



EXECUTIVE SUMMARY

STUDY OBJECTIVES & PROCESS

The City of Calgary is proposing an interchange at the junction of 16 Avenue North (Trans-Canada Highway) and 19 Street East. This intersection is one of only two junctions along 16 Avenue North between Deerfoot Trail and Stoney Trail that is not currently grade separated. The City's long range goal is to improve this section of 16 Avenue, part of the skeletal road network, by removing the at-grade intersection at 19 Street and replacing it with an interchange with appropriate connectivity.

Specifically, the following study objectives have been identified to guide the functional planning process in determining the most suitable interchange solution at 19 Street:

- » Develop a comprehensive engagement plan that allows key stakeholders and the general public to provide critical input at key study intervals to inform the study team with respect to community needs, impacts, and improvement considerations for all modes of travel;
- » Identify the various site constraints and challenges within the study area;
- » Review and assess the current and future traffic conditions within the study area;
- » Generate options for the configuration of the proposed interchange at 19 Street, including any modifications to the adjacent interchanges and the inclusion of appropriate infrastructure for active transportation modes;
- » Develop an appropriate evaluation framework to be applied to the options in order to determine the recommended solution with respect to all modes of travel;
- » Conduct the necessary analysis to support the evaluation process;
- » Prepare the functional design of the recommended solution, including horizontal and vertical geometry, active transportation infrastructure, construction staging, and implementation costs; and,
- » Document the study findings in a comprehensive report.

Given the proximity of the adjacent interchanges along 16 Avenue on either side of 19 Street, the study involved not only the development of an interchange at 19 Street but the necessary changes to the adjacent interchanges such that all three interchanges will be able to function efficiently. The study area is shown in *Figure E1*.



Figure E1: Study Area

16 Avenue NE – Deerfoot Trail to Barlow Trail Functional Planning Study Executive Summary



The study was conducted in several phases with stakeholder and public engagement solicited at each phase. The phases, along with the sub activities and key deliverables for each phase, are listed below:

Phase 1: Issue Identification / Needs Assessment

- » Site investigations
- » Existing traffic condition assessment
- » Traffic demand forecasting
- » Geotechnical investigations
- » External Stakeholder Meeting
- » Public Open House 1
- » Issue Identification Summary Report

Phase 2: Develop Options

- » Design Criteria – Technical Memorandum
- » Concept Generation – Summary
- » Option Screening – Technical Memorandum
- » External Stakeholder Workshop
- » Option Refinement
- » Option Evaluation Framework – Technical Memorandum

Phase 3: Plan Selection

- » Option Analysis and Evaluation
- » Public Open House 2
- » Option Evaluation Summary Report

Phase 4: Report Back / Functional Design

- » Functional Design - Horizontal and Vertical Geometry
- » Bridge Structure Layouts
- » Utility Relocation Plan
- » Stormwater Management Plan
- » Construction Staging Plan
- » Recommended Plan Cost Estimate
- » Public Information Session
- » Functional Planning Report

Phase 5: Refine Concept and Report Back

- » Refine Functional Design
- » Public Consultation
- » Update Functional Planning Report

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SUMMARY OF KEY ISSUES & CHALLENGES

Key issues and study challenges were derived through extensive investigations of the study area with respect to traffic operations and safety, roadway geometric issues, existing geotechnical and environmental conditions, current active transportation facilities, transit services, and site constraints. Consultation with external stakeholders at a workshop and the general public at open house events also provided further insight to the various study issues. The key study issues are summarized below.



Typical traffic conditions looking east from 19 Street



Typical traffic conditions looking west from 19 Street

- » The existing interchanges on 16 Avenue at Deerfoot Trail and Barlow Trail will be impacted by the development of a new interchange at 19 Street due to the tight spacing between the junctions.
- » The existing profile of 16 Avenue is approximately five to six percent (5% to 6%) uphill from Deerfoot Trail to 19 Street. This grade limits the number of options that can be considered for 16 Avenue without exceeding design guidelines. This section of 16 Avenue is also within a substantial cut.
- » Potential changes to the profiles of either 19 Street and/or 16 Avenue will impact the accesses in the northeast quadrant of the intersection, as they would likely need to be closed due to the grade differential. Any interchange component in the northeast quadrant of the intersection would also impact 17 Avenue.
- » There is some additional right-of-way for improved roadways to the west of the intersection and to the southeast, but there is no additional right-of-way for the roadways in the northeast quadrant of the intersection. There is also a utility right-of-way running parallel to 16 Avenue to the south.
- » A key concern raised during the public consultation was related to the need to acquire property for right-of-way for the new interchange and access. Specifically, several businesses in the vicinity of the interchange could see a loss of access with the closure of 17 Avenue and restrictions on 19 Street from 14 Avenue to 18 Avenue due to grade differentials.
- » There is a fire station located on 18 Avenue, northwest of the subject intersection. Emergency vehicles will require access to and across 16 Avenue to be able to respond to calls. There is also a Calgary Fire Department maintenance facility further west along 18 Avenue.
- » Because 16 Avenue is a main goods route through the City of Calgary, truck traffic will need to be accommodated in the design.
- » The section of 16 Avenue in the study area has been identified as part of the HOV network and a future route for the North Crosstown BRT.
- » 19 Street is a cycle route and a pedestrian corridor, with the only available crossing of 16 Avenue within the study area. All these modes of transportation must be accommodated and/or enhanced with the options created for the intersection of 16 Avenue and 19 Street.
- » Based on the analysis of existing and future traffic conditions, most movements at the 16 Avenue and 19 Street intersection operate with a poor level of service, and in 2039 the westbound through movement on 16 Avenue is failing in both peak hours.
- » The overall traffic volumes on the road network within the study area are forecast to increase by approximately five percent in the AM peak and have no significant change in the PM peak based on a comparison of the 2006 and 2039 traversal matrices provided by the City of Calgary. Increases in travel delay at the intersections and junctions within the study area are due to significant changes in the traffic patterns on the road network. For example, without changes to the road network the total network travel time is expected to increase in the PM peak by 52%.
- » The Mayland residential community to the south of 16 Avenue is concerned about shortcutting traffic along 19 Street.
- » There are numerous utilities (water, sewer, storm, electrical, gas, cable), both above and below ground in the immediate vicinity of the 16 Avenue and 19 Street intersection. There are also some potential utility conflicts at the Deerfoot Trail and Barlow Trail interchanges, depending on the proposed changes at these junctions.

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- » There are four sites to the northeast of the intersection of 16 Avenue and 19 Street that may have soil and groundwater contamination, primarily due to the presence of previous and existing fuel stations. These contaminants may extend into the road right-of-way. There is one site to the northwest of the intersection that was previously a car service station. Although the site was remediated; some groundwater contamination was discovered during recent testing. There were also additional sites (dry cleaner, salt storage, wood preservative facility) that could also have contamination within the study limits.

The initial options were developed to address the issues identified at the outset of the study and those provided by the various stakeholders.

OPTION GENERATION

The process undertaken to generate the various interchange options included an initial concept development stage, the option screening stage, and finally the option refinement stage. The refined options are those interchange configurations that were taken to the next level of detailed evaluation.

In the concept development stage, several initial options were generated for the proposed interchange at the junction between 16 Avenue and 19 Street. For each initial option, interchange improvements or modifications at the Deerfoot Trail and Barlow Trail interchanges were also included.

Adherence to the established design criteria was paramount as was the application of fundamental interchange planning and design features including:

- » Exit and entrance ramps on the right side only (mainline) which follows accepted North American conventions and driver expectations.
- » Provision of a single exit from the mainline for each interchange.
- » Full movement interchanges considered at each junction and all exit / entrance ramps being provided in pairs. By providing ramps in pairs, the return movement through the same cross street is permitted along with more direct guide signing.
- » Urban design features that permit safe crossing at intersections by pedestrians and cyclists.

In the development of the initial interchange options, a number of key themes were followed including:

- » Free flow connections between the skeletal road classifications – Deerfoot Trail and 16 Avenue east.
- » The use of collector distributor systems to minimize weaving operations along 16 Avenue.
- » Extension of the urban boulevard classification to 16 Avenue east where through traffic would travel through signalized intersections at each junction.
- » Tight diamond interchange configuration at 19 Street to avoid / minimize property impacts.
- » Split diamond interchange configurations between 19 Street and Barlow Trail to minimize structures.
- » Reconfiguration of the aged cloverleaf interchange configuration at Barlow Trail.
- » Diverging diamond interchange configuration at Deerfoot Trail / 16 Avenue.

A total of 15 initial options were developed including the preferred concept from a previous study conducted in 1986. These 15 initial options were then assessed such that a short list of options could be taken forward to the more detailed option evaluation phase of the study. The shortlisted options were then reviewed at a workshop attended by a group of external stakeholders. Based on the feedback provided by the participants, the short listed options were refined with several features of some options mixed with features from other options. The resulting hybrid short listed options, renamed Options 1, 2, 3, and 4, were approved by the City of Calgary for subsequent detailed analysis and evaluation. They are briefly described below and shown graphically in **Figures E2, E3, E4, and E5**.

16 Avenue NE – Deerfoot Trail to Barlow Trail Functional Planning Study Executive Summary



OPTION 1

Theme: Connected or “split” diamond interchanges between 19 Street and Barlow Trail to reduce conflicting traffic operations along the 16 Avenue mainline. Independent diverging diamond interchange at Deerfoot Trail.

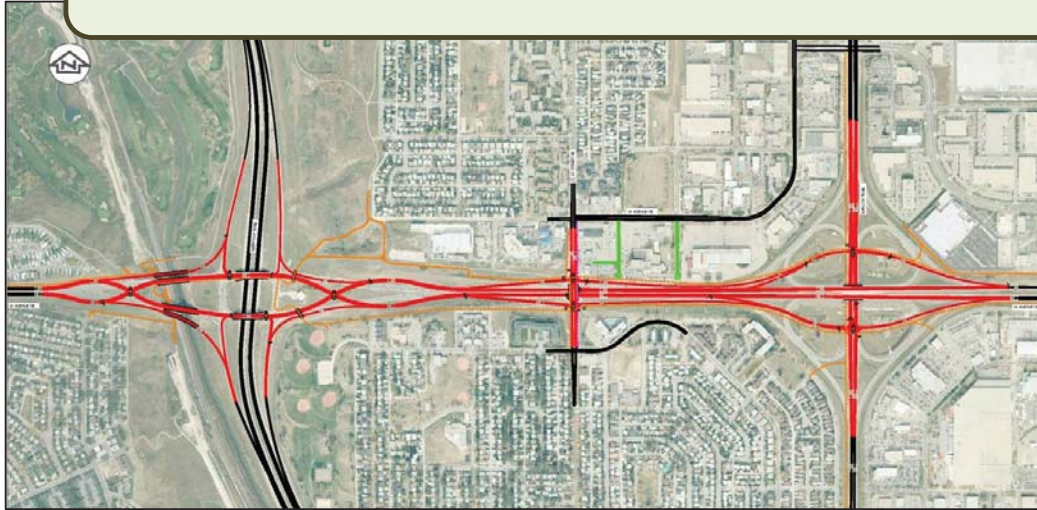


Figure E2: Option 1

Description / Key Points:

- » Diamond interchange at 19 Street:
 - 16 Avenue passing under 19 Street with limited grade change proposed on 19 Street;
 - Approximately 50 metres of separation between signalized ramp terminal intersections along 19 Street – “tight diamond”;
 - Six lane cross section on 19 Street including adjacent turning lanes;
 - Split diamond concept in conjunction with Barlow Trail interchange, therefore no direct EB on ramp to 16 Avenue and no direct WB off-ramp from 16 Avenue.
- » Reconfigured interchange at Deerfoot Trail – Diverging Diamond Interchange:
 - Two major intersections required to cross the eastbound and westbound traffic streams – minimum of three lanes in each direction;
 - Two new structures required over rail tracks / Nose Creek.
- » Reconfigured interchange at Barlow Trail – Diamond interchange configuration:
 - Approximately 200 metres of separation between signalized ramp terminal intersections along Barlow Trail allowing back to back left turn lanes between the intersections;
 - Retains existing 16 Avenue structures;
 - Split diamond concept in conjunction with 19 Street interchange, however, full movements provided for Barlow Trail traffic.
- » Pedestrian and Cycling Features:
 - Multi-use regional pathway on 19 Street crossing 16 Avenue. North south regional pathway to connect to east west regional pathways north and south of 16 Avenue. On street bike lanes on 19 Street between 14 Avenue and 18 Avenue;
 - Improved connectivity of existing east west regional pathway north of 16 Avenue between Deerfoot Trail and Barlow Trail. New east west regional pathway south of 16 Avenue between Deerfoot Trail and Barlow Trail and further east;
 - Improved pedestrian / cycling facilities and connections to existing pathways at Deerfoot Trail interchange;
 - Regional pathway along west side of Barlow Trail between 23 Avenue and Centre Avenue (approximately).

16 Avenue NE – Deerfoot Trail to Barlow Trail Functional Planning Study Executive Summary



OPTION 2

Theme: Connected or “split” diamond interchanges at 19 Street and Barlow Trail to reduce conflicting traffic operations along 16 Avenue mainline. Through movements on 16 Avenue improved to free flow with addition of third level at Deerfoot Trail interchange.

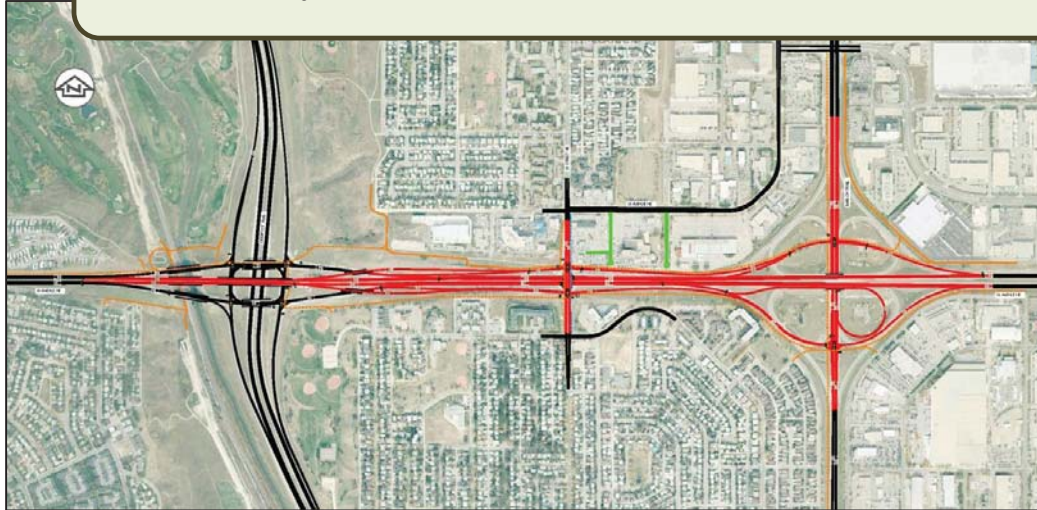


Figure E3: Option 2

Description / Key Points:

- » Diamond interchange at 19 Street:
 - 16 Avenue passing under 19 Street with limited grade change proposed on 19 Street;
 - Approximately 50 metres of separation between signalized ramp terminal intersections along 19 Street – “tight diamond”;
 - Six lane cross section on 19 Street including adjacent turning lanes;
 - Split diamond concept in conjunction with Barlow Trail interchange, therefore no direct EB on ramp to 16 Avenue and no direct WB off-ramp from 16 Avenue.
- » Through movement for 16 Avenue added as third level at Deerfoot Trail interchange:
 - Long structure required to accommodate four lane cross section of 16 Avenue over Deerfoot Trail, rail tracks, and Nose Creek. Two new structures required over rail tracks / Nose Creek;
 - Complex structures required to grade separate the ramps between the Deerfoot Trail interchange and the 19 Street interchange. “Basket weave” structures will minimize weaving operations.
- » Reconfigured interchange at Barlow Trail – Diamond interchange configuration:
 - Approximately 280 metres of separation between signalized ramp terminal intersections along Barlow Trail allowing back to back left turn lanes between the intersections;
 - Retains existing 16 Avenue structures;
 - Split diamond concept in conjunction with 19 Street interchange, however, full movements provided for Barlow Trail traffic;
 - Loop ramp retained in southeast quadrant to accommodate the EB to NB movement.
- » Pedestrian and Cycling Features:
 - Multi-use regional pathway on 19 Street crossing 16 Avenue. North south regional pathway to connect to east west regional pathways north and south of 16 Avenue. On street bike lanes on 19 Street between 14 Avenue and 18 Avenue;
 - Improved connectivity of existing east west regional pathway north of 16 Avenue between Deerfoot Trail and Barlow Trail. New east west regional pathway south of 16 Avenue between Deerfoot Trail and Barlow Trail and further east;
 - Improved pedestrian / cycling facilities and connections to existing pathways at Deerfoot Trail interchange;
 - Regional pathway along west side of Barlow Trail between 23 Avenue and Centre Avenue (approximately).

16 Avenue NE – Deerfoot Trail to Barlow Trail Functional Planning Study Executive Summary



OPTION 3

Theme: Connected interchanges at 19 Street and Barlow Trail to reduce conflicting traffic operations along 16 Avenue mainline. Parclo A configuration employed at Barlow Trail. Through movements on 16 Avenue improved to free flow with addition of third level at Deerfoot Trail interchange.

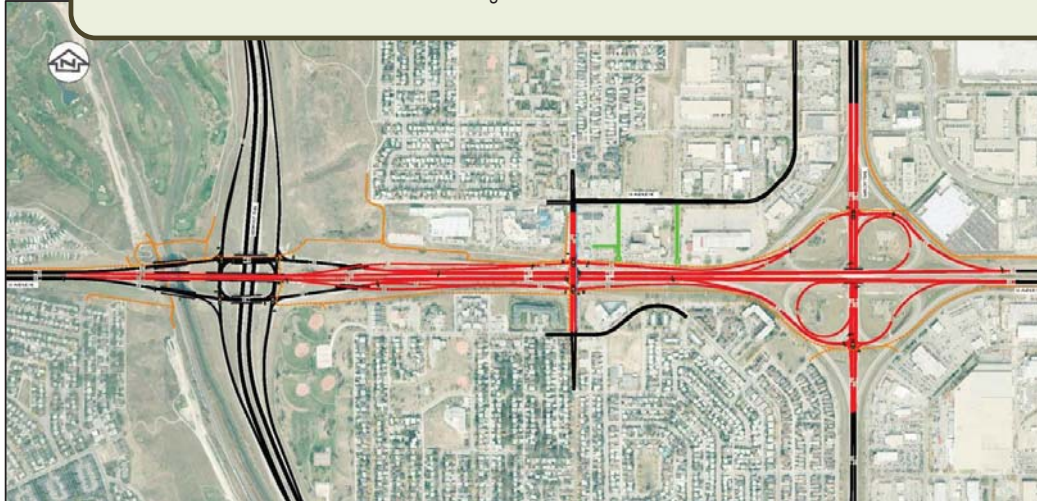


Figure E4: Option 3

Description / Key Points:

- » Diamond interchange at 19 Street:
 - 16 Avenue passing under 19 Street with limited grade change proposed on 19 Street;
 - Approximately 50 metres of separation between signalized ramp terminal intersections along 19 Street – “tight diamond”;
 - Six lane cross section on 19 Street including adjacent turning lanes;
 - Connected ramps in conjunction with Barlow Trail interchange, therefore no direct EB on ramp to 16 Avenue and no direct WB off-ramp from 16 Avenue.
- » Through movement for 16 Avenue added as third level at Deerfoot Trail interchange:
 - Long structure required to accommodate four lane cross section of 16 Avenue over Deerfoot Trail, rail tracks, and Nose Creek. Two new structures required over rail tracks / Nose Creek;
 - Complex structures required to grade separate the ramps between the Deerfoot Trail interchange and the 19 Street interchange. “Basket weave” structures will minimize weaving operations.
- » Reconfigured interchange at Barlow Trail – Parclo A configuration:
 - Approximately 350 metres of separation between signalized ramp terminal intersections along Barlow Trail;
 - Retains existing 16 Avenue structures;
 - Full movements provided for Barlow Trail traffic. Loop ramps provided in NE and SW quadrants, with direct access to 16 Avenue.
- » Pedestrian and Cycling Features:
 - Multi-use regional pathway on 19 Street crossing 16 Avenue. North south regional pathway to connect to east west regional pathways north and south of 16 Avenue. On street bike lanes on 19 Street between 14 Avenue and 18 Avenue;
 - Improved connectivity of existing east west regional pathway north of 16 Avenue between Deerfoot Trail and Barlow Trail. New east west regional pathway south of 16 Avenue between Deerfoot Trail and Barlow Trail and further east;
 - Improved pedestrian / cycling facilities and connections to existing pathways at Deerfoot Trail interchange.

16 Avenue NE – Deerfoot Trail to Barlow Trail Functional Planning Study Executive Summary



OPTION 4

Theme: Connected diamond interchanges at 19 Street and Barlow Trail to reduce conflicting traffic operations along 16 Avenue mainline. Free flow through lanes on 16 Avenue tied directly to directional ramps at the Deerfoot Trail interchange. Couplet system to provide through movement connectivity along 16 Avenue between Barlow Trail, 19 Street, and west of Deerfoot Trail.

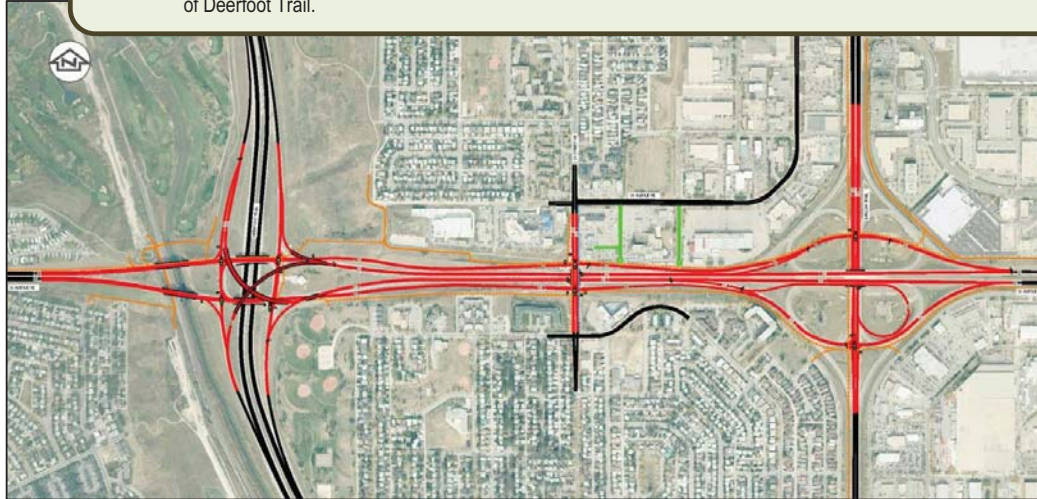


Figure E5: Option 4

Description / Key Points:

- » Diamond interchange at 19 Street:
 - 16 Avenue passing under 19 Street with limited grade change proposed on 19 Street;
 - Approximately 50 metres of separation between signalized ramp terminal intersections along 19 Street – “tight diamond”;
 - Six lane cross section on 19 Street including adjacent turning lanes;
 - Ramps act as one way couplet system for through traffic on 16 Avenue, with the north ramps providing westbound movements and the southern ramps providing eastbound movements.
- » Directional ramps added to Deerfoot Trail interchange:
 - Southbound to Eastbound directional ramp – third level structure required;
 - Westbound to Southbound directional ramp – fourth level structure required;
 - Directional ramps connect with 16 Avenue as the means to provide free flow movements between 16 Avenue East and Deerfoot Trail;
 - Other movements to / from Deerfoot Trail would continue through the existing intersections with 16 Avenue.
- » Reconfigured interchange at Barlow Trail – Diamond interchange configuration:
 - Approximately 280 metres of separation between signalized ramp terminal intersections along Barlow Trail;
 - Retains existing 16 Avenue structures;
 - Split diamond concept in conjunction with 19 Street interchange, however, full movements provided for Barlow Trail traffic (to access direct ramp connections to Deerfoot Trail);
 - Loop ramp retained in southeast quadrant to accommodate the EB to NB movement.
- » 16 Avenue with free flow lanes and couplet system (one way roads on either side of 16 Avenue):
 - Free flow lanes on 16 Avenue orientated to Deerfoot Trail;
 - Couplet system, as extension of urban boulevard provides connectivity to / from Barlow Trail; 19 Street; Deerfoot Trail.
- » Pedestrian and Cycling Features:
 - Multi-use regional pathway on 19 Street crossing 16 Avenue. North south regional pathway to connect to east west regional pathways north and south of 16 Avenue. On street bike lanes on 19 Street between 14 Avenue and 18 Avenue;
 - Improved connectivity of existing east west regional pathway north of 16 Avenue between Deerfoot Trail and Barlow Trail. New east west regional pathway south of 16 Avenue between Deerfoot Trail and Barlow Trail and further east;
 - Improved pedestrian / cycling facilities and connections to existing pathways at Deerfoot Trail interchange;
 - Regional pathway along west side of Barlow Trail between 23 Avenue and Centre Avenue (approximately).

16 Avenue NE – Deerfoot Trail to Barlow Trail Functional Planning Study Executive Summary



OPTION EVALUATION

The criteria used for comparative evaluation of the shortlisted interchange options along with the applicable indicators are summarized in the table below. The development of these criteria was described in the Evaluation Framework technical memorandum which was originally submitted in November 2013 and updated in January 2014. **Table E1** below includes the modes and indicators that the criteria will evaluate for each option. The description of each criterion and how they were applied in the evaluation of the short listed options is provided at the end of this section.

Table E1: Evaluation Criteria

Criteria	Mode	Indicator
Traffic Operations	Autos / Trucks	Hours of Total Vehicle Delay / Savings (hrs) Intersection Performance (Level of Service)
Connectivity	Pedestrians Cyclists Transit	Neutral / Minimal / Moderate / Significant Improvement or Impact
Accessibility	Pedestrians Cyclists Transit Autos / Trucks	Neutral / Minimal / Moderate / Significant Improvement or Impact
Safety	Pedestrians Cyclists Autos / Trucks	Neutral / Minimal / Moderate / Significant Improvement or Impact
Property Impacts		Number of Properties Affected Square metres of property impacted by type
Vehicle Emissions	Autos / Trucks	Tonnes of Greenhouse Gases (GHGs)
Guide Sign Complexity		Minimal / Moderate / Significant Complexity
Design Forgiveness		No / Minimal / Moderate level of forgiveness
Constructability		Minimal / Moderate / Significant Complexity
Costs		Construction Costs (\$) Property Acquisition Costs (\$) Utility Relocation Costs(\$)
Benefit / Cost		Comparison of Benefits (\$) to Costs (\$)

For each criterion, and where quantitative evaluation was not practical, impacts or improvements were evaluated in a qualitative manner using indicators relative to the base case. For this study, qualifiers ranging from "neutral", "minimal", "moderate", or "significant" were applied.

The evaluation results for each option are summarized below in **Table E2**. The table also provides a ranking or score for each criterion. Scoring was indicated as follows:



From the summary table, both Option 2 and Option 3 seem to outperform the other two options. Specifically, the most efficient option in terms of traffic operation is Option 3, followed closely by Option 2. However, in terms of connectivity and accessibility for active modes of travel, Option 2 outperforms Option 3. All other criteria are relatively similar between Option 2 and Option 3.

Based on the small difference in travel time savings and the ability to provide improved pedestrian / cycling connectivity via a north-south regional pathway along the west side of Barlow Trail, it was recommended that Option 2 be moved forward as the recommended option or plan.

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16 AVENUE NE – DEERFOOT TRAIL TO BARLOW TRAIL Final Report		Table E2: Summary of Evaluation Results			
Criteria	Base	Option 1	Option 2	Option 3	Option 4
Traffic Operations	Change in travel delay in comparison to the base case (Travel Time Savings).	2012 (AM+PM): 1,128 2039 (AM+PM): 1,594	2012 (AM+PM): 1,583 2039 (AM+PM): 3,572	2012 (AM+PM): 2,334 2039 (AM+PM): 4,057	2012 (AM+PM): -3,180 2039 (AM+PM): -3,098
Connectivity	<p>Pedestrians: Multiple regional pathways exist throughout the study area with limited connectivity on the south side of 16 Avenue.</p> <p>Cyclists: Multiple regional pathways, on street bikeways and bike lanes exist throughout the study area with limited connectivity on the south side of 16 Avenue.</p> <p>Transit: Multiple transit routes exist throughout the study area including north-south bus routes along 19 Street. Transit does not exist along 16 Avenue.</p>	<p>Significant Improvements</p> <p>Pedestrians: Significant improvements to the regional pathways with additional connections between the north and south sides of 16 Avenue and between Barlow Trail and Deerfoot Trail.</p> <p>Cyclists: Significant improvements to the regional pathways and improved bike lanes with connections on the north and south side of 16 Avenue and between Barlow Trail and Deerfoot Trail.</p> <p>Transit: The future North Crosstown BRT route proposed along 16 Avenue will significantly improve east-west transit connectivity to surrounding rapid transit routes. Transit exchanges proposed at 19 Street will connect this BRT route to the bus routes along 19 Street.</p>	<p>Significant Improvements</p> <p>Pedestrians: Significant improvements to the regional pathways with additional connections between the north and south sides of 16 Avenue and between Barlow Trail and Deerfoot Trail.</p> <p>Cyclists: Significant improvements to the regional pathways and improved bike lanes with connections on the north and south side of 16 Avenue and between Barlow Trail and Deerfoot Trail.</p> <p>Transit: The future North Crosstown BRT route proposed along 16 Avenue will significantly improve east-west transit connectivity to surrounding rapid transit routes. Transit exchanges proposed at 19 Street will connect this BRT route to the bus routes along 19 Street.</p>	<p>Moderate Improvements</p> <p>Pedestrians: Moderate improvements to the regional pathways with additional connections between the north and south sides of 16 Avenue and between Barlow Trail and Deerfoot Trail. Regional pathway along the west side of Barlow Trail is not possible.</p> <p>Cyclists: Significant improvements to the regional pathways and improved bike lanes with connections on the north and south side of 16 Avenue and between Barlow Trail and Deerfoot Trail. Due to design, a north-south regional pathway along the west side of Barlow Trail is not possible.</p> <p>Transit: The future North Crosstown BRT route proposed along 16 Avenue will significantly improve east-west transit connectivity to surrounding rapid transit routes. Transit exchanges proposed at 19 Street will connect this BRT route to the bus routes along 19 Street.</p>	<p>Significant Improvements</p> <p>Pedestrians: Significant improvements to the regional pathways with additional connections between the north and south sides of 16 Avenue and between Barlow Trail and Deerfoot Trail.</p> <p>Cyclists: Significant improvements to the regional pathways and improved bike lanes with connections on the north and south side of 16 Avenue and between Barlow Trail and Deerfoot Trail.</p> <p>Transit: The future North Crosstown BRT route proposed along 16 Avenue will significantly improve east-west transit connectivity to surrounding rapid transit routes. Transit exchanges proposed at 19 Street will connect this BRT route to the bus routes along 19 Street.</p>
Accessibility	<p>Pedestrians: Reasonable access points to community on the north side of 16 Avenue but limited on the south side.</p> <p>Cyclists: Reasonable access points to community on the north side of 16 Avenue but limited on the south side.</p> <p>Transit: Multiple transit routes exist throughout the study area and provide access to low density residential communities, recreational areas and industrial areas.</p> <p>Autos / Trucks: Vehicular access to communities on the north and south sides of 16 Avenue is limited to signalized at grade intersections along the major roads.</p>	<p>Significant Improvements</p> <p>Pedestrians: Adding regional pathways along 16 Avenue, particularly on the south side, will significantly improve pedestrian access to communities.</p> <p>Cyclists: Adding regional pathways along 16 Avenue, particularly on the south side and adding on-street bike lanes on 19 Street will significantly improve cyclist access to communities.</p> <p>Transit: Transit exchanges proposed at 19 Street and 16 Avenue will provide moderately improved access for those traveling on the existing north-south bus routes (along 19 Street) to the future North Crosstown BRT route.</p> <p>Autos / Trucks: Vehicular access to communities at 16 Avenue and 19 Street is minimally improved with the 19 Street interchange, separating the through movements on 16 Avenue from those accessing the communities.</p>	<p>Significant Improvements</p> <p>Pedestrians: Adding regional pathways along 16 Avenue, particularly on the south side, will significantly improve pedestrian access to communities.</p> <p>Cyclists: Adding regional pathways along 16 Avenue, particularly on the south side and adding on-street bike lanes on 19 Street will significantly improve cyclist access to communities.</p> <p>Transit: Transit exchanges proposed at 19 Street and 16 Avenue will provide moderately improved access for those traveling on the existing north-south bus routes (along 19 Street) to the future North Crosstown BRT route.</p> <p>Autos / Trucks: Vehicular access to communities at 16 Avenue and 19 Street is minimally improved with the 19 Street interchange, separating the through movements on 16 Avenue from those accessing the communities.</p>	<p>Moderate Improvements</p> <p>Pedestrians: Adding regional pathways along 16 Avenue, particularly on the south side, will significantly improve pedestrian access to communities. Regional pathway along the west side of Barlow Trail is not possible.</p> <p>Cyclists: Adding regional pathways along 16 Avenue, particularly on the south side and adding on-street bike lanes on 19 Street will significantly improve cyclist access to communities. Regional pathway along the west side of Barlow Trail is not possible.</p> <p>Transit: Transit exchanges proposed at 19 Street and 16 Avenue will provide moderately improved access for those traveling on the existing north-south bus routes (along 19 Street) to the future North Crosstown BRT route.</p> <p>Autos / Trucks: Vehicular access to communities at 16 Avenue and 19 Street is minimally improved with the 19 Street interchange, separating the through movements on 16 Avenue from those accessing the communities.</p>	<p>Significant Improvements</p> <p>Pedestrians: Adding regional pathways along 16 Avenue, particularly on the south side, will significantly improve pedestrian access to communities.</p> <p>Cyclists: Adding regional pathways along 16 Avenue, particularly on the south side and adding on-street bike lanes on 19 Street will significantly improve cyclist access to communities.</p> <p>Transit: Transit exchanges proposed at 19 Street and 16 Avenue will provide moderately improved access for those traveling on the existing north-south bus routes (along 19 Street) to the future North Crosstown BRT route.</p> <p>Autos / Trucks: Vehicular access to communities at 16 Avenue and 19 Street is minimally improved with the 19 Street interchange, separating the through movements on 16 Avenue from those accessing the communities.</p>
Safety	<p>Pedestrians: 28</p> <p>Cyclists: 28</p> <p>Autos / Trucks: 72</p>	<p>Pedestrians: 20</p> <p>Cyclists: 21</p> <p>Autos / Trucks: 63</p>	<p>Pedestrians: 26</p> <p>Cyclists: 25</p> <p>Autos / Trucks: 82</p>	<p>Pedestrians: 20</p> <p>Cyclists: 21</p> <p>Autos / Trucks: 83</p>	<p>Pedestrians: 28</p> <p>Cyclists: 29</p> <p>Autos / Trucks: 85</p>
Property Impacts	<p>#</p> <p>Sq.M</p>	<p>#: 5</p> <p>Sq.M: 7,115</p>	<p>#: 5</p> <p>Sq.M: 7,055</p>	<p>#: 5</p> <p>Sq.M: 7,055</p>	<p>#: 4</p> <p>Sq.M: 6,060</p>
Vehicle Emissions	<p>%</p>	<p>2012: 2.66%</p> <p>2039: 2.20%</p>	<p>2012: 0.79%</p> <p>2039: 0.01%</p>	<p>2012: -0.43%</p> <p>2039: 0.74%</p>	<p>2012: >10%</p> <p>2039: >10%</p>
Guide Sign Complexity	<p>Qualitative</p>	<p>Minimal to Moderate Complexity</p> <p>No more than three destinations at any one decision point. Signing of diverging diamond interchange may be confusing to drivers, especially with split exits to Deerfoot Trail.</p>	<p>Minimal Complexity</p> <p>No more than three destinations at any one decision point. Majority of decision points have only a single destination, in addition to the through movement.</p>	<p>Minimal Complexity</p> <p>No more than three destinations at any one decision point. Majority of decision points have only a single destination, in addition to the through movement.</p>	<p>Moderate to Significant Complexity</p> <p>Many decision points present three to four distinct destination choices and at times are presented to the driver at locations that may not meet driver expectations.</p>



16 Avenue NE – Deerfoot Trail to Barlow Trail Functional Planning Study Executive Summary



16 AVENUE NE – DEERFOOT TRAIL TO BARLOW TRAIL FUNCTIONAL PLANNING STUDY Final Report

Criteria	Base	Unit	Option 1	Option 2	Option 3	Option 4
Design Forgiveness		Qualitative	Minimal Forgiveness Diverging diamond interchange at Deerfoot Trail does not provide any forgiveness in any direction of travel.	Moderate Forgiveness Numerous opportunities at each interchange to turn around or re-enter the 16 Avenue corridor.	Moderate Forgiveness Numerous opportunities at each interchange to turn around or re-enter the 16 Avenue corridor.	No to Minimal Forgiveness Limited opportunities to turn around or re-enter the 16 Avenue corridor. Significant consequences in missing exit to 16 Avenue east of Barlow Trail.
Constructability		Qualitative	Minimal to Moderate Complexity No significant staging issues, complex structures, or the ability to accommodate traffic during construction. Utility impacts are similar to the other options as are the environmental impacts. Opportunities for interim staging of improvements.	Moderate to Significant Complexity Complex ramp configurations between Deerfoot Trail and 19 Street. Complex structures (high skew angle) along ramps. Opportunities for interim staging of improvements.	Moderate to Significant Complexity Complex ramp configurations between Deerfoot Trail and 19 Street. Complex structures (high skew angle) along ramps. Opportunities for interim staging of improvements.	Significant Complexity Complex directional ramp configuration with equally complex structures at the Deerfoot Trail interchange. Limited opportunities for interim staging of improvements.
Costs	\$		Capital: 120M Property: 10M Utility Conflict: 5M Total: 135M	Capital: 190M Property: 10M Utility Conflict: 5M Total: 205M	Capital: 195M Property: 10M Utility Conflict: 5M Total: 210M	Capital: 205M Property: 10M Utility Conflict: 5M Total: 220M
Benefits / Costs	BC	BC	BC: 0.85	BC: 1.04	BC: 1.14	BC: -0.95

DESCRIPTION OF CRITERIA

- » **Traffic Operations:** This measure was used to evaluate the traffic operations or traffic performance of each option. Detailed traffic operations models were employed to quantify the overall travel time for all vehicles travelling within the study area. This value was compared to the base case with the difference representing the travel time savings gained through the improvements proposed in each option. The higher the travel time savings meant less travel delay in the study area network and thus the most efficient option in terms of traffic operations.
In addition, level of service at each signalized intersection in the study corridor was analyzed with the results presented using industry standard indicators (average vehicle delay / intersection level of service). Also, travel times for several representative routes through the study area were generated for each option to illustrate the potential savings resulting from the proposed improvements.
Traffic operations specifically focused on vehicular travel and not multi-modal travel. Other modes such as walking and cycling were addressed under Connectivity, Accessibility, and Safety.
- » **Connectivity:** For each mode of travel listed, the level of connectivity to the adjacent communities and existing infrastructure (pedestrian / cycling facilities, transit stops) were assessed relative to the base case or existing conditions. Primary, connectivity was assessed with respect to the barriers created by 16 Avenue, Deerfoot Trail, and Barlow Trail. The level of improvement or impact was qualitatively described using Neutral / Minimal / Moderate / Significant descriptors.
- » **Accessibility:** For each mode of travel listed, the level of accessibility to the adjacent communities to / from the 16 Avenue corridor was assessed relative to the base case or existing conditions. The level

- of improvement or impact to the level of accessibility provided was qualitatively described using Neutral / Minimal / Moderate / Significant descriptors.
- » **Safety:** For each mode of travel listed, the potential improvement or impact to safety was qualitatively assessed relative to the base case or existing conditions. Where possible, quantitative values (e.g. number of conflict points) were identified to assist with the evaluation and comparison between options. The level of improvement or impact was qualitatively described using Neutral / Minimal / Moderate / Significant descriptors.
- » **Property Impacts:** For this measure, quantitative estimates of the number and type of properties impacted were identified for each option. In addition, the level of impact was identified with regards to a partial acquisition or a full acquisition. For partial acquisitions, an estimate of the area impacted was provided.
- » **Vehicle Emissions:** Vehicle emissions for each option were based on the output from the traffic operations model and the specific analysis conducted for each option. Emissions were calculated from the fuel consumption estimates for each vehicle type (autos or trucks) and by applying expansion factors to estimate greenhouse gases (e.g. CO and CO2). Values of greenhouse gases were presented in comparison to the base case.
- » **Guide Sign Complexity:** As some of the options seem to require complex movements, this measure was added to provide an indicator as to the complexity of the guide signs to provided positive way finding through the interchanges. Factors such as the number and location of signs required as well

- as the complexity of the potential text were included in the assessment of each option. The level of complexity was qualitatively described using Minimal / Moderate / Significant descriptors.
- » **Design Forgiveness:** This measure assessed whether the design of the interchanges permits some recovery movements to occur in the case where a driver makes a mistake in exiting the 16 Avenue corridor at the wrong location. The level of forgiveness was qualitatively described using No / Minimal / Moderate descriptors.
- » **Constructability:** This measure assessed the complexity of construction for each option and included the ability to stage the construction, traffic accommodation during construction, and the type of construction including complex structures, major utility relocations, or other issues which may affect schedules or add further risks. The level of constructability / complexity was qualitatively described using Minimal / Moderate / Significant descriptors.
- » **Costs:** Implementation costs for each option were estimated from the single line depictions. The implementation costs included construction of the infrastructure (roadways, structures, pedestrian / cycling facilities), property acquisition requirements, and major utility relocations costs.
- » **Benefit / Cost Ratio:** A ratio of the benefits and costs for each option was calculated. For benefits, the travel time savings was converted into monetary units by applying a generalized value of time. The travel time savings was then annualized and summed over a 25 year period. These accumulated benefits were compared to the implementation costs using appropriate net present value calculations.

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PUBLIC CONSULTATION

Engaging the public was an important component of this project and essential to the successful completion of this study. The City consulted with stakeholders and the community to determine the best recommendation for short- and long-term improvements for the intersection of 16 Avenue and 19 Street.

As previously described, the study was divided into five phases, with each phase involving both technical work and public engagement activities. *Figure E6* shows the timing of the consultation activities that took place at distinct periods of the study.

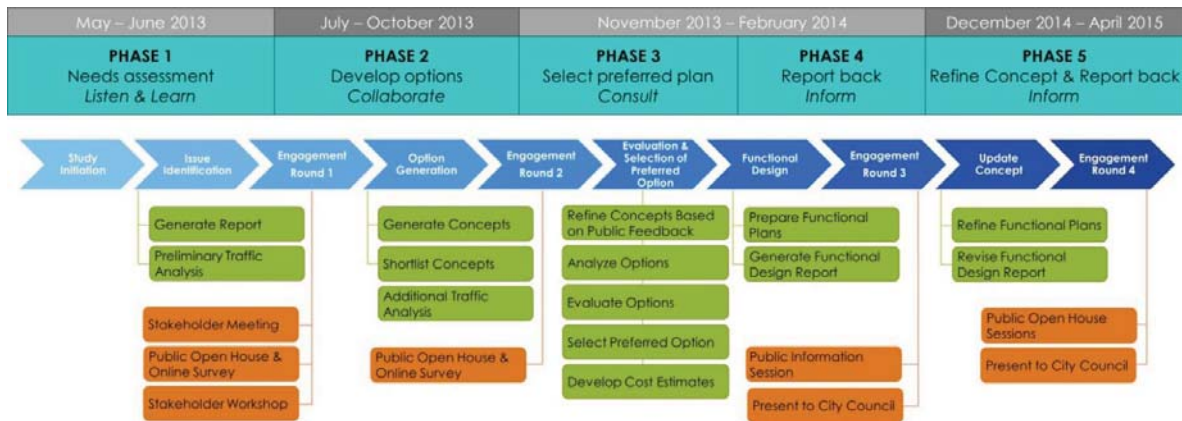


Figure E6: Study Engagement Process and Timeline

In the first phase prior to developing any options, the study team listened and learned from the stakeholders and the public as part of Engagement Round 1. From the information gathered, the study team was able to generate improvement options that would potentially meet the expectations of the adjacent communities and stakeholders while addressing the existing and forecasted corridor deficiencies. Through timely collaboration with the stakeholders which resulted in refinement of the initial options, consultation with the public was undertaken as part of Engagement Round 2. This second round of engagement invited additional input which in turn led to further refinement of the options that permitted the study team to move forward with the option evaluation process. The third round of engagement involved informing the public and stakeholders on the preferred option and thus providing an opportunity to validate the study recommendations. The fourth and final round of engagement involved seeking further comments from the public in the adjacent communities to the east of the study area noting the extent of the proposed interchange improvements beyond the 19 Street intersection.

Approximately 50 key stakeholders, consisting of community, special interest group, and business representatives, were identified at the study outset. This stakeholder group was invited to provide input and work collaboratively with the project team throughout the study at the stakeholder meetings and workshops. The public engagement process also included opportunities for the larger community to provide input through the open houses and online surveys.

The open house events and information sessions were organized as informal drop-in sessions, where participants were encouraged to review display boards and discuss issues with the Study Team. These events provided the external agencies / stakeholders, property owners, business operators, and the public with the opportunity to learn about project-specific information, ask questions, share information about the study area, and identify any support for and / or concerns with the project. Collectively, more than 280 people attended an open house, information session, stakeholder meeting and / or stakeholder workshop as well as participated in online feedback opportunities during the initial three rounds of engagement. In the final round of engagement, an additional 156 people attended the three open house events and more than 35 feedback forms were received, 10 of which were submitted online.

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A summary of each major consultation activity that took place throughout the study is provided below with respect to the type of event, date, location, attendees, purpose of the activity, and critical feedback.

ENGAGEMENT ROUND 1 - STAKEHOLDER MEETING	
Date and Time	April 30, 2013 from 6:30 PM – 8:30 PM
Location	Radisson Hotel Calgary Airport (2120 16 Avenue N.E.)
Stakeholders	Community members, special interest groups, property owners, and business representatives
Number of Attendees	50 stakeholders were invited to the meeting and 27 attended
Feedback Forms	21 feedback forms were submitted
Purpose of Meeting	Introduce the project team; provide current and historical information about the project; identify issues, concerns and additional stakeholders; and, gather feedback on the proposed public engagement process.
Online Needs Assessment Survey	In addition, prior to the meeting, an online needs assessment survey was emailed to the participants. Between April 11 and April 25, 14 stakeholders responded to the survey and the feedback was incorporated into the meeting summary.
Stakeholder Feedback	<ul style="list-style-type: none"> – Pleased with the information presented at the meeting and the public engagement process. – View traffic congestion and business/community access as the issues of highest concern. The issues most frequently identified as moderate concerns were aesthetics or community enhancements, safety for pedestrians, motorists and cyclists, and motor vehicle speed. – Signal cycles at the intersection of 16 Avenue and 19 Street N.E. should be longer, specifically the advance left turns, as these results in increased congestion. – Prefer weekday evening meetings between 5 p.m. and 9 p.m. for future meetings.

ENGAGEMENT ROUND 1 - PUBLIC OPEN HOUSE #1	
Date and Time	May 22, 2013 from 5:30 PM – 8:30 PM
Location	Crossroads Community Association (1803 14 Avenue N.E.)
Stakeholders	Public
Number of Attendees	117 people attended
Feedback Forms	59 feedback forms were submitted
Purpose of Open House	Learn about the project and the engagement process, and provide input about the community's needs, concerns or issues.
Online Consultation	Parallel to the open house, the public was invited to complete feedback forms online provided on the project website calgary.ca/16ave19st. Between May 22 and June 7, 2013, 49 feedback forms were submitted. Feedback was incorporated into the open house summary.
Public Feedback	<ul style="list-style-type: none"> – Many participants who provided input live near the intersection. – The majority of respondents (94%) use the intersection as a motorist, 70% of those use it daily. – The top transportation issues identified by respondents as moderate or high concerns were traffic congestion (85%), safety for motorists (72%) and safety for pedestrians (71%). – The top transportation issues respondents said need to be addressed in the short-term (3 to 5 years) intersection improvements were traffic congestion, frequency of advance signals at 16 Avenue and 19 Street N.E. and increasing capacity of turning lanes at 16 Avenue and 19 Street N.E. – Respondents most frequently cited shortcutting through the community and traffic signals in the area as additional concerns with the intersection. – Evaluation criteria most important to respondents were community access, traffic safety & operations, and walkability. – The majority of respondents (86%) feel the public engagement process provides enough opportunities for input. – The majority of respondents (71%) were pleased with the information provided at the public open house and felt the information presented helped them better understand the scope of the project (86%).

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ENGAGEMENT ROUND 2 - STAKEHOLDER WORKSHOP	
Date and Time	September 11, 2013 from 6:30 PM to 8:30 PM
Location	Crossroads Community Association (1803 14 Avenue N.E.)
Stakeholders	Community members, special interest groups, property owners, and business representatives
Number of Attendees	59 stakeholders were invited to the meeting and 10 attended
Feedback Forms	3 feedback forms were received
Purpose of Workshop	Gather input from stakeholders to be used to refine and select the short listed options for further development and subsequent evaluation.
Online Survey	Following the workshop, participants were invited to complete an online survey. Feedback was incorporated into the workshop summary.
Stakeholder Feedback	<ul style="list-style-type: none"> – Rated options D, A and H or J as their top choices, in that order. – Some felt the Diverging Diamond interchange was confusing for motorists, and counter-intuitive. – Prefer options that provide free-flow traffic on 16 Avenue. – The Split Diamond interchange at 19 Street and Barlow Trail requires motorists to choose destinations very early and may be confusing for motorists. – Liked options that provided all movements at all intersections.

ENGAGEMENT ROUND 2 - PUBLIC OPEN HOUSE #2	
Date and Time	December 4, 2013 from 5 PM to 8 PM
Location	Vista Heights School (2411 Vermillion Street N.E.)
Stakeholders	Public
Number of Attendees	60 people attended
Feedback Forms	Seven feedback forms were submitted
Purpose of Open House	Review project details and to present information on: public feedback from the first open house, issues and challenges, a review of the options, proposed option evaluation criteria, and next steps.
Online Consultation	Parallel to the open house, the public was invited to complete feedback forms online provided on the project website calgary.ca/16ave19st. Between December 4 and 19, 2013, Ninety-four (94) feedback forms were submitted but the majority was incomplete. Feedback was incorporated into the open house summary.
Public Feedback	<ul style="list-style-type: none"> – The majority of respondents (72%) live within the study area and nearly half (47%) of open house attendees were from Mayland Heights. – Almost all respondents had no comments or felt the proposed changes to the multi-use pathways were satisfactory. – Many respondents had "no comments" about the transit exchange. – All of the comments for option 4 regarding changing traffic patterns are negative. – Of the 29 people that provided a response about which option they prefer, 45% selected option 3.

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ENGAGEMENT ROUND 3 - PUBLIC INFORMATION SESSION	
Date and Time	March 13, 2014 from 5 PM to 8 PM
Location	Crossroads Community Association (1803 14 Avenue N.E.)
Stakeholders	Public
Number of Attendees	Approximately 68 people attended
Feedback Forms	34 comment forms were submitted
Purpose of Information Session	Present the recommended option, inform the community how public input was used in the decision-making process, and communicate the next steps of the project as it moves to City Council for approval.
Public Feedback	<ul style="list-style-type: none"> – The majority of respondents (72%) live near the study area. – Most respondents said the information presented met their expectations (87%). – Almost all respondents said the response to their questions was satisfactory (91%). – The majority of respondents (66%) said the recommended plan reflects some of their feedback. – The majority of respondents (68%) support the recommended plan. – The majority of respondents (87%) said the public engagement process met their expectations. – Almost all respondents (97%) said they had enough opportunity to provide feedback. – All respondents said the meeting details were provided in a timely manner. – Almost all respondents (97%) said the information presented was understandable. – The majority of respondents (57%) heard about public engagement meetings from road signs.

ENGAGEMENT ROUND 4 OPEN HOUSE #1	
Date and Time	February 19, 2015 from 5 PM to 8 PM
Location	Village Square Leisure Centre (2623 56 St N.E.)
Stakeholders	Public
Number of Attendees	Approximately 89 people attended
Feedback Forms	Six comment forms were submitted
Purpose of Open House	Present the recommended option including making residents aware of the proposed changes to the existing Deerfoot Trail and Barlow Trail interchange, inform the community how public input was used in the decision-making process, and communicate the next steps of the project as it moves to City Council for approval.
Online Consultation	Parallel to the open house events in Round 4, the public was invited to complete feedback forms online provided on the project website calgary.ca/16ave19st . Between February 19 and March 12, 2015, Ten (10) feedback forms were submitted.
Public Feedback	<ul style="list-style-type: none"> – All respondents <i>strongly agree</i> or <i>agree</i> the information presented met their expectations. – All respondents <i>strongly agree</i> or <i>agree</i> the project team's response to their questions was satisfactory. – All respondents said the recommendations reflect their feedback. – All respondents said the recommendations were understandable. – The majority of respondents (67% / 2 respondents) said they had enough opportunity to provide feedback. – All respondents said the public engagement process met their expectations. – The majority of respondents (67% / 2 respondents) said opportunities for input were provided in a timely manner. – A third of respondents (33% / 2 respondents) heard about the open houses from the councillor's office/ward webpage.

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ENGAGEMENT ROUND 4 - OPEN HOUSE #2	
Date and Time	February 25, 2015 from 5 PM to 8 PM
Location	St. Rupert School (111 Rundlehill Drive N.E.)
Stakeholders	Public
Number of Attendees	Approximately 10 people attended
Feedback Forms	One comment form was submitted
Purpose of Open House	Present the recommended option including making residents aware of the proposed changes to the existing Deerfoot Trail and Barlow Trail interchange, inform the community how public input was used in the decision-making process, and communicate the next steps of the project as it moves to City Council for approval.
Online Consultation	Parallel to the open house events in Round 4, the public was invited to complete feedback forms online provided on the project website calgary.ca/16ave19st. Between February 19 and March 12, 2015, Ten (10) feedback forms were submitted.
Public Feedback	<ul style="list-style-type: none"> – The majority of attendees (70% / 7 attendees) live near the study area. – The respondent did not participate in the 2013/1014 engagement process. – The respondent said they <i>agree</i> the information presented was understandable. – The respondent said they <i>agree</i> the project team's response to their questions was satisfactory. – The respondent said they <i>agree</i> the information presented met their expectations. – The respondent heard about the open houses from five different sources: email, calgary.ca, road sign, information notice and the councillor's office/ward webpage.

ENGAGEMENT ROUND 4 – OPEN HOUSE #3	
Date and Time	March 10, 2015 from 5 PM to 8 PM
Location	Crossroads Community Association (1803 14 Avenue N.E.)
Stakeholders	Public
Number of Attendees	Approximately 57 people attended
Feedback Forms	20 comment forms were submitted
Purpose of Information Session	Present the recommended option including making residents aware of the proposed changes to the existing Deerfoot Trail and Barlow Trail interchange, inform the community how public input was used in the decision-making process, and communicate the next steps of the project as it moves to City Council for approval.
Online Consultation	Parallel to the open house events in Round 4, the public was invited to complete feedback forms online provided on the project website calgary.ca/16ave19st. Between February 19 and March 12, 2015, Ten (10) feedback forms were submitted.
Public Feedback	<ul style="list-style-type: none"> – More than half of attendees (55% / 31 attendees) live in Mayland Heights. – Almost all respondents (95% / 17 respondents) <i>agree</i> or <i>strongly agree</i> the project team's response to their questions was satisfactory. – Half of respondents (50% / 7 respondents) said the recommendations reflect their feedback. – The majority of respondents (90% / 17 respondents) <i>agree</i> or <i>strongly agree</i> the information presented met their expectations. – Almost all respondents (87% / 14 respondents) said they had enough opportunity to provide feedback. – Almost all respondents (94% / 16 respondents) said opportunities for input were provided in a timely manner. – Most respondents (89% / 16 respondents) said the public engagement process met their expectations. – All respondents said the recommendations were understandable. – More than half of respondents (52% / 12 respondents) heard about the open houses from road signs.

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RECOMMENDED PLAN

A functional design was completed for the recommended plan to clearly demonstrate the horizontal and vertical geometry of each roadway element within the recommended plan and the interaction of each within the confines of the existing right-of-way. A complete functional design also permits the identification of any associated impacts to the existing physical infrastructure and adjacent properties.

The recommended plan for the new interchange at 19 Street and 16 Avenue also involves improvements at the existing interchange with Deerfoot Trail as well as the reconfiguration of the existing interchange at Barlow Trail. The recommended plan is shown in **Figure E7**.

OVERVIEW

A fundamental objective identified early in the study was to maintain access between 16 Avenue and each of the three north south roadways: Deerfoot Trail, 19 Street, and Barlow Trail. The recommended plan meets this fundamental objective by providing direct access between 16 Avenue and the closely spaced crossing roadways through a combined interchange solution with interconnecting ramp configurations. The key components and features of the recommended plan include:

The construction cost for the recommended plan is estimated to be just over \$201 M.

- » Through lanes on 16 Avenue provided on a new four lane structure located over the existing Deerfoot Trail interchange;
- » Basket weave ramp structures incorporated in the eastbound and westbound directions to minimize weaving operations along 16 Avenue between Deerfoot Trail and 19 Street;
- » Six lane cross section on 19 Street overpass to accommodate four through lanes and adjacent left turn lanes; regional multi-use pathways are located on each side of the new overpass with bicycle lanes connecting northward to 18 Avenue and southward to 14 Avenue in both directions on 19 Street;
- » Lowered grade on 16 Avenue to pass under 19 Street, which remains at existing grade;
- » Modified split diamond interchange provided along 16 Avenue at 19 Street and at Barlow Trail, with a tight diamond configuration at 19 Street;
- » The split diamond interchange configuration at Barlow Trail permits full movements to / from 16 Avenue;
- » A loop ramp provided for the eastbound to northbound movement at Barlow Trail with two signalized ramp terminal intersections proposed along Barlow Trail;
- » Barlow Trail widened to a six lane cross section between the new south ramp terminal intersection and the existing six lane cross section south of 23 Avenue;
- » Regional pathways provided in the east west direction on both sides of 16 Avenue and in the north south direction at 19 Street and at Barlow Trail.

ACTIVE TRANSPORTATION FEATURES

The recommended plan includes extensive improvements to the connectivity of regional pathways and cycling facilities, contributing to the completion of a pedestrian and cycling network within the 16 Avenue and 19 Street corridor. The regional pathway is a 3 metre multi-use pathway open to all active transportation users. Where the pathway crosses at-grade signalized intersections, applicable markings will be used to permit cyclists to ride in the crossing along with wider than standard wheelchair ramps (3 metres wide).

The recommended improvements include both new routes and enhancements to existing pedestrian and bicycle facilities. New paths and bikeways will provide linkages between facilities in areas that were previously not served or underserved by active transportation facilities. Additional regional pathways have been provided at major roadways, connecting the pathway across major arterial crossings using signalized intersections (at 19 Street, Barlow Trail and 16 Avenue). All regional pathways include wheelchair ramps at crossings, accommodating a smooth transition between different facilities. In addition to the proposed regional pathway link, on-street bike lanes have been included on 19 Street, north and south of the new overpass structure, to improve bicycle connectivity between communities on either side of 16 Avenue.

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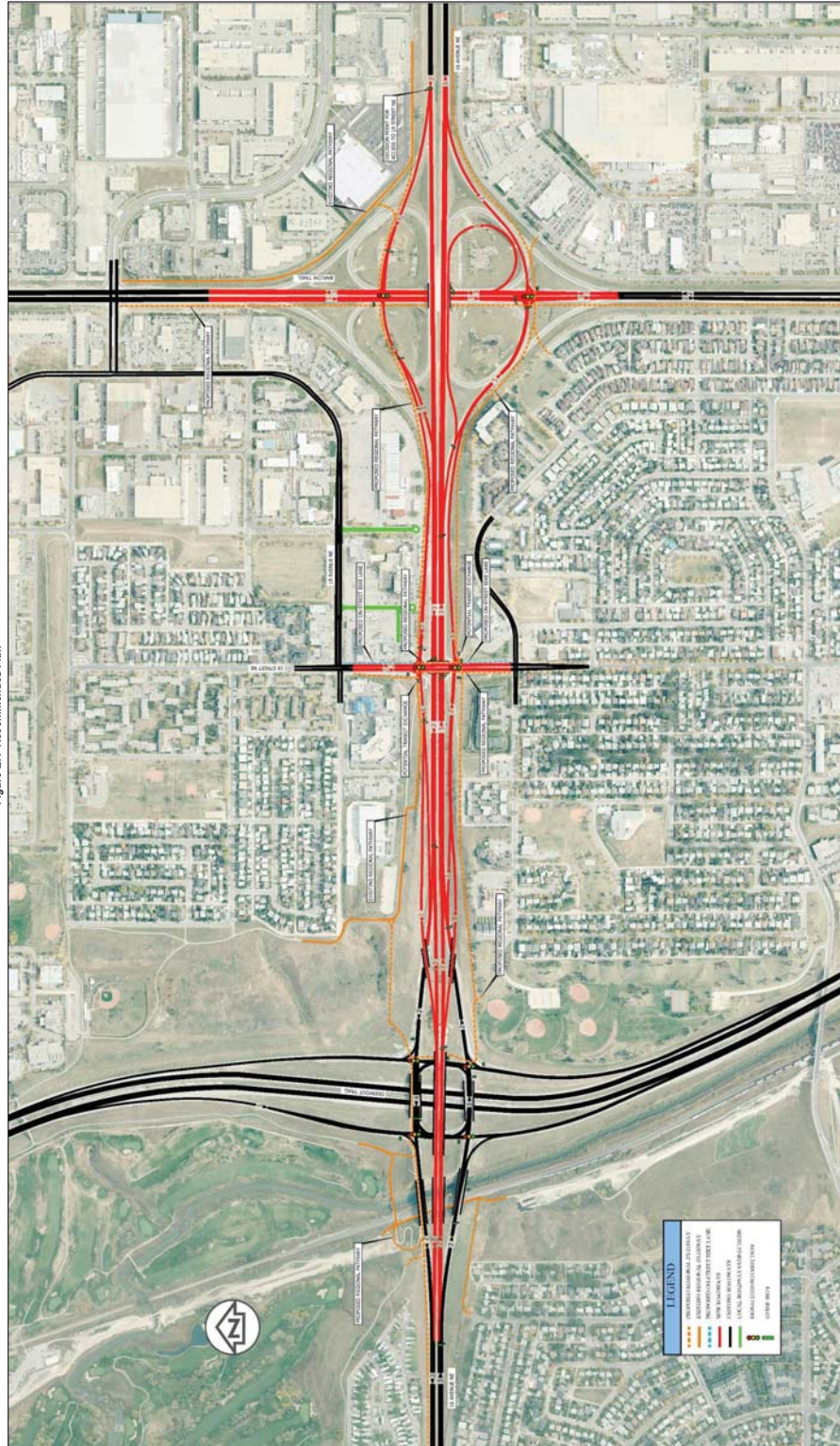


Figure E7. Recommended Plan



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East-West updates and / or additions to regional pathways and bikeways include the following elements:

- » There is currently no regional pathway east of 19 Street, but east of Barlow Trail, the pathway continues. An extension is proposed that would connect the existing segments of the east-west regional pathway via the new at-grade signalized intersections at Barlow Trail just north of 16 Avenue.
- » An east-west regional pathway on the south side of 16 Avenue connects 36 Street to Deerfoot Trail and beyond. This pathway would cross Barlow Trail and 19 Street at new at-grade signalized intersections running parallel to 16 Avenue.
- » An east-west regional pathway that runs along the north side of 16 Avenue west of 19 Street will provide a more direct alternative to the existing pathway for westbound and eastbound travellers.
- » An east-west regional pathway on the south side of 16 Avenue would connect 19 Street to Deerfoot Trail and beyond, crossing Deerfoot trail at signalized at-grade intersections on the south side of 16 Avenue.

North-South updates and / or additions to regional pathways and bikeways include the following elements:

- » A north-south regional pathway running along the west side of Barlow Trail between 23 Avenue and Centre Avenue.
- » A north-south regional pathway that runs along the west side of 19 Street between 18 Avenue and 14 Avenue. This facility would cross the ramp terminal intersections to the north and south of the 16 Avenue interchange and overpass. A short segment of regional pathway would also be provided along the east side of the 19 Street overpass to accommodate all active transportation users. A cross-section of 19 Street depicting the regional pathways is illustrated in **Figure E8**. North and south of the 19 Street overpass structure, a sidewalk will extend along the east side of 19 Street, to 18 Avenue NE and 14 Avenue NE. New on-street, one-way buffered bike lanes (0.5 metre buffer + 1.5 metre lane) are also provided on 19 Street in both directions, north and south of the ramp terminal intersections. The existing pedestrian overpass will be removed and replaced with the regional multiuse path on the new 19 Street overpass structure.

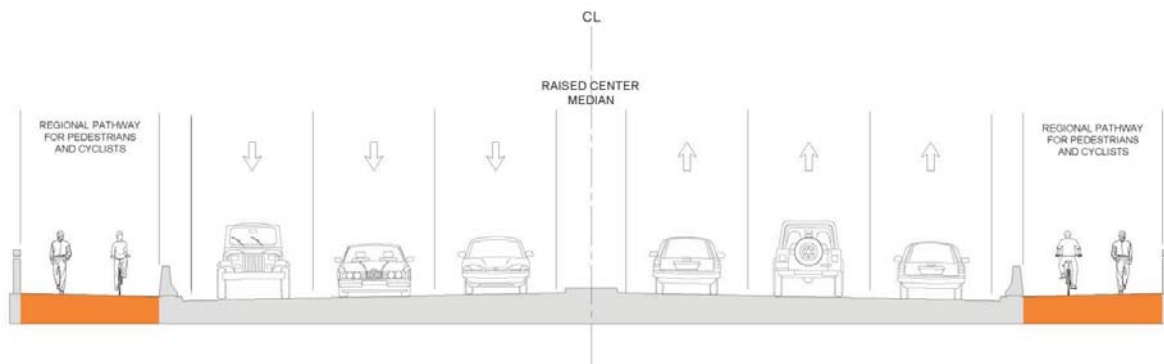


Figure E8: 19 Street NE Cross-Section

TRANSIT FACILITIES

Existing transit service along 19 Street is anticipated to continue with the proposed interchange at the intersection with 16 Avenue. With the proposed interchange at 19 Street and 16 Avenue, the bus stops for the existing transit services will be relocated to either side of the ramp terminal intersections.

It is proposed that the routing for the future North Crosstown Bus Rapid Transit (BRT) service along 16 Avenue will follow the future exit / entrance ramps between 16 Avenue and 19 Street to intersect the existing north south transit services along 19 Street. A far side transit exchange would be provided along the westbound on ramp from 19 Street to 16 Avenue westbound. This stop would permit efficient transfers between the BRT service and the north / south transit service on

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19 Street given the proposed nearside (southbound) and optional far side (northbound) proposed bus stops at the north ramp terminal intersection at 19 Street.

Similarly, a far side transit exchange would be provide along the eastbound entrance ramp from 19 Street to 16 Avenue eastbound which would again permit efficient transfers between the BRT service and the north / south transit service on 19 Street given the proposed nearside (northbound) and optional far side (southbound) bus stops at the south ramp terminal intersection at 19 Street.

PROPERTY IMPACTS

With the recommendation to lower 16 Avenue under 19 Street, and to maintain 19 Street at the current grade level, the potential for property impacts were significantly reduced. Only one property located north of 16 Avenue between 19 Street and Barlow Trail is anticipated to be impacted by the interchange configurations forming the recommended plan. No impacts are anticipated in providing a formal sidewalk on the eastside of 19 Street north of 16 Avenue. The anticipated property impact is limited to a narrow strip of right-of-way which would be required from the following lot as described below and shown in **Figure E9**:

- » Crossroads Furniture Gallery Parking Lot (2222 18 Avenue NE) – 924643 Alberta LTD.
 - Narrow strip adjacent to 16 Avenue (19 Street westbound ramp)
 - Total Area = 0.19 hectares
 - No impacts to existing access

Environmental impacts are anticipated with respect to the gas station property located in the northeast quadrant of the north 19 Street ramp terminal intersection.

Potential surplus lands due to modifications at the Barlow Trail interchange are shown on **Figure E10**. The actual amount of surplus land will depend on future decisions by the City.

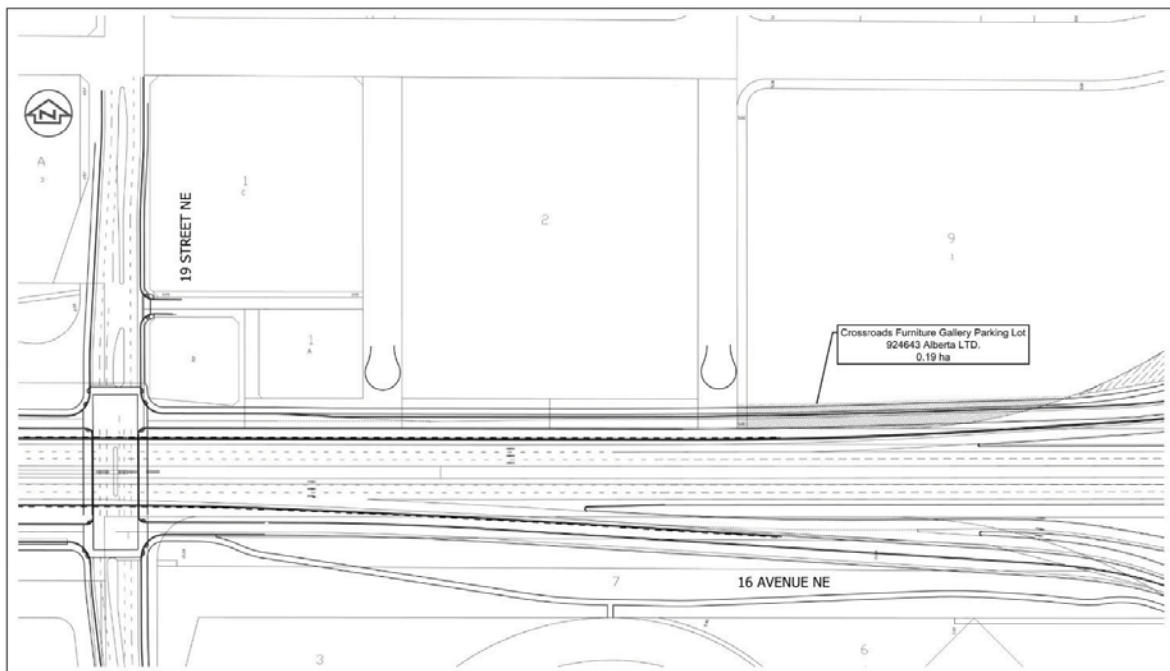


Figure E9: Property Impacts

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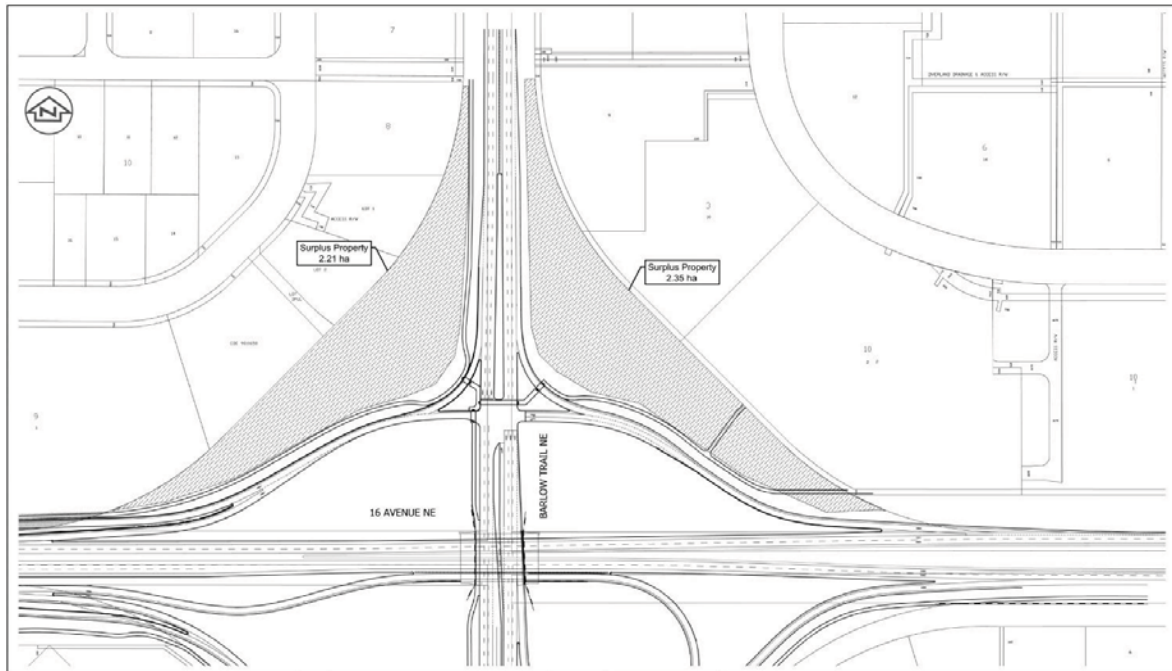


Figure E10: Surplus Property

CONSTRUCTION COST ESTIMATE

The improvements to the existing Deerfoot Trail and Barlow Trail interchanges, in addition to the creation of a new interchange at 19 Street and 16 Avenue, have been estimated using unit costs based on similar design projects. The costs for property acquisition, major utility relocation and environmental mitigation have also been estimated. The overall construction cost for the recommended plan, based on the functional design, is estimated to be approximately \$201 million.

A breakdown of the key components is provided below:

Grade Construction	\$50,000,000
Structures	\$92,500,000
Property Acquisition	\$1,000,000
Utility Impacts	\$7,000,000
Other Provisions	\$4,000,000
Contingency (30%)	\$46,500,000
Total	\$201,000,000

CONSTRUCTION STAGING

To develop a possible construction staging strategy, the recommended plan was reviewed with respect to a number of key issues and challenges including utility conflicts, property impacts, costs, and overall ease of construction. Through this review, four distinct stages were identified in which the recommended plan could be delivered over a number of years. The four distinct stages for delivering the recommended plan are illustrated in **Figures E11, E12, E13 and E14**.

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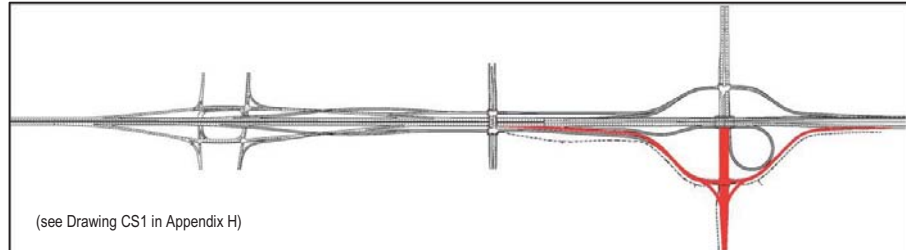


Figure E11: Stage 1 – Short Term Improvements at 19 Street Intersection / Barlow Trail Interchange

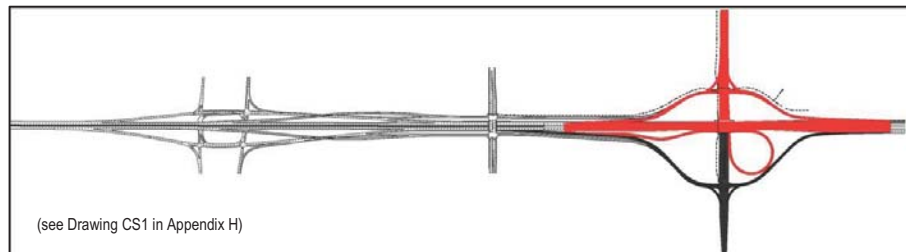


Figure E12: Stage 2 – Completion of Barlow Trail Interchange and Major Utility Relocations

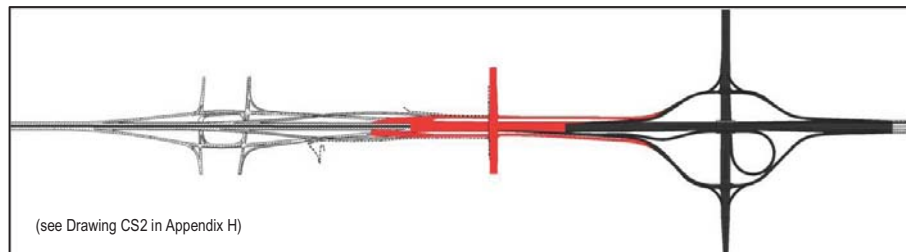


Figure E13: Stage 3 – Completion of 19 Street Interchange

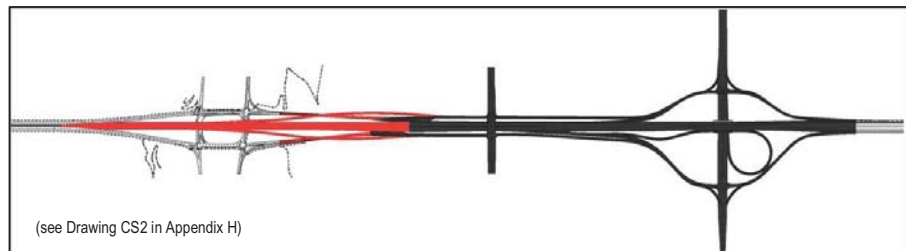


Figure E14: Stage 4 – Completion of Deerfoot Trail Interchange Ramps and Structures

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The construction staging costs of the four distinct stages are shown in the breakdown below.

Phase 1

Grade Construction	\$5,500,000
Structures	\$0
Property Acquisition	\$0
Utility Impacts	\$1,800,000
Other Provisions	\$1,900,000
Contingency (30%)	\$2,800,000
Total	\$12,000,000

Phase 2

Grade Construction	\$14,400,000
Structures	\$1,200,000
Property Acquisition	\$1,000,000
Utility Impacts	\$0
Other Provisions	\$1,000,000
Contingency (30%)	\$5,300,000
Total	\$23,000,000

Phase 3

Grade Construction	\$12,400,000
Structures	\$12,700,000
Property Acquisition	\$0
Utility Impacts	\$1,900,000
Other Provisions	\$1,400,000
Contingency (30%)	\$8,600,000
Total	\$37,000,000

Phase 4

Grade Construction	\$17,500,000
Structures	\$78,500,000
Property Acquisition	\$0
Utility Impacts	\$3,300,000
Other Provisions	\$1,400,000
Contingency (30%)	\$30,200,000
Total	\$131,000,000

16 Avenue NE – Deerfoot Trail to Barlow Trail Functional Planning Study Executive Summary



Staged Construction Cost Summary

Stage 1	\$12 M
Stage 2	\$23 M
Stage 3	\$37 M
Stage 4	\$131 M
Total Staged Cost	\$203 M

The costs assumed for the four stages do not take into account increased project costs due to demobilization and remobilization between each stage should they be delivered individually and not as a single project as a whole. The difference between the total recommended plan construction cost (\$201 million) and the total staged construction cost (\$203 million) is attributed to the construction of temporary ramp connections between Stage 3 and Stage 4 and the rounding of costs for the individual stages. A surcharge of up to 5% could be added to subsequent Stages 2, 3, and 4 to allow for other project costs (e.g. mobilization) due to staging.