of existing tracks.
- Constructability (assuming bridge structures' construction is compatible).
- OB track speeds are not affected.

5 Summary and Recommendation

Hatch was requested by CT to develop alternative design concepts for a new siding and crossovers between the Big 4 building and Erlton. Of the four that were produced, CT preferred two of them and requested that Hatch provide a recommendation for one of them.

Hatch recommends siding Option 1c based on the following operational requirements and cost impacts:

Operational Requirements

- Traditional siding configuration
- Minimal impact to mainline run times
- Safer motorman platform location options

Cost Impacts

- Minimal track realignment
- Simpler OCS configuration and constructability
- No concern of Erlton TPSS clearance

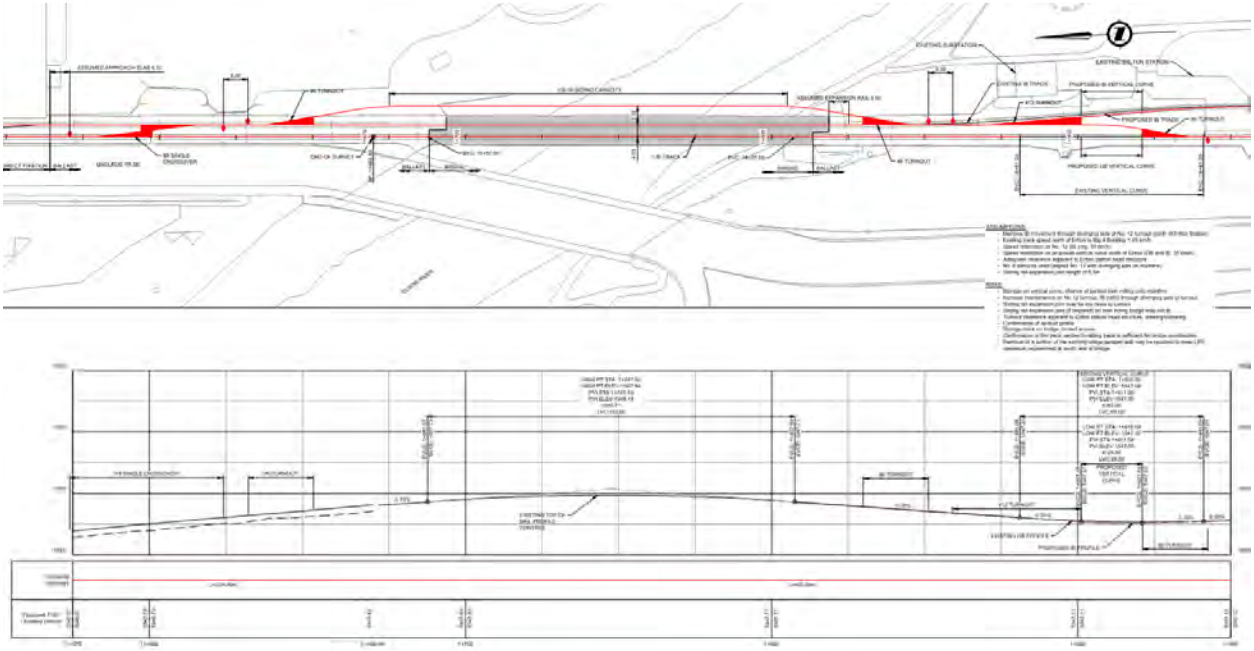
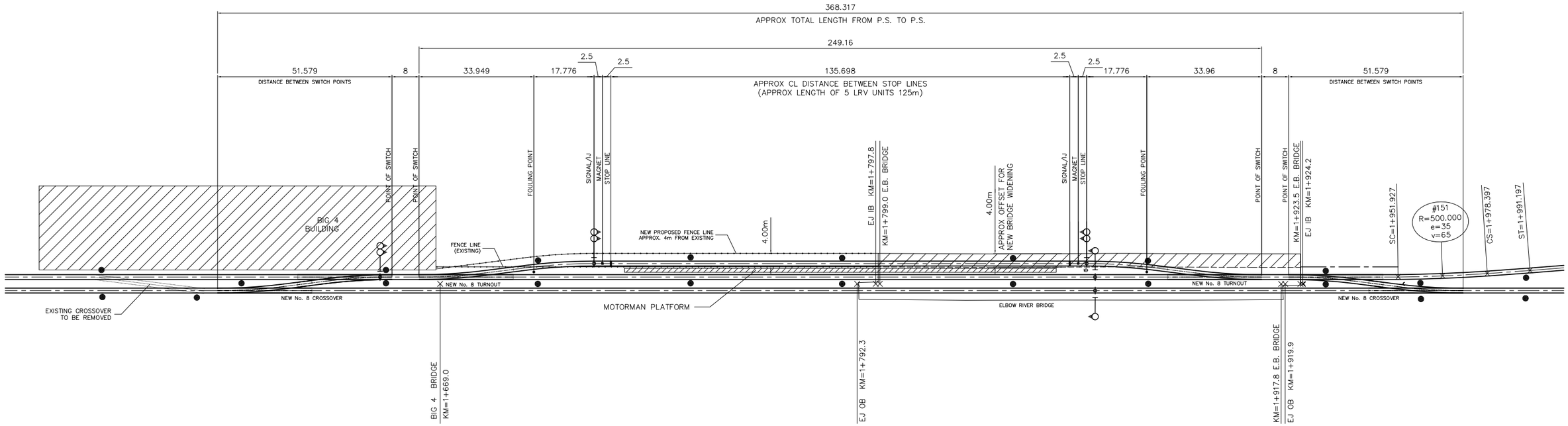


Figure 4 – Siding Option 1c

6 Next Steps

1. Analysis to determine if the clearance between the two bridges can be increased.
2. Hydrotechnical considerations for in-water pier placement.
3. Open Track modelling to determine impact to LRT run times from track realignment.
4. Assess the relocation of the mainline OCS transition at Erlton.

Appendix A



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NO.	NAME	NO.	NAME
TRANSIT PLANS		SUPPLIER'S PLANS	
ASSOCIATED PLANS			

REV.	DESCRIPTION	DATE	BY	APP'D
3	–	–	–	–
2	–	–	–	–
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REVISIONS

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE NOTED

POLICIES & PROCEDURES # –

SHEET 1 OF –

APPROVED BY:	TITLE:	DATE:
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Calgary Transit

INFRASTRUCTURE
ENGINEERING SUPPORT

Standard Plan of

STAMPEDE 'C' TRACK RELOCATION SOUTH OF BIG 4 BUILDING

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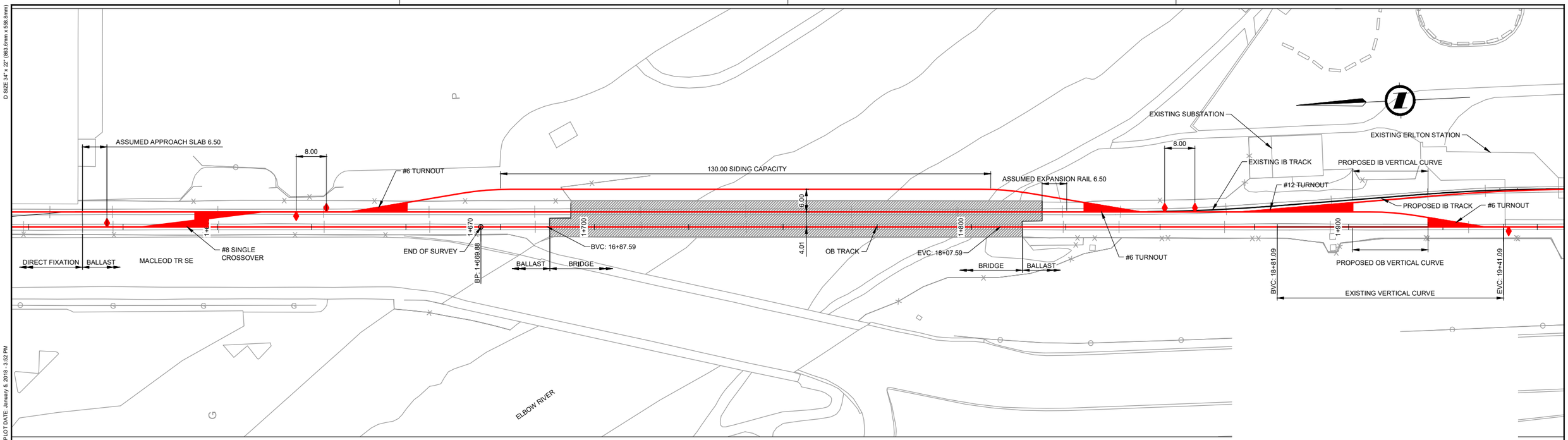
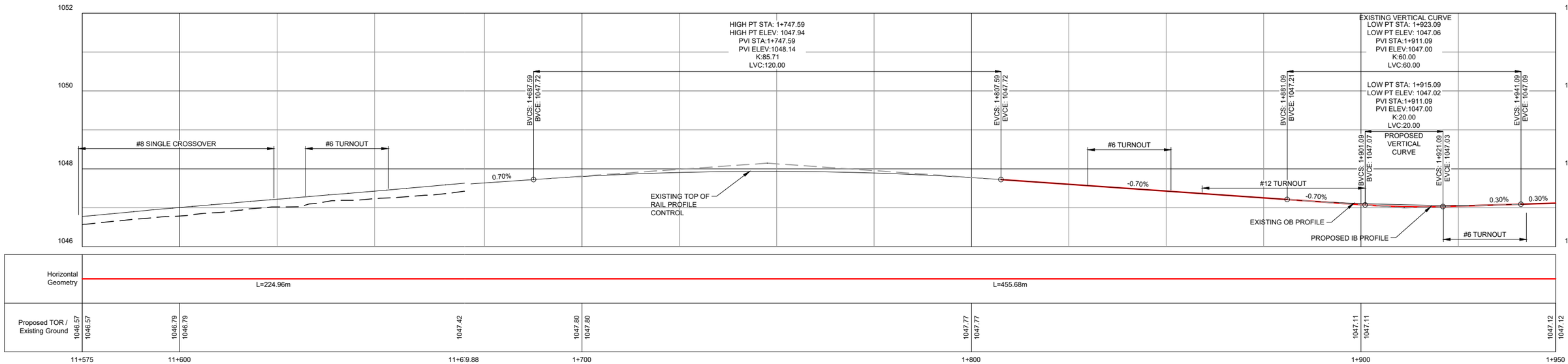
SCALE: NTS | DWG. NO. RR-31-01-0000 | SHEET 1 OF 1





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HATCH

HATCH PROJECT No. H-355369

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PERMIT TO PRACTICE No.:

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REV.	DATE	ISSUED FOR	AUTH. BY
A	2018/01/04	Issued for Discussion	-

PRELIMINARY

Calgary

17 AVENUE SE & STAMPEDE STATION (17SX)
ERLTON SIDING OPTION 1c

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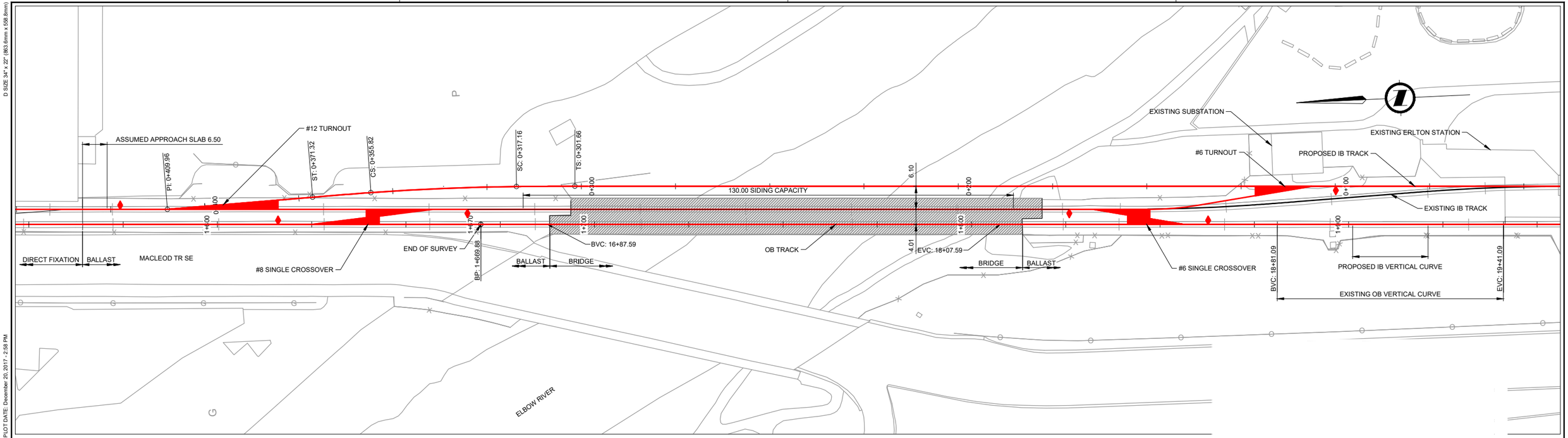
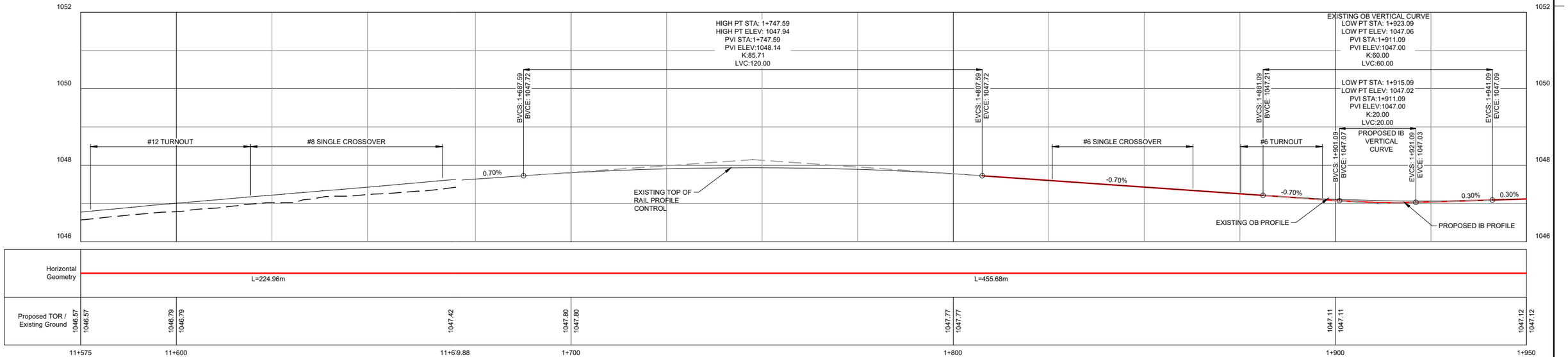
DATE: 2017/12/11	SHEET: 1 of 1		





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A	2017/12/11	Issued for Discussion	-

PRELIMINARY

Calgary

17 AVENUE SE & STAMPEDE STATION (17SX)
ERLTON SIDING OPTION 4b

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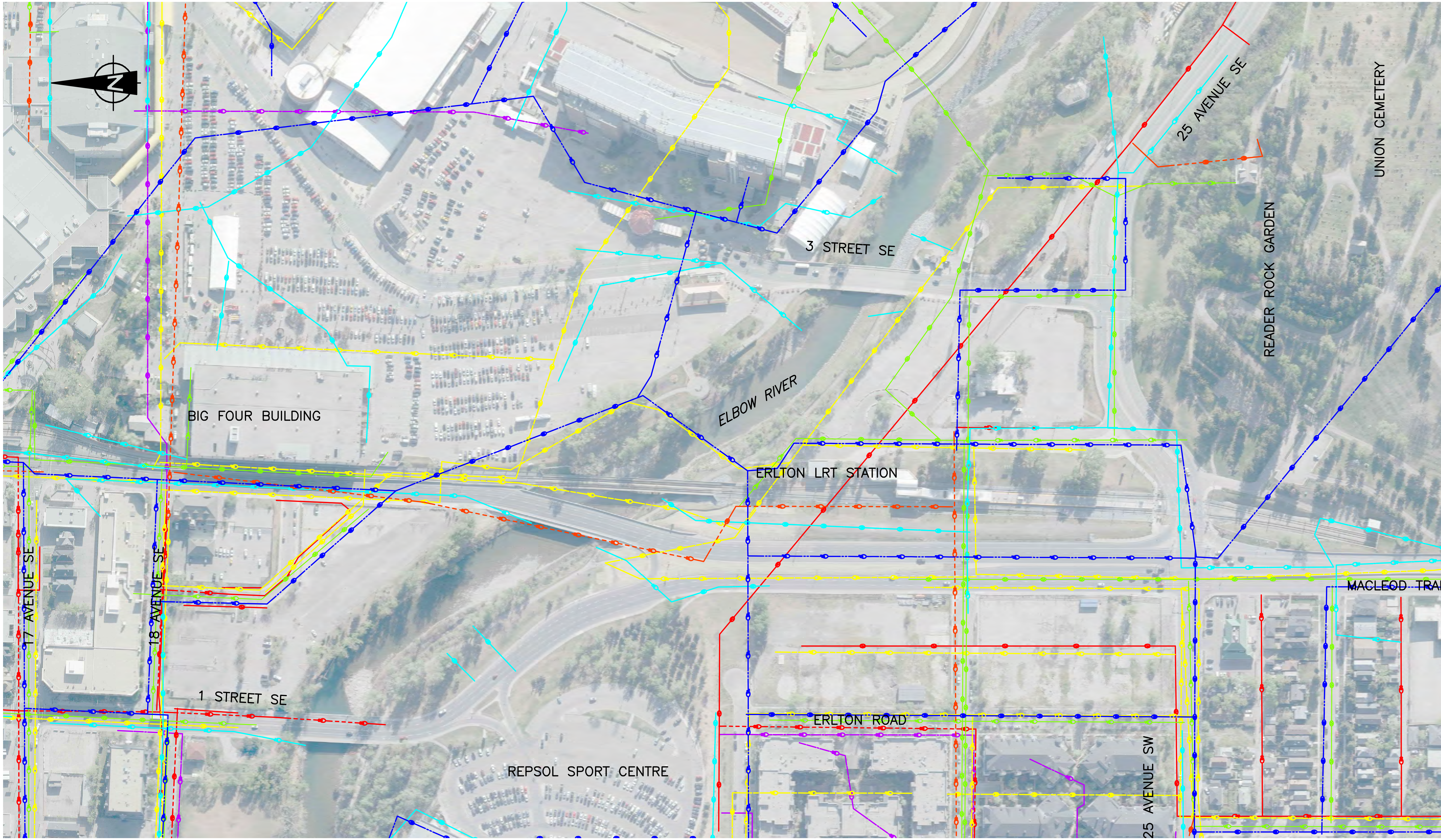
Appendix F

UTILITIES



McElhanney

CABLE
ELECTRIC (OVERHEAD)
ELECTRIC (UNDERGROUND)
GAS
TELEPHONE
SANITARY SEWER
STORM SEWER
WATER

25 0 50
1:2500

Utility Overview

25 Avenue SE LRT Grade Separation Study

App. F-1

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