Bicycle Grid for Downtown Edmonton Feasibility Study: Edmonton FastTracks

Technical Assessment

Prepared for:
Edmonton City Council

Prepared by:
Stantec Consulting Ltd.

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1.0 INTRODUCTION

This report is a technical assessment to support discussion and decisions on a minimum grid of protected bike lanes in central Edmonton to provide bicycle facilities that will attract and support people of all ages and abilities.

1.1 COUNCIL MOTION

City Council made the following motion for Stantec and the City of Edmonton to assess the feasibility of a protected bike lane network in central Edmonton.

Minimum Grid for Physically Separated Bike Lane Infrastructure That Administration, in partnership with Stantec, provide an updated report on a minimum grid for physically separated bike lane infrastructure in the City of Edmonton's core and the report should include the potential use of relatively inexpensive (within existing resources) temporary infrastructure (example: bollards, mobile concrete curbs), as can be found in the City of Calgary's pilot project.	Sustainable Dev. **Due by:** Sep. 2016 Urban Planning Committee

1.2 DOWNTOWN GROWTH & VISION ZERO

Edmonton is experiencing significant population and employment growth and tremendous investment, particularly in Downtown Edmonton. With the growth, the city is changing, congestion is increasing, and transportation safety concerns are on the rise. There are a number of actions that are underway to tackle these issues related to growth, not the least of which are *The Way Ahead* and associated *Ways* plans, LRT investment, and increasing action on Vision Zero. Like many communities, Edmonton is expanding its safe systems approach to transportation through adoption of a Vision Zero policy with the **goal of zero fatalities and serious injuries**. People walking and cycling are disproportionately involved in these types of collisions and specific actions have been shown to significantly reduce the frequency and severity of collisions between people driving vehicles and those walking and cycling. One action with strong evidence of reducing serious and fatal collisions for people cycling is the provision of bicycle infrastructure, most notably infrastructure that provides physical separation from motor vehicles.

1.3 CYCLING MOTIVATORS & DETERRENTS

There is growing evidence, including significant research in Canada and findings from Alberta, that bicycle infrastructure can increase the number of people cycling which results in a broad spectrum of benefits related to health, equity, affordability, livability, environment, and many others. There has also been research into the motivators and deterrents to cycling. The findings from various studies repeatedly show the major factor deterring people from choosing to cycle is related to concerns of safety (Winters et al., 2011; Teschke and Winters, undated; Winters, 2008; Dill and McNeil, 2012; McNeil, Monsere, and Dill, 2015; Monsere et al., 2014). We have heard these same concerns from employees of Stantec as we prepare to move to a new office in Downtown Edmonton in 2018.

How can cycling safety be improved?

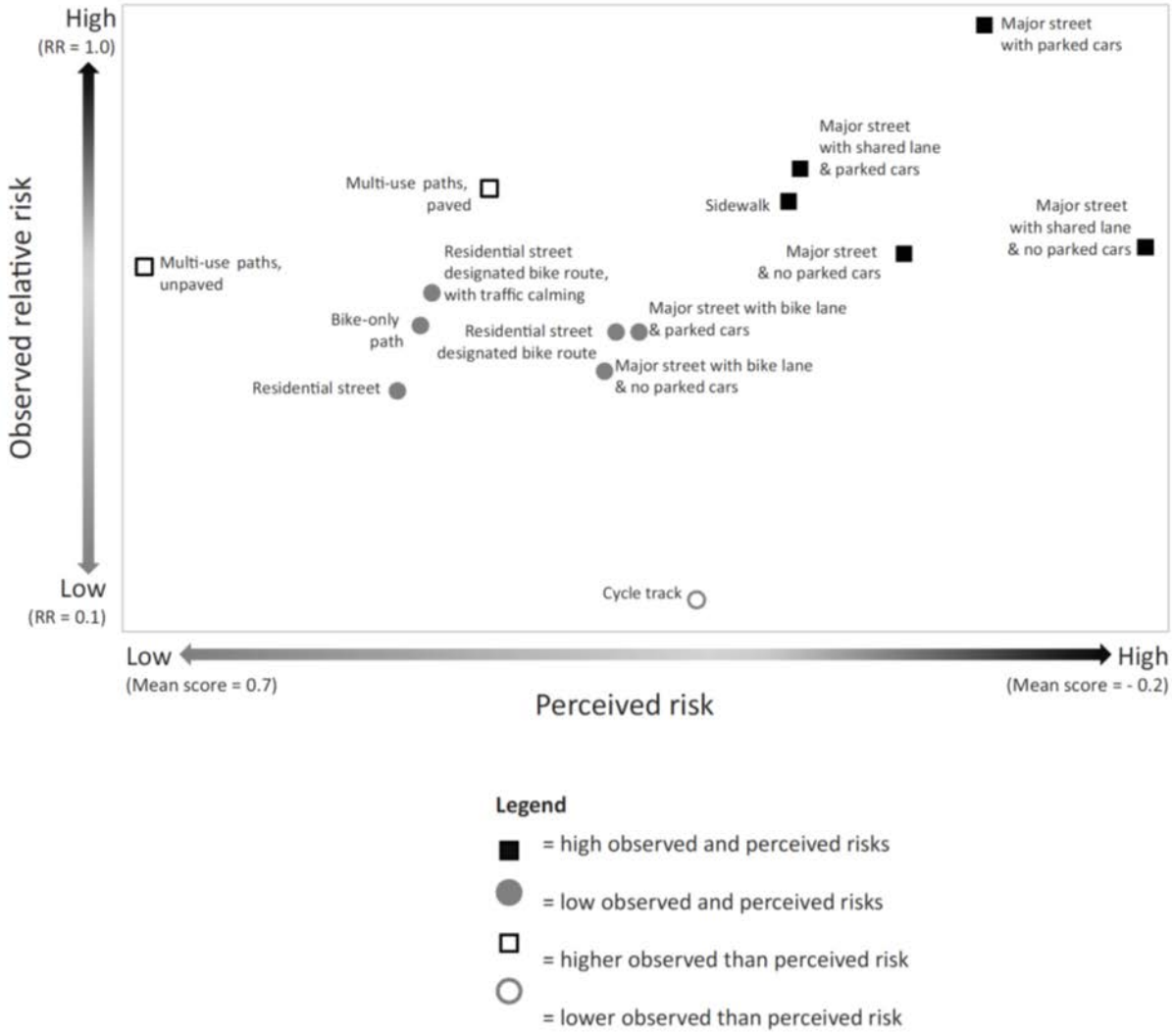
There has been substantial research that studied the relative safety of different types of bicycle facilities and factors that could impact cyclist safety (Teschke et al., 2012; Jacobsen, 2003; Harris et al, 2013; Wachtel and Lewinson, 1994; SWOV, 2010; Schepers and Voorham, 2010; Wijlhuizen, Dijkstra, and van Petegem, 2014; Furth et al., 2013; Garder, Leden, and Pulkkinen, 1998; Räsänen and Summala, 1998; Lusk et al., 2011; Schepers et al., 2011; Thomas and DeRobertis, 2013; Zangenehpour et al., 2016; Cripton et al., 2015; Fees et al., 2015). This research from Europe and North America has found that physically separated bike lanes (i.e., protected bike lanes or cycle tracks) and low traffic volume and low speed streets are safer than riding in mixed traffic without dedicated infrastructure (i.e., vehicular cycling). Findings also highlight the impact that grade, railway tracks, traffic control devices, direction of travel, motor vehicle speeds and volumes, construction activity, and other factors have on safety.

How do the perceived risks/safety compare to the observed risks/safety?

Researchers from the University of British Columbia and Simon Fraser University initiated the Bicyclists' Injuries and the Cycling Environment (BICE) study to quantify both the perceived and observed injury risk of different bicycle infrastructure types with data from Toronto and Vancouver (Teschke et al., undated; Winters et al., 2012). The findings from the study show that "route choices and decisions to cycle are affected by perceptions of safety, and we found perceptions usually corresponded with observed safety" (Winters et al., 2012). The instances where perceived and observed risk did not correspond were for off-street multi-use paths (i.e., shared use paths; perceived as safer than they are) and cycle tracks (i.e., protected bike lanes; perceived as less safe than they are). Figure 1 illustrates the findings from this Canadian study.

Based on the available research, creating a minimum grid of protected bike lanes in Edmonton would create a network of bicycle routes that will attract more people to cycling, improve safety, and achieve broader community goals. Data from the Calgary Cycle Track Network project is confirming this research.

Figure 1 Observed Risk vs Perceived Risk by Route Type (Winters et al. 2012)

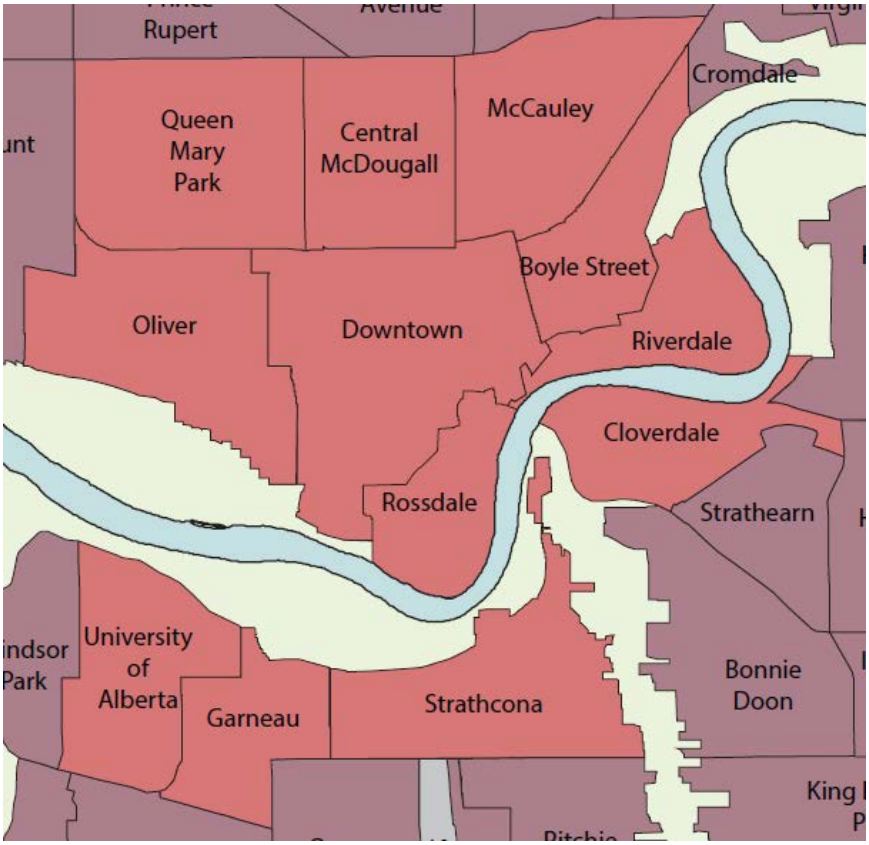


2.0 STUDY SCOPE

2.1 SCOPE OF FEASBILITY STUDY

The motion by City Council identified Edmonton's Core Neighbourhoods as being part of the study. This area includes Downtown Edmonton and its surrounding neighbourhoods and former downtown Strathcona and some of its adjacent neighbourhoods as illustrated in Figure 2.

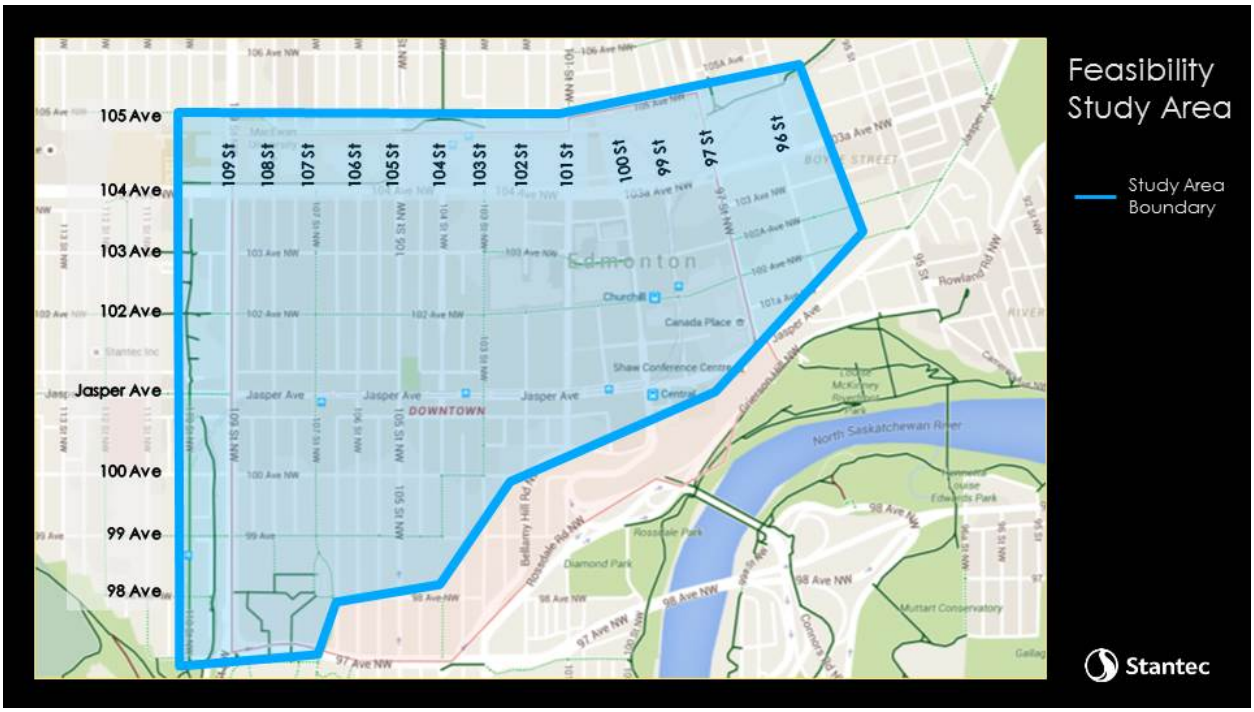
Figure 2 Map of Core Neighbourhoods



In our original scoping to complete a high level assessment for Paths for People, we had intended to deliver a technical assessment focused on identifying feasible routes for protected bike lanes in Downtown based on identifying streets where spare traffic capacity exists. To deliver the feasibility study for City Council outlined in this report, we have expanded the scope and detail of the assessment to include more thorough consideration of intersection operations, snow clearing and removal, bus service integration/impact mitigation, traffic signal equipment requirements, capital costs, and identifying next steps. This expanded scope has increased the cost to deliver the study and has limited our ability to deliver an assessment and network for the entirety of Edmonton's Core Neighbourhoods.

This report focuses on assessing the feasibility of a connected minimum grid of protected bike lanes along Downtown Edmonton streets with connections to critical regional bike routes that provide access to Downtown as illustrated in Figure 3. A second phase of the study could be completed to assess the feasibility of bike routes within the rest of Edmonton's Core Neighbourhoods.

Figure 3 Map of Feasibility Study Scope



2.2 CALGARY'S STORY

History

Calgary is nearing the end of a Council approved pilot period of a 6.5 km network of on-street cycle tracks (i.e., protected bike lanes) within the downtown. The history of how this ambitious project evolved is relevant and useful to understand for Edmonton's Downtown minimum grid of protected bike lanes.

Building on the actions of the 2011 Council approved Cycling Strategy, and an approved Council motion in 2012 to develop a network of protected bikes lanes in the downtown, City of Calgary Administration (with the help of Stantec) developed a 7.3 km network of downtown routes. The strategy was a phased implementation of the routes at a pace that staffing resources at the time could manage. In late 2013, a second annual update report on the Cycling Strategy was presented. In that report, the proposed network, including a first phase implementation of 1st Street SE, a heavily used commuter route exiting the downtown, was

presented. While analysis demonstrated that there was spare capacity to repurpose one of the four traffic lanes for bicycle infrastructure, the commuting public did not see it this way and a divisive public debate was born. When it was apparent that support for 1st Street SE was waning in the early months of 2014, and the fate of the entire cycle track network potentially in jeopardy, the idea for piloting the entire network for a 1 year period was created. This was put forward for a lengthy (12 hour) public debate in April 2014 at a committee of Council. The network pilot was then voted on by Council in May 2014 and was narrowly approved with one route (1st Street E) excluded. The approval was contingent on a robust Evaluation Plan for the pilot to help Council decide whether or not the project was a success and what its fate should be (i.e., make it permanent, leave it as it, remove it). Council also directed Administration to keep the pilot as low cost and temporary as possible. Though $7.5 million was approved to deliver the pilot project, the completed project was delivered for only $5.7 million(excluding operating costs). Based on approvals, speed of installation, and Council date reporting, the pilot will be open for about 18 months prior to Council's upcoming decision on the network's long term fate in December 2016.

Stakeholder Engagement, Research and Communication

In person and online engagement in 2013 identified priority themes for the network: connectivity, directness, safety, comfort, community context, constructability, operations. These themes influenced the Evaluation Plan.

A statistically valid telephone survey to determine public support for the project was conducted in September 2014 (before construction) and again in September 2015 (a few months into the pilot). Satisfaction was 63% in 2014 and 64% in 2015. An additional survey is planned for September 2016.

The project team led an extensive communications and education program to inform the public about the changes to the roadway and how to use the cycle tracks when walking, driving, and cycling. This included a televised "Report to Calgarians" educational commercial and a project fact sheet that reached over 60,000 stakeholders, residents, and business owners along the cycle track routes and across the Centre City.

The City also hired a seasonal team of Bicycle Ambassadors to help people walking, cycling, and driving with how to use the network safely by talking to them and providing them with educational materials to take with them. Over the summer (May to August) of 2015, the team had over 20,000 interactions with people along the project routes.

Evaluation Plan & Data Collection

A robust Evaluation Plan was developed and approved by Council in January 2015 (prior to opening). The evaluation matrix within that plan was divided into five themes: satisfaction, safety, walking/cycling/auto activities, economic vitality, and demographics. Under these five themes, nine to eleven performance measures along each route were identified. An evaluation

sheet or "report card" showing targets, baseline values, and 2015 and 2016 values was developed to easily demonstrate progress toward approved targets. A report (including these report cards) will be presented to Council in December 2016 to render a final decision on the cycle track pilot.

A significant amount of data collection is required for the Evaluation Plan which contributes to the project costs. The City's data collection staff gathered baseline data in September 2014, interim data in September 2015, and will collect final data in September 2016 using: manual counts and observations, video cameras with automated counting software, automated counters in the pavement, GPS and stopwatches. In addition, 24 hour bicycle volumes are collected through permanent automated counters that can be accessed by the public online at www.calgary.ca/bikedata.

2.3 NETWORK PRINCIPLES

The minimum grid of protected bike lanes in Downtown Edmonton has been based on the principles outlined in the Dutch *Design Manual for Bicycle Traffic* (CROW, 2007), commonly referred to as the CROW Manual. The principles and their importance are consistent with recent findings of studies related to level of service for bicycle facilities and are also being used by other jurisdictions (Foster et al., 2015; LaMondia and Moore, 2015; Transport for London, 2014; TAC, 2016). Stantec has used similar principles on projects, including for Calgary's Centre City Cycle Track Network.

- Cohesion: Important destinations and regional routes are interconnected with a complete bicycle network (i.e., route spacing of 2 to 3 blocks).
- Directness: Directness in terms of distance and travel time, minimizing the number of intersections where cyclists have no right of way, the amount of travel delay, and need for out of direction travel.
- Safety: Avoiding conflicts, managing conflicts through design and operations, and separating bicycles from motor vehicles when speeds are over 30 km/hr.
- Comfort: Encounters between people riding bikes and those driving vehicles are minimized by combining busy cycle connections as little as possible with busy vehicle connections.
- Attractiveness: Busy routes are located in areas where there is sufficient social comfort in the community.

In addition to the above principles, we also considered the ease of construction and all-seasons operation and maintenance (e.g., snow clearing) as further principles.

3.0 ASSESSMENT OF SUITABLE ROUTES

The suitability of transforming Downtown streets to provide an all ages and abilities protected bike lane network was assessed related to a number of factors prior to considering potential design options. The factors that were used for the assessment contribute to one or more of the Principles outlined in Section 2.0 and are outlined below as are the assessment findings.

3.1 SYNOPSIS OF FACTORS CONSIDERED

The following factors were used to assess the suitability of Downtown streets for inclusion in a minimum grid network of protected bike lanes and are explained in more detail in this Section.

- Traffic Operations
- Construction Activity
- Connections to Destinations / Regional Routes & Route Continuity
- Public Transit Impacts
- Parking Impacts
- Existing Pavement Conditions & Timeliness to Implement a Route
- Recently Completed Street Improvements

3.2 TRAFFIC OPERATIONS

Traffic operations were reviewed within Downtown Edmonton to identify streets that have spare existing capacity and could accommodate reducing the number of vehicle lanes and replacing them with protected bike lanes.

The City of Edmonton maintains a computer model version of its network of streets with signalized intersections using a program called Synchro. This program includes traffic information, roadway configuration information, and traffic signal design and timing information as inputs. Program outputs include traffic performance measures and parameters that can be used to set signal timing and change or optimize traffic signal performance. Synchro can be readily used to forecast traffic changes through a change in the roadway configuration to add a bikeway or reassign vehicle travel lanes. It can readily predict changes in traffic performance and may suggest minor changes in signal timing to alleviate potential problems.

Stantec used the City of Edmonton's existing Synchro network to evaluate the current traffic operations performance of the Downtown street network. Performance was defined as under capacity (volume to capacity ratio[1], or v/c ratio, under 0.85), approaching capacity (v/c ratio

[1] Volume to capacity ratio represents the utilization of the available roadway capacity (ITE, 2008). A value of 1.0 means the amount of traffic is equal to the calculated traffic capacity given its characteristics and the traffic signal timing. A v/c ratio less than one means the number of vehicles is less than the capacity (i.e., there is spare capacity).

of 0.85 to 1.0), and at/over capacity (v/c ratio of 1.0 or more). Those streets at/over capacity were removed from consideration. The Synchro model was then adjusted for all remaining streets to remove one vehicle lane or turn lanes and add turn lanes where necessary to accommodate protected bike lanes and manage conflicts. The existing traffic signal timings were not adjusted. The traffic operations performance (i.e., motor vehicle traffic response) for the revised network was then evaluated to determine which streets were more suitable by minimizing traffic impacts.

Figure 4 illustrates the traffic performance for the existing traffic conditions in the downtown network. The graphic illustrates the "worst" traffic condition experienced during either the AM or PM peak periods. Street segments in **GREEN** are under capacity. Those shown in **YELLOW** are currently near or approaching capacity and can be subject to congestion. Street segments in **RED** are over capacity, often resulting in backups that make it difficult to clear the intersection on the next green signal. These backups can extend through nearby intersections where block lengths are short. Street segments indicated in **RED** may not be appropriate for consideration of lane reductions unless the project strategy involves intentionally reducing the importance or significance of a roadway and its traffic usage. Street segments shown in **YELLOW** may require additional care and attention to determine if they can accommodate lane reductions. Streets such as Jasper Avenue, 109 Street, and 104 Avenue were removed from consideration based in part upon the analysis of the existing network. In addition, 101 Street, 100 Street, and 97 Street carry significant commuter traffic and act as access for Downtown construction activities.

Figure 4 Traffic Assessment Map – Existing Conditions (Combined AM & PM Peak)

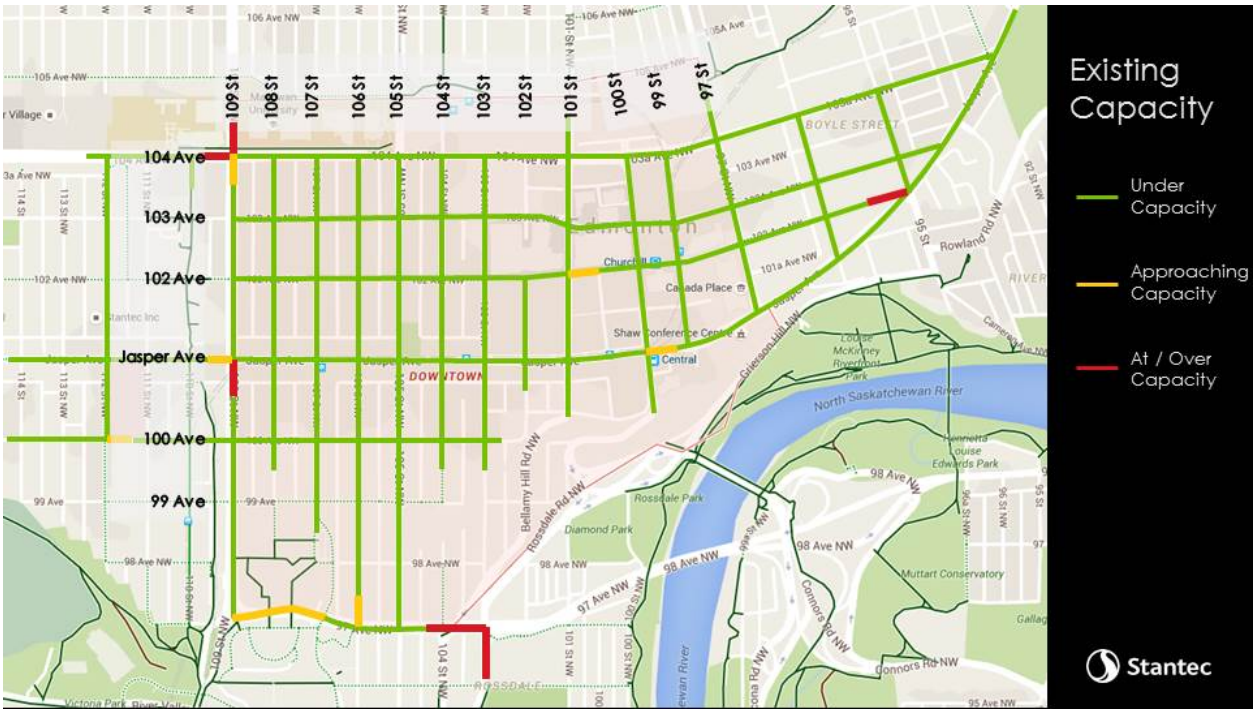
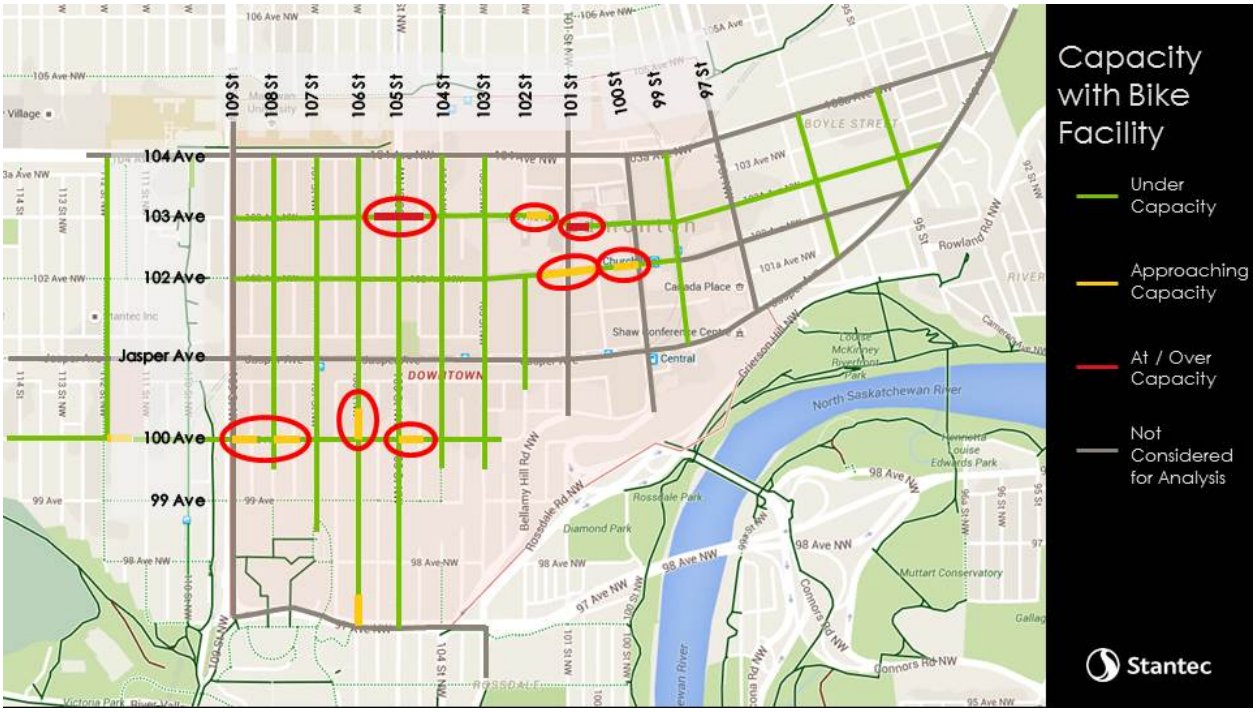


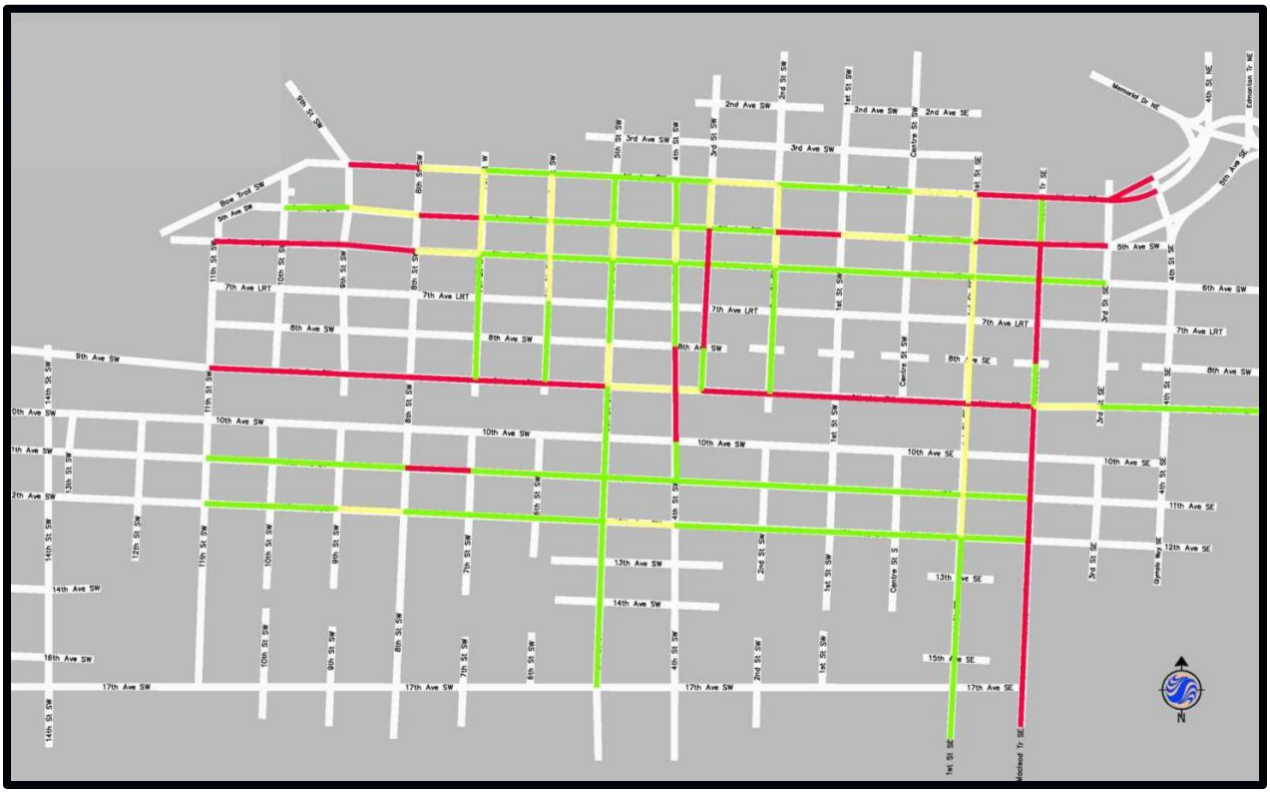
Figure 5 illustrates the traffic performance to provide protected bike lanes on the remaining streets that were not removed based on the existing performance. One vehicle lane was removed along each street to determine the traffic performance while maintaining the existing traffic signal timings. The analysis indicates that a reduction in lanes will not have a great impact upon most streets in the study area. A few links have changed from green to yellow, suggesting that special care may be advised to ensure that intersections function properly, but often these can be alleviated through slight adjustments to signal timing. Of particularly note, the operation of 103A Avenue degrades significantly and is likely a poor candidate for removing vehicle lanes to provide protected bike lanes. There is also significant construction activity and transit service occurring along this street.

Figure 5 Traffic Assessment Map – Lane Reductions for Protected Bike Lanes (Combined AM & PM Peak)



For comparison purposes, Figure 6 illustrates the assessment that was completed for the Calgary Centre City Cycle Track network. From a traffic capacity perspective, Calgary was much more constrained as compared to Edmonton with more yellow and red street segments. This required the selection of some routes that were approaching capacity and additional work was needed to refine the design and operations to limit impacts to traffic performance.

Figure 6 Example of Calgary's Traffic Assessment



From our experience in Calgary and through our review of the traffic capacity in Downtown Edmonton, we believe the locations along 100 Avenue that are approaching capacity can be mitigated with minor signal timing modifications. The locations along 102 Avenue that are shown as approaching capacity (Figure 5) are not a concern as the design and operation of 102 Ave will be changing significantly with the Valley Line LRT through this section of the corridor.

3.3 CONSTRUCTION ACTIVITY

There is a considerable amount of construction activity underway in Downtown Edmonton at this time. Key sites include construction of ICE District affecting 103 and 104 Avenues. Construction is anticipated for the Valley Line LRT along 102 Avenue from 103 Street through to Jasper Avenue. There is also drainage construction along 105 Street. Routes that are already reduced for construction may not be appropriate for consideration for the protected bike lane network in the near term, in part because further lane reductions may not be possible.

Future construction is inevitable in the Downtown area. During these activities, it will be important to maintain the protected bike lanes that are installed to maintain accessibility and connectivity, and reduce conflicts. This can be achieved through temporary treatments for a short period of time often by restricting left turns at construction sites or reducing vehicle travel lanes to accommodate walking and cycling activities.

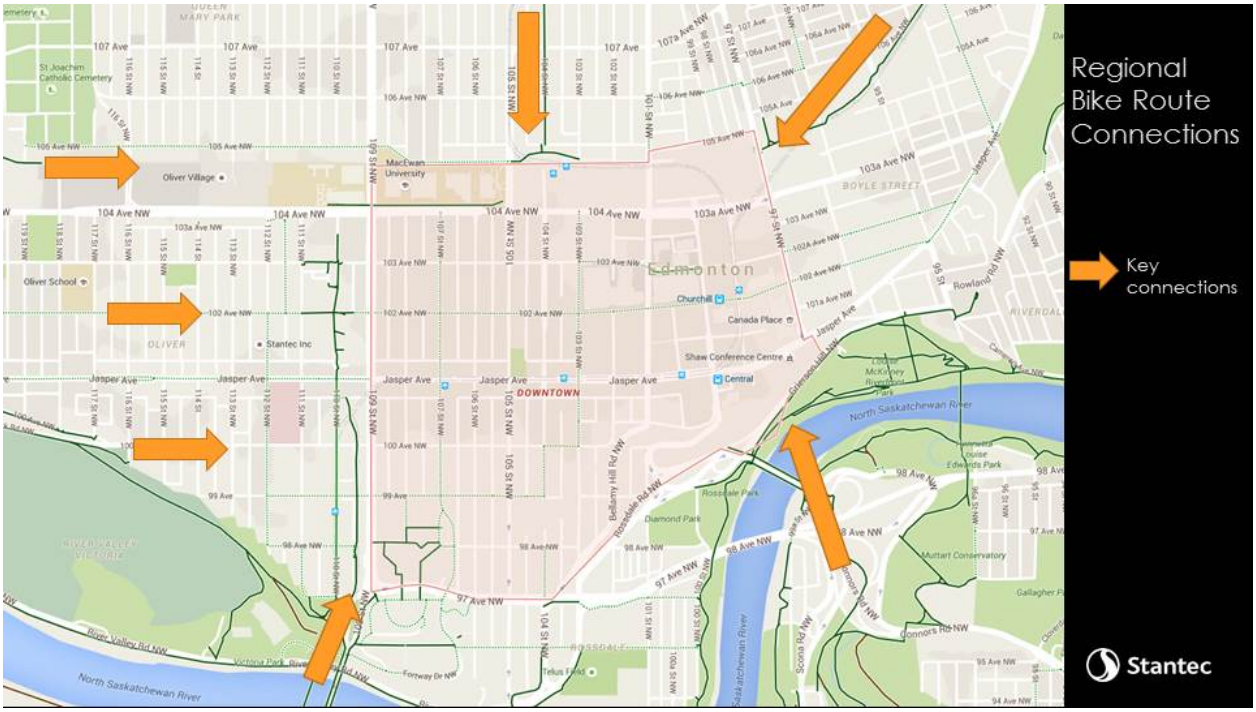
3.4 CONNECTIONS & CONTINUITY

Downtown has a diversity of destinations. Employment is concentrated in the northeast portion of Downtown around City Hall and southwest Downtown around the Legislature. There are parks, cultural, and entertainment venues in all areas of Downtown and housing is also dispersed though more limited on the east side. There is also significant population to the west and south of Downtown in Oliver, Strathcona, and Garneau.

There are also numerous existing regional bike route connections that serve the Downtown destinations and residents as shown in Figure 7. Regional bike routes exist along the Capital Line LRT to the northeast with a shared use path, 105 Avenue/121 Street shared path to the northwest, shared path along Railtown and the Ribbon of Steel with connections to the High Level Bridge to the west and south, shared path along the Metro Line LRT to the north, and shared paths in the River Valley and bridges to the paths in the south. The 102 Avenue Major Bikeway (i.e., protected bike lane) to the west is also under construction. Finally, there are connections via 100 Avenue to Groat Road, MacKinnon Ravine, and Victoria Park to the west. It is important to note these connections are considered to be for all ages and abilities with separation from traffic (except 100 Avenue between Railtown and Victoria Promenade).

The ability of the Downtown routes to serve these destinations and provide direct connections to the regional bike routes was important in reviewing route suitability.

Figure 7 Regional Bike Route Connections



3.5 PUBLIC TRANSIT IMPACTS

Transit operations were considered through the assessment. Minimizing the impacts to transit operations and limiting the mixing of people riding bicycles and transit vehicles at bus stops is an important factor. Transit currently does not operate along:

- 102 Avenue
- 96 Street
- 99 Street
- 104 Street
- 106 Street
- 108 Street
- 109 Street

There are two low frequency routes that operate along 100 Avenue with a low number of transit boardings along 100 Avenue. Discussions with ETS indicate buses stopping in the westbound direction along the north side of 100 Avenue can be rerouted which removes this conflict.

Along 103 Street, there are currently three bus stops on the east side of the street and two on the west side. ETS has reviewed the ability to shift the bus stops along the west side of 103 Street to an alternate location and have determined this is possible, thereby removing this conflict.

Major transit corridors in Downtown include 100 Street, 101 Street, Jasper Avenue, 104 Avenue, 103 Avenue, 97 Street, and 107 Street. Higher quality treatments would be required along these streets to manage conflicts between people biking, transit vehicles, and people boarding and alighting from buses.

3.6 PARKING IMPACTS

Most streets in Downtown Edmonton allow on-street parking/loading all day and some during off-peak periods only. 100 Avenue and 104 Avenue do not allow parking at any periods of the day. While Downtown has an abundant supply of parking on-street and off-street, the assessment of suitability reviewed streets with the intention to minimize the amount of parking that would have to be removed to provide protected bike lanes along the street. More consideration was completed when developing design options.

3.7 PAVEMENT CONDITION & TIMELINESS

Pavement condition affects the ride quality for people on bicycles. Following site visits to all streets in Downtown, most streets have adequate pavement conditions although some roughness and issues exist in spot locations. However, the current condition of 105 Avenue is very poor. And while there is a design plan for 105 Avenue to transform the street into a neighbourhood greenway (i.e., traffic calming, bicycle facilities, pedestrian-orientation), there is no funding for this project other than the first phase from 116 Street to the 121 Street shared use path connection. The timelines for improving the physical conditions of the pavement surface and the connections at a number of locations (e.g., 97 Street, 101 Street) are long and, based on the anticipated timelines for the protected bike lane network, 105 Avenue is not a suitable

route at this time but should be a priority in the Capital Budget to support safe walking and cycling to MacEwan University, Queen Mary Park, Central McDougall, and McCauley.

3.8 RECENTLY COMPLETED IMPROVEMENTS

The assessment also incorporated considerations of recently completed street improvements, particularly those that have included significant investment. There are four streets that have included significant investment recently and provide reasonable connectivity and continuity through the Downtown and to regional bike routes.

- Jasper Avenue has been designed and the first phase recently constructed. The design does not include bicycle facilities and it would be difficult to retrofit.
- 108 Street/Capital Boulevard had significant investment recently including paver stones and streetscape elements. Altering the street would require additional investment in a street that was just reconstructed.
- 104 Street has been designed to be a walkable street and has limited potential to include protected bike lanes without completely removing parking due to the existing design and traffic calming at the intersections.
- 96 Street/The Armature is under construction and has been designed to include extensive streetscaping as well as bicycle facilities. The design has created a bike-friendly street that could form the eastern north-south route in the protected bike lane network.

3.9 ASSESSMENT OF POSSIBLE ROUTES

The initial screening of the downtown streets considered traffic operations. This screening removed two east-west streets and four north-south streets, due to the amount of motor vehicle traffic that these streets currently carry (see Figure 4 and Figure 5). The following streets were removed from further consideration:

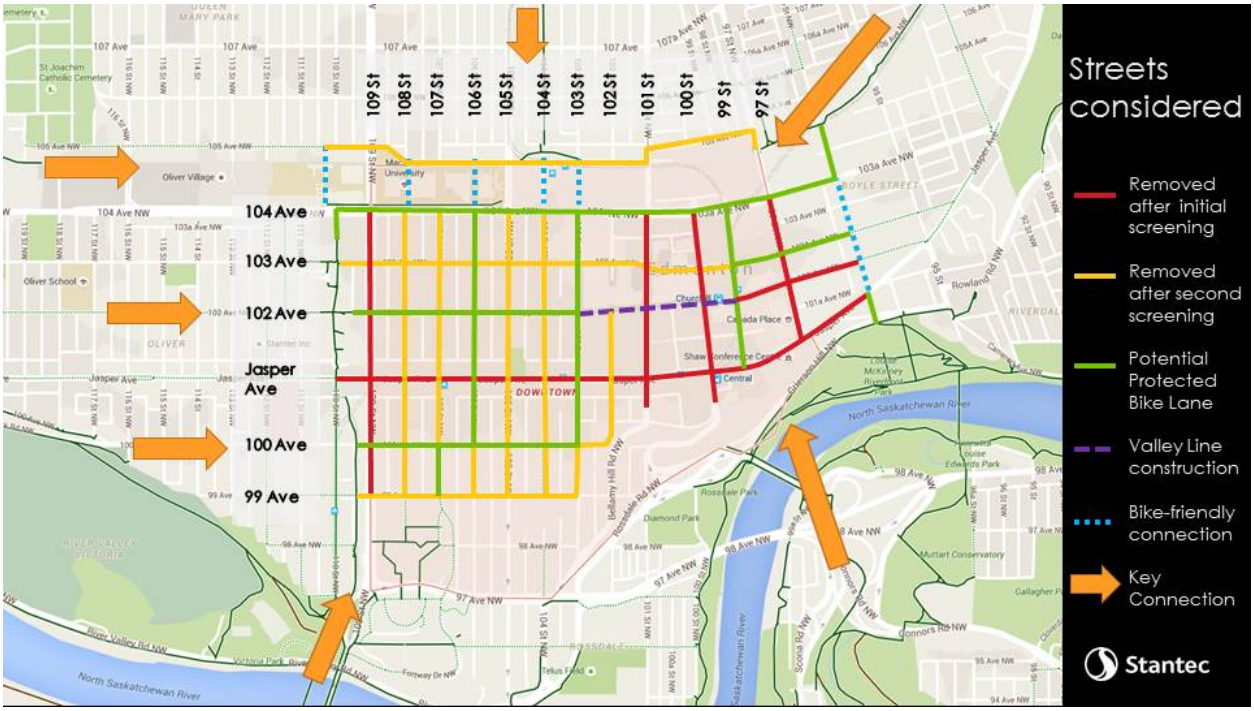
- Jasper Avenue between Railtown and 96 Street (Traffic Operations)
- 102 Avenue between 99 Street and 96 Street (Valley Line LRT constrained right of way)
- 109 Street between 104 Avenue and 99 Street (Traffic Operations)
- 101 Street between 104 Avenue and 100 Avenue (Traffic Operations)
- 100 Street between 104 Avenue and 100 Avenue (Traffic Operations)
- 97 Street between 104 Avenue and Jasper Avenue (Traffic Operations)

The remaining streets were then passed through a secondary screening based on the remaining factors described previously in Section 3.0. The secondary screening excluded additional streets from further study as described below in Table 1. The results of the initial and secondary screening are shown in Figure 8.

Table 1 Streets Excluded from Further Study after Secondary Screening

Street excluded from further study	Rationale
99 Avenue (Ribbon of Steel to 103 Street)	• Poor connections to Railtown and regional bike routes further west.
100 Avenue (103 Street to 102 Street)	• No connections available east of 103 Street (and as a result of excluding 102 Street from the network)
103 Avenue (Railtown to 99 Street)	• Significant construction activity related to ICE District has reduced the operating width of the street to one lane in each direction. • With Valley Line LRT construction and the ultimate design for 102 Avenue, buses have been shifted in large part to 103 Avenue.
105 Avenue (Railtown to 96 Street)	• The existing pavement condition, drainage construction activity, and numerous physical constraints require significant capital investment and impact the ability and timeliness of providing bicycle facilities in the very near term.
102 Street (102 Avenue to 100 Avenue)	• This route provides limited connectivity and continuity due to the street network structure north of 102 Avenue and City Centre Mall.
104 Street (104 Avenue to 99 Avenue)	• Existing design and geometry of the street requires complete removal of parking to provide protected bike lanes.
105 Street (104 Avenue to 99 Avenue)	• Drainage construction is underway and will impact the continuity and ability to provide facilities.
107 Street (104 Avenue to 100 Avenue)	• Significant bus operations and future location for LRT limits the ability to accommodate bicycle infrastructure long term. • No connection through MacEwan University north of 104 Avenue.
108 Street (104 Avenue to 99 Avenue)	• Experienced significant recent investment in streetscaping limiting the desire to reconstruct or alter the street design.

Figure 8 Initial and Secondary Screening Results



3.10 SUMMARY OF PROMISING ROUTES

The remaining streets illustrated in Figure 9 are Downtown streets that are promising locations for protected bike lanes and could be used to form a grid of east-west and north-south all ages and abilities bike routes to access Downtown's destinations and regional bike route connectors. The spacing of these routes is consistent with the Principles outlined in Section 2.0. The network is approximately 7.1 km in length which is similar to the length of Calgary's Centre City Network (Figure 10).

Table 2 provides additional description of the merits for each promising route.

Figure 9 Potential Protected Bike Lane Network

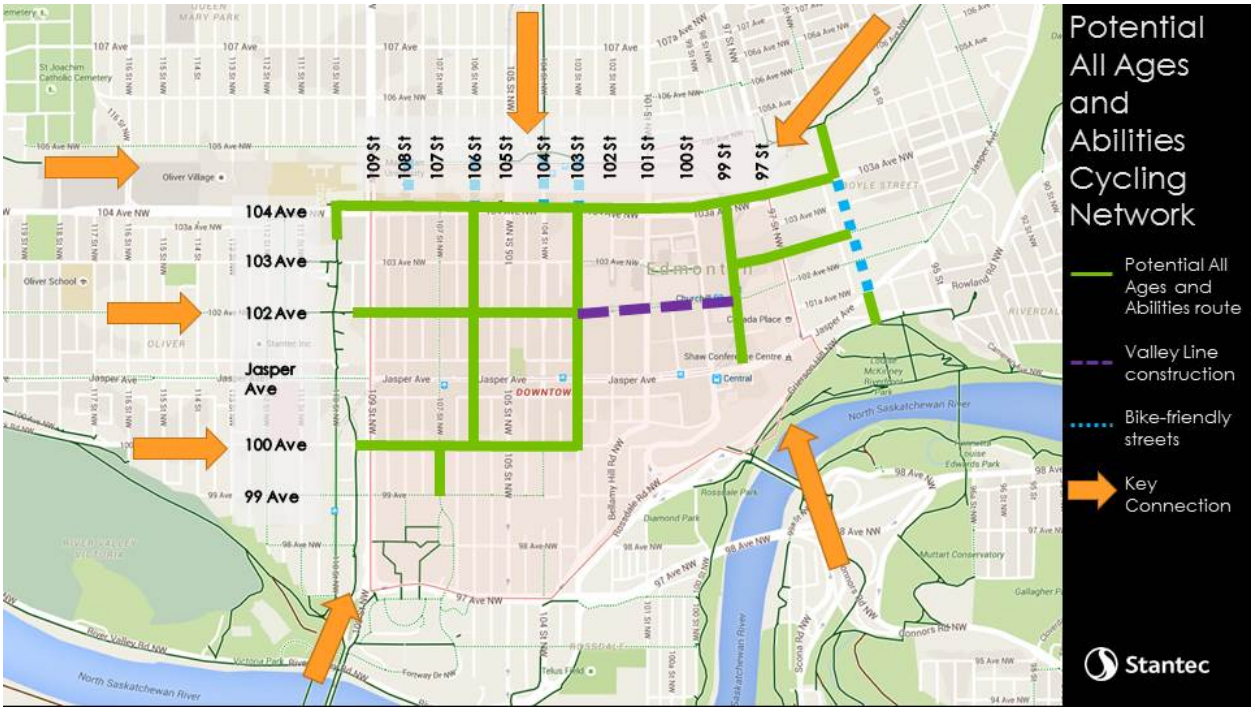


Figure 10 Calgary Centre City Cycle Track Network

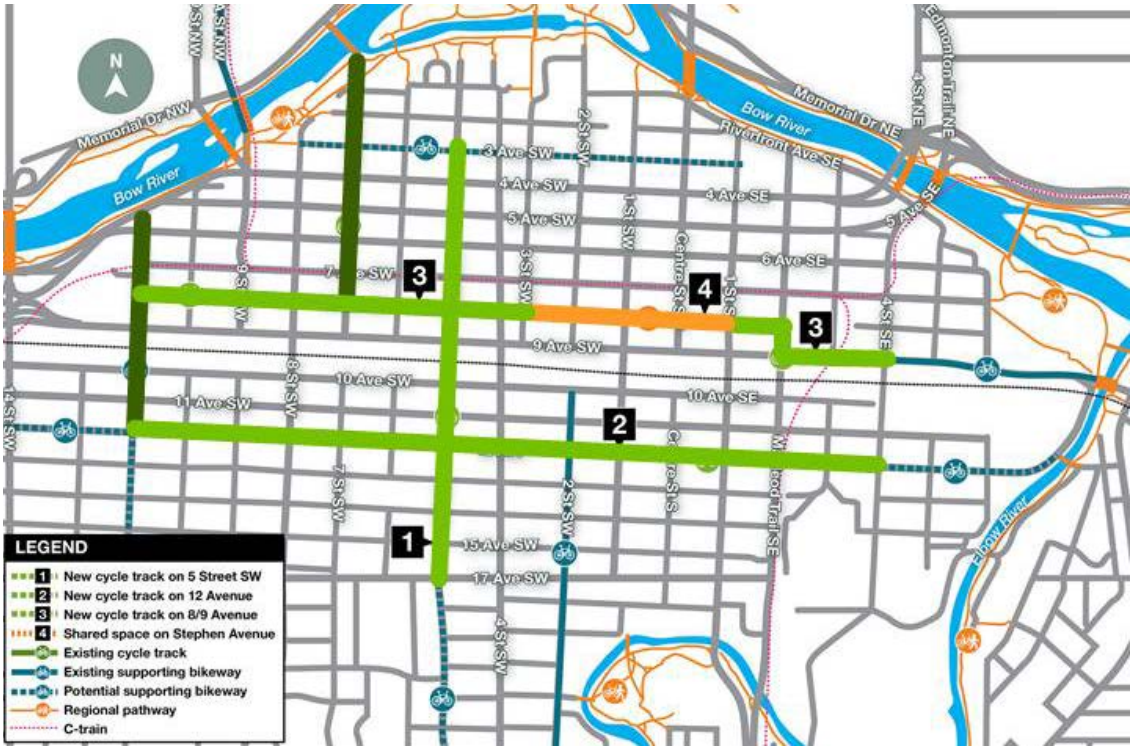


Table 2 Promising Downtown Streets for Protected Bike Lanes

Potential Protected Bike Lane Street	Key Features
100 Avenue	Connections to Railtown paths and provides an east-west route for access to destinations south of Jasper Avenue
102 Avenue	Connections to future protected bike lane in conjunction with Valley Line LRT and east-west route for access to destinations north of Jasper Avenue such as City Centre Mall, parks, Winspear, Citadel, and Churchill Square and connections to Railtown
102A Avenue	Part of the Valley Line LRT protected bike lane north of 102 Avenue, provides access to destinations in east downtown including the Museum, Churchill Square, and City Hall
104 Avenue	Connections to MacEwan University and interim shared path route prior to 105 Avenue's transformation
96 Street	Existing bike-friendly street with short extensions required to connect to regional bike routes to the north and south
99 Street	Part of the Valley Line LRT protected bike lane north of 102 Avenue, provides access to destinations in east downtown including the Museum, Churchill Square, Rice Howard Way, and City Hall
103 Street	Connections to ICE District and employment and provides a north-south bike route between the commuter corridors of 100 Street/101 Street and 105 Street
106 Street	Connects to and through MacEwan University and provides a north-south route to access the employment, education, and commercial destinations in west Downtown between the commuter corridors of 105 Street and 109 Street
107 Street (99 Ave to 100 Ave)	Provides connection to the Legislature and employment in the area as well as regional bike routes and the High Level Bridge
110 Street	Provides the final connection for the Railtown shared path to directly extend to and through MacEwan University for communities north of 104 Avenue

4.0 POTENTIAL DESIGNS

The promising streets identified through the suitability assessment were further reviewed to determine the potential designs for these streets that would allow for the addition of protected bike lanes. The curb-to-curb dimensions were considered fixed. Intersection operational techniques were also considered to enhance crossings and reduce/mitigate conflicts.

The potential designs are based on low cost, adaptive materials and ones that facilitate the functionality and nimbleness that is required. Due to this requirement, certain materials are not included in the potential designs even though they may be in the City's inventory. For example, while the City has a supply of jersey barriers, the use of these for the barrier between the protected bike lanes and parking would not allow people getting out of cars to be able to open their doors or easily cross to the sidewalk.

4.1 AVAILABLE WIDTHS

Existing street widths (measured face of curb (FOC) to face of curb) were gathered for all routes using AutoCAD engineering files and field verified. The most constrained street widths typically occur at the intersections where there are curb extensions that reduce crossing distances for people walking. A summary of the routes with the most constrained widths are:

- 100 Avenue: 12.7 m (between 104 Street and 108 Street)
- 106 Street: 13.1 m (between 100 Avenue and Jasper Avenue)
- 103 Street: 13.1 m (between 100 Avenue and Jasper Avenue)
- 99 Street: 10.2 m (immediately north of 102 Avenue)

With the exception of 99 Street, two through traffic lanes and a turning lane can be accommodated at intersections with a two-way protected bike lane. At midblock locations, parking can be maintained adjacent to the bike facility. 103 Street and 106 Street typically have existing street widths in excess of 15.5 m. In those instances, parking can be accommodated on both sides. Also of note, parking is currently not accommodated along 100 Avenue.

4.2 DESIGN CRITERIA

Design criteria for the protected bike lanes are based on three main sources:

- Table 4.1: Constrained Dimension Considerations of the City of Edmonton Complete Streets Guidelines
- Design criteria used for the City of Calgary Centre City Cycle Track Network
- Discussions with City of Edmonton and City of Calgary Roads Maintenance staff

The **minimum width design criteria** used in this study are as follows:

- Bike Facilities:
  One-way protected bike lanes: 2.1 m
  Two-way protected bike lanes: 3.1 m
  Buffer from traffic lane: 0.5 m
  Buffer from parking lane: 1.0 m

- Traffic Lanes:
  Non-transit lanes: 3.0 m (plus 0.25 m gutter width if adjacent to a curb)
  Transit lanes: 3.2 m (plus 0.25 m gutter width if adjacent to a curb)
  Right Turn lanes: 2.5 m (for short right turn lanes parallel to protected bike lanes)
  Left Turn lanes: 3.0 m

- Parking Lanes: 2.2 m (plus 0.25 m gutter width if adjacent to a curb)

Where existing width was too constrained to meet these design criteria, very modest width reductions were made (i.e., up to 0.2 m) by reducing the two-way protected bike lanes and/or the "buffer from parking lane".

4.3 DESIGN OPTIONS

Geometric Considerations

Protected bike lane facilities on each side of the road with a buffer between parked vehicles on both sides requires 3.1 m of width on each side of the street (i.e., 2.1 m protected bike lane plus 1.0 m buffer) for a total width of 6.2 m. If parking is only required on one side, one-way facilities still require 5.7 m of total width. For two-way facilities, a minimum width of only 4.1 m is required with the parking buffer, a savings of approximately 2m as compared to the design of one-way protected bike lanes.

Operational Considerations

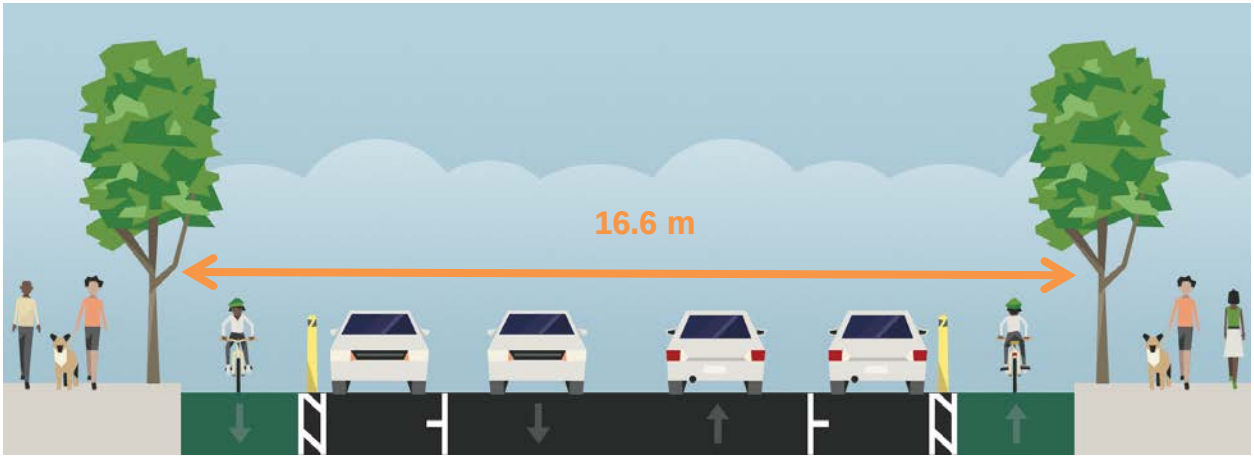
Discussions with City of Calgary and City of Edmonton Roads Maintenance staff revealed three important findings:

- One-way protected bike facilities are not preferred. Given their narrow width, special equipment is required to access these facilities for snow clearing and removal.
- Two-way protected bike facilities should be at least 3.1 m in width to allow for snow clearing and removal equipment with a 3.0 m blade width.
- The winter maintenance pilot in Edmonton suggests a vertical barrier between the vehicle travel lanes and protected bike lanes is very important to be able to maintain a cleared surface for people riding bicycles and limit migration of snow, slush, and aggregate material into the bike lanes from the vehicle lanes.

Design Configuration Options

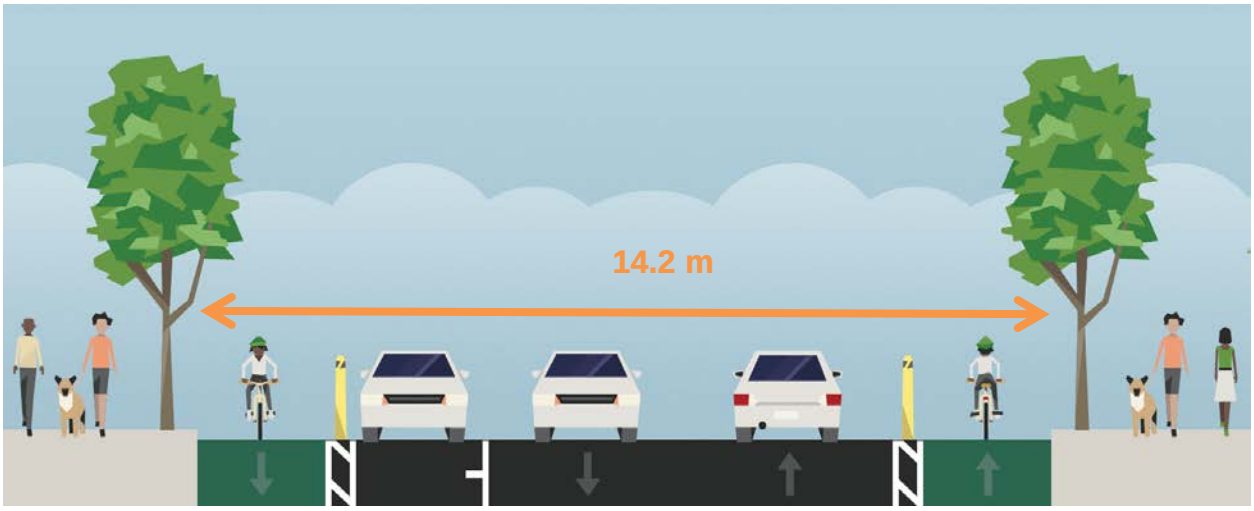
As shown in Figure 11, providing one-way protected bike lanes on both sides, with parking on both sides of the street, requires almost 17 m of street width if transit is not operating along the street. The routes for protected bike facilities proposed through the route suitability assessment generally fall short of this available width.

Figure 11 One-Way Facility with Parking Both Sides



As shown in Figure 12, providing one-way protected bike lanes on both sides, with parking on only one side of the street requires approximately 14 m of street width (without transit). 100 Avenue and sections of 103 Street and 106 Street south of Jasper Avenue do not have this available width which would impact the continuity of protected bike lanes along these routes where the width becomes constrained.

Figure 12 One-Way Facility with Parking One Side



As shown in Figure 13, a two-way protected bike lane with parking on both sides of the street requires about 15 m of street width. Figure 14 illustrates that a two-way protected bike lane with parking on one side (adjacent to the protected bike lane) requires less than 13 m of streets width (if transit does not operate on the street). With a few exceptions, this street width is available on all proposed bike routes. Since 100 Avenue does not currently have parking and its width is constrained for longer segments, the design for 100 Avenue will include two-way protected bike lanes on one side of the street and three vehicle lanes.

Figure 13 Two-way Facility with Parking Both Sides (Preferred)

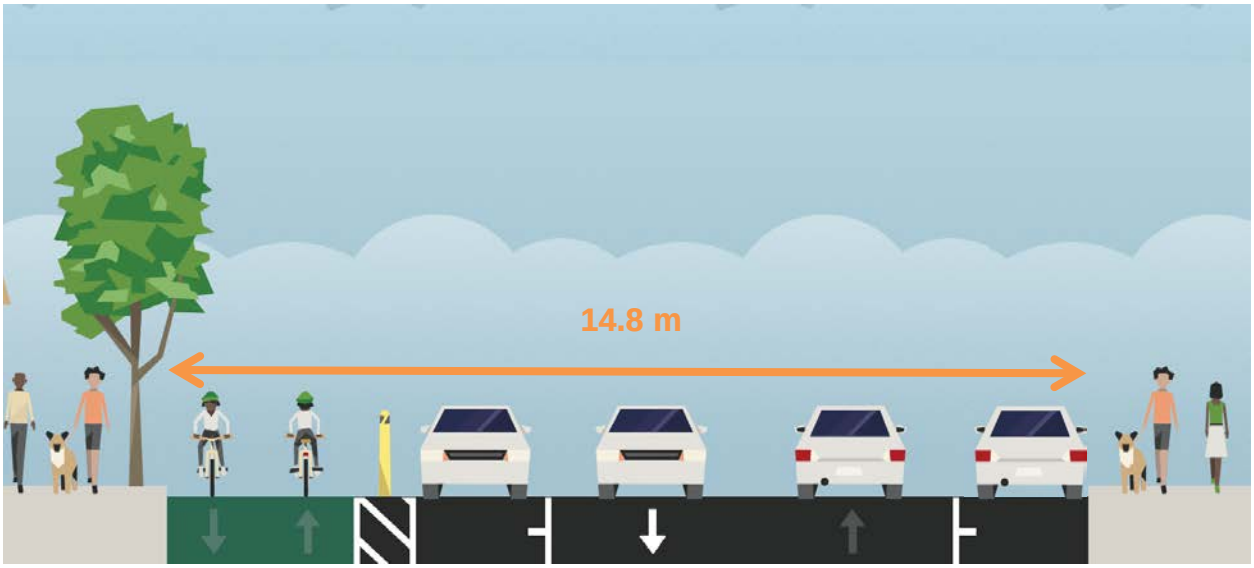
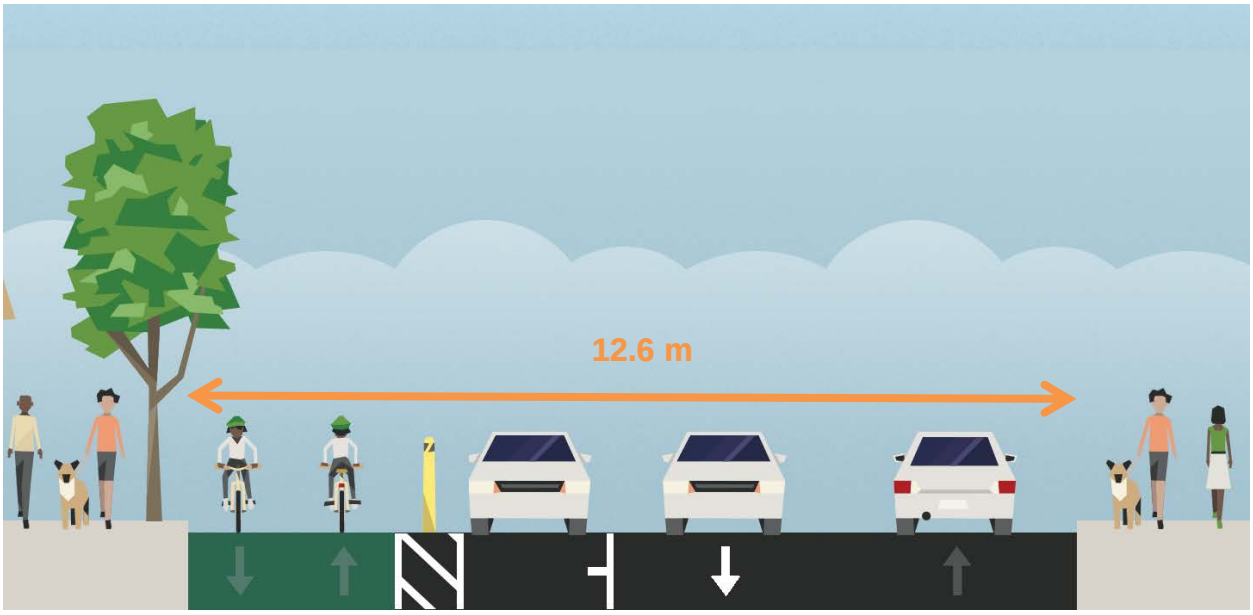


Figure 14 Two-way Facility with Parking One Side (Preferred)



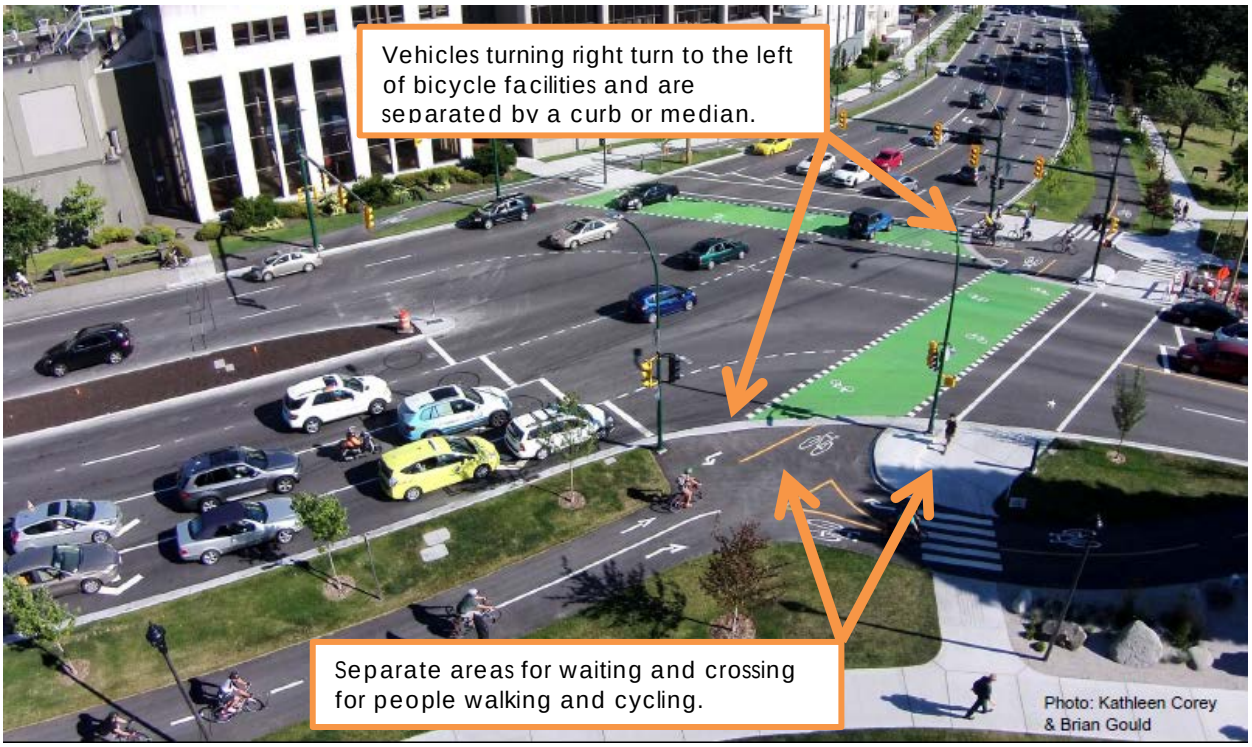
4.4 INTERSECTION DESIGN

The design of intersections requires a considerable amount of care because of the need to account for people walking, people cycling, and through traffic and turning movements for motor vehicles. Signalized intersections can be especially complex, as people cycling and driving can encounter conflicts while making specific movements. Designs that were developed to minimize costs have often become problematic at intersections due to conflicts and issues, mostly involving turning vehicles and through cyclists.

Right turns made by motorists across a one-way or two-way protected bike lane often require special attention, because motorists are not accustomed to watching for people cycling that are approaching from the right. Best practice guides the design of intersections so that conflicts are eliminated or greatly reduced.

Conflicts can be reduced through physical roadway, path, and intersection design treatments but often require land areas near street corners that cannot easily be provided within an existing urban environment. Even when employing a physical design treatment such as a protected intersection (Figure 15), traffic signals are often also paired with the geometric design to further manage conflicts.

Figure 15 Protected Intersection Example (Vancouver)



Another common strategy that has been employed on one-way protected bike lanes is the use of a mixing zone. This design approach terminates the separation between vehicle and bicycle lanes 15 m to 30 m before each intersection and encourages motorists to merge into or across the protected bike lane before making turns. This treatment is economical, but is not compatible with two-way protected bike lanes, does not address left turn conflicts, and is less attractive to inexperienced cyclists (i.e., the people that protected bike lanes are attempting to attract).

Figure 16 Mixing Zone Example (New York City)

When turning movements are a factor, and design constraints are present, the design will normally rely upon traffic signal strategies that regulate, reduce, or eliminate turn conflicts. These strategies often rely upon the use of bicycle traffic signal displays that can be programmed to allow cyclists to proceed while motorists are stopped or vice versa. Proper intersection design also takes into consideration the frequency of pedestrian crossings, since motorists are already more attentive when turning through frequently used crosswalks.

While commonly and widely used in Europe, bicycle signal indications are relatively rare in North America. They have only recently been standardized for use in Canada, but they have become a widespread treatment for signalized intersections in conjunction with protected bike lanes. Bicycle signals are featured at all of the signalized intersections in the Calgary Centre City Cycle Track network. One especially beneficial quality of bicycle traffic indications is that they normally experience very good compliance by cyclists when compared with traditional vehicle signals. Another benefit is that they reduce the presence of cyclists still within the intersection when cross traffic receives a green signal.

Figure 17 Bicycle Traffic Indication/Bicycle Signal (Calgary)

Experience from Vancouver and other cities suggest that when the number of motorists turning across a protected bike lane exceeds 80-100 per hour, conflicts should be addressed during the design phase. This level of turning traffic exists frequently at intersections on busy multi-lane streets but is not as common at streets that experience light to moderate usage. Every signalized intersection along a proposed protected bike lane should be checked to assess the potential turn conflict, and strategies appropriately employed to reduce or eliminate these conflicts.

Bicycle signals can be used to provide a head start (along with pedestrians) to eliminate the frequent conflicts with motorists who turn right at the onset of green. They can also be used to stop cyclists early and allow motorists to turn left or right before and/or as soon as the vehicle signal turns yellow. In some cases, a left turn or right turn arrow can be used to further assist motorists in turning across a busy bikeway. In other cases, cyclists can be given green signals for multiple directions, similar to a pedestrian scramble, allowing bicycle through traffic and turns to be made free from motor vehicle conflicts.

Figure 18 Vehicle Turn Signal with Bicycle Signal (Calgary)

Construction costs for protected bike lanes normally include a significant expense for modifying traffic signals to provide bicycle signals and modify the signal operation accordingly. These can amount to 30% to 50% of the total construction cost and can vary depending upon the level of conflict reduction desired.

The precise design for each intersection in the Edmonton protected bike lane minimum grid will be dependent upon the specific configuration and traffic conditions. All designs will be intuitive and based upon applications that have been implemented in other communities. However, an education process is strongly recommended upon system opening to advise people about the details of intersection operation. This can be done effectively by using ambassadors at key intersections upon project opening, as well as through media, social media, and print materials.

4.5 POTENTIAL DESIGN FOR EACH PROMISING ROUTE

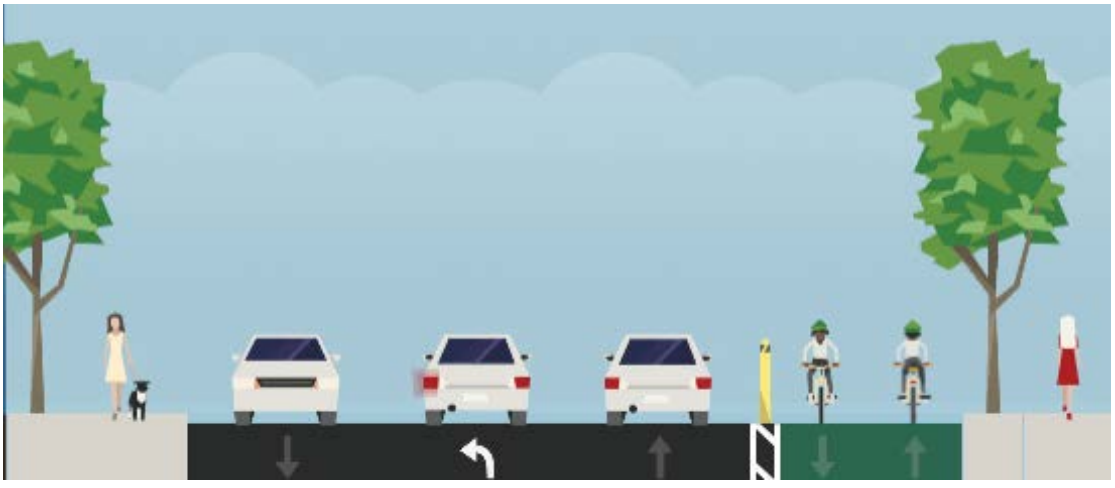
The following section summarizes potential designs for each route within the minimum grid of protected bike lanes for Edmonton illustrated in Figure 9. For most routes, a two-way protected bike lane is proposed along one side of the street due to the geometric constraints along the streets. In using two-way protected bike lanes, experience from Calgary suggest they are easier to maintain in all seasons including snow clearing and removal because existing full-size equipment can be used which reduces costs, speeds snow clearing and removal, and does not require the purchase of new equipment. Traffic signal treatments can also be used to manage conflicts, enhance crossings, and support traffic flow.

All cross sections shown below are looking west for Avenues and north for Streets. The only exception is for 102A Avenue as noted on the drawing.

4.5.1 100 Avenue

100 Avenue is currently a four lane, undivided street and has no on-street parking. The lanes along 100 Avenue are one shared through and right turn lane and one shared through and left turn lane in each direction. This type of street configuration is inefficient because turning vehicles block vehicles travelling through. In many cases, changing this configuration to a shared through and right turn lane in each direction with a dedicated left turn bay are more appropriate and have very similar vehicle capacity. The traffic operations assessment for this study showed this type of conversion for 100 Avenue does in fact maintain good traffic flow and provides space for a two-way protected bike lane on the north side of 100 Avenue. Figure 19 illustrates a potential design for 100 Avenue.

Figure 19 Potential 100 Avenue Design



The two-way facility allows people riding bikes to make easy connections to north-south routes along 103 Street, 106 Street, and Railtown. With further traffic signal timing adjustments, it is also

possible to have all movements operate within the green range of traffic operation, protect through and turning bicycle movements, and accommodate vehicle turning movements.

The crossing of the Railtown shared use path across 100 Avenue will require further investigation to improve the safety of this crossing that is heavily used by people cycling and walking. With the collision history and bicycle travel patterns along 100 Avenue from Railtown to 116 Street and Victoria Promenade, there is rationale to extend this route further than Railtown as part of the implementation but this has not been reviewed as part of this study.

4.5.2 102 Avenue

The 102 Avenue design is a two-way protected bike lane along the south curb of the street for this current five lane road with parking in the off peaks. The design for 102 Avenue is consistent with the Valley Line LRT design that is currently under construction. The width accommodates winter snow clearing and maintenance. West of 103 Street, 102 Avenue can accommodate one vehicle lane in each direction, a left turn bay, on-street parking, and short vehicle right turn bays. The accommodation of turn bays and signal timing techniques can be used to separate the turning vehicles and bicycles conflicts at intersections. Figure 20 illustrates the potential design for 102 Avenue and is consistent with the design for 102 Avenue in conjunction with Valley Line LRT.

One location that will require some extra attention is to the west of 105 Street where a business is parking vehicles on the boulevard and would be backing vehicles out across the protected bike lane. This requires some further study but there are options to manage and mitigate this conflict.

Another issue that should be addressed is the need to maintain access for people walking and cycling along 102 Avenue through the Valley Line LRT construction zone between 103 Street and 99 Street during the duration of construction. Without this connection, there is no viable all ages and abilities route to access the many employment, retail, cultural, entertainment, and other destinations located east of 103 Street.

Figure 20 Potential 102 Avenue Design at Intersections

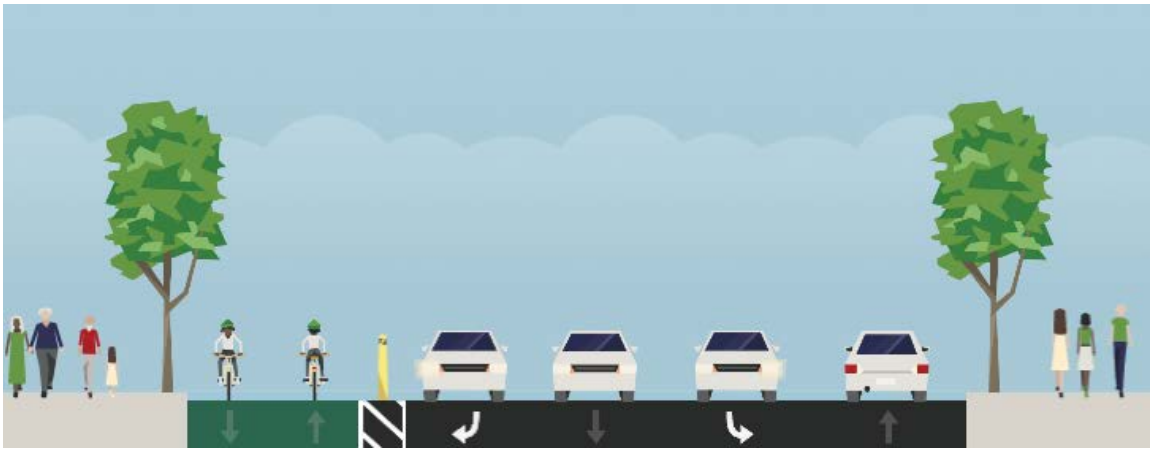
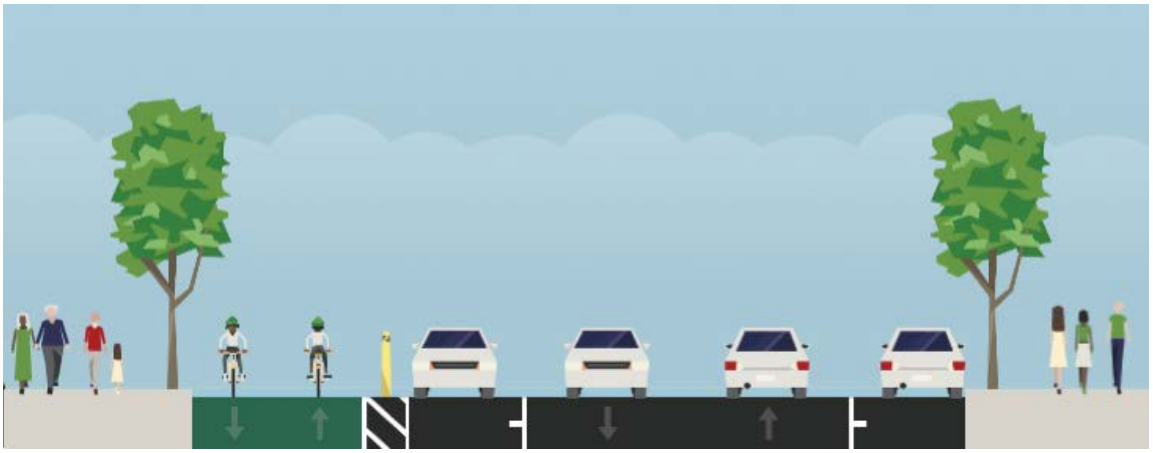


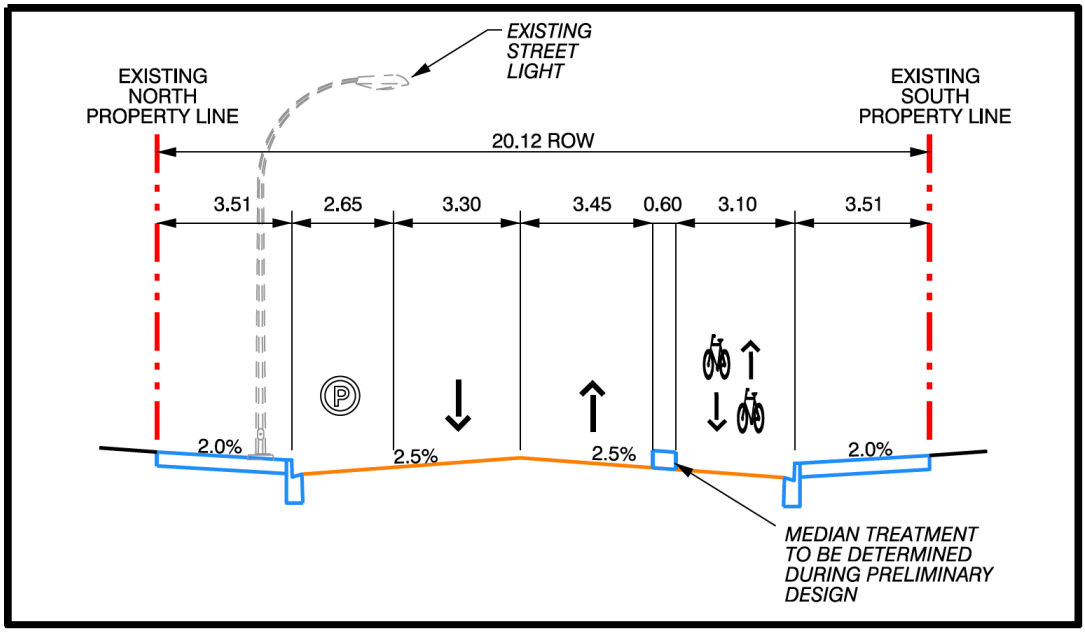
Figure 21 Potential 102 Avenue Design Midblock



4.5.3 102A Avenue

The continuation of the 102 Avenue protected bike lane along 102A Avenue is consistent with the Valley Line LRT Concept Plan. 102A Avenue can accommodate a two-way protected bike lane along the south side of the street from 99 Street to 96 Street. The design can maintain one lane of vehicle traffic in each direction and on-street parking. Traffic signal techniques can be used to separate vehicle and bicycle conflicts at intersections. Figure 22 illustrates the potential design for 102A Avenue.

Figure 22 Potential 102A Avenue Design



4.5.4 104 Avenue

Unlike most of the routes within the minimum grid network, 104 Avenue is proposed as an off-street shared use path. Along the north side of 104 Avenue adjacent to MacEwan University, a dual sidewalk already exists and curb ramps have been constructed from 110 Street to 105 Street. 105 Street to 104 Street has a wide sidewalk and Rogers Place will have a broad sidewalk provided as part of its construction. This area will be busy during events at the arena likely necessitating people riding bikes to dismount, however this will not coincide with typical commuting periods. East of Rogers Place, there is a paved path that is just to the north of the curb-line sidewalk that provides access to the CN Tower and the plaza and wide sidewalks being constructed in conjunction with the Royal Alberta Museum up to 97 Street. From 97 Street to 96 Street, there is a portion of sidewalk that requires widening (Figure 23) to provide sufficient width (i.e., minimum of 3 m and 4 m preferred). 104 Avenue would provide an east-west route along the north edge of Downtown prior to the completion of the upgrades to 105 Avenue.

In addition to the limited section of sidewalk widening, intersection crossings would require upgrading to improve the visibility and right of way for cycling at intersections.

Figure 23 104 Avenue Sidewalk Widening

4.5.5 96 Street

96 Street/The Armature is almost fully constructed. This bike-friendly street is the eastern north-south bike route for the Downtown minimum grid. North of 103A Avenue, 96 Street requires transformation and, with its wide curb-to-curb dimension, can support the addition of protected bike lanes, maintain one vehicle lane in each direction, right turn bays, and on-street parking.

At the intersection of Jasper Avenue, a new traffic signal should be installed to reduce the conflicts at this intersection with its history of motor vehicle collisions involving people walking and cycling as per the City's Vision Zero policy. The sidewalk connection from 96 Street to Grierson Hill to access the River Valley paths should be widened or have poles relocated to

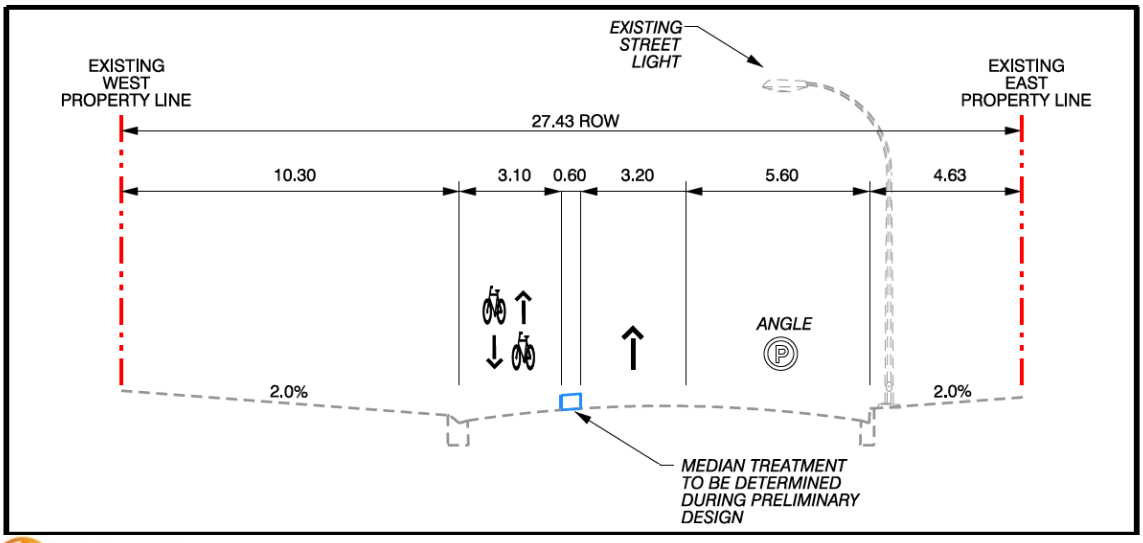
improve the function of this segment as a shared use path. Figure 24 illustrates the location of improvements for 96 Street from Jasper Avenue to Grierson Hill.

Figure 24 Potential 96 Street Design (South of Jasper Avenue)

4.5.6 99 Street

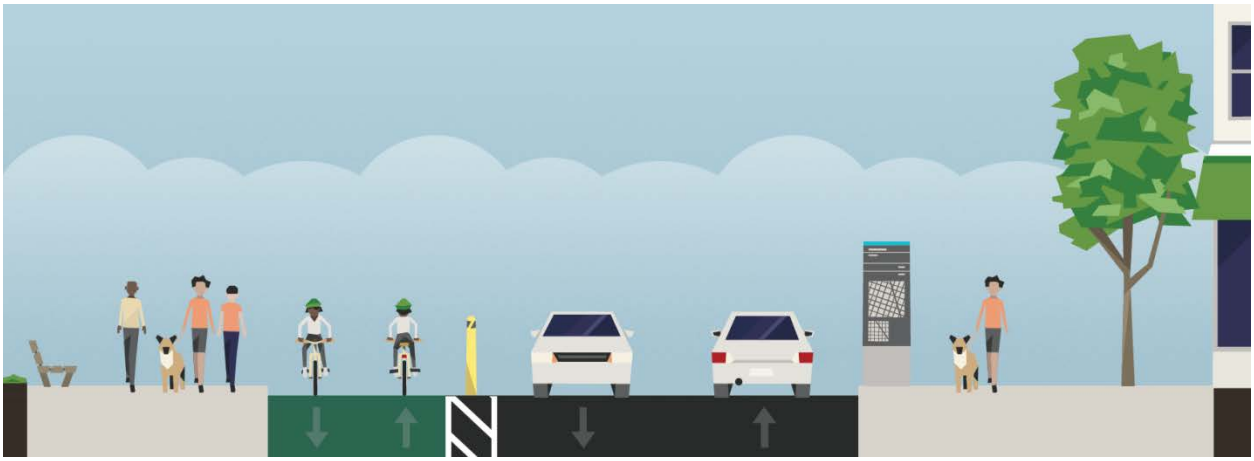
99 Street between 102 Avenue and 102A Avenue is designed to be consistent with the Valley Line LRT Concept Plan. Under this plan, 99 Street is converted to one-way northbound and parking is retained along the east side of the street. A two-way protected bike lane is added in place of the former southbound travel lane as illustrated in Figure 25. The barrier design may require removal during the summer festival season.

Figure 25 Potential 99 Street Design (Valley Line-related segment, 102 to 102A Avenue)



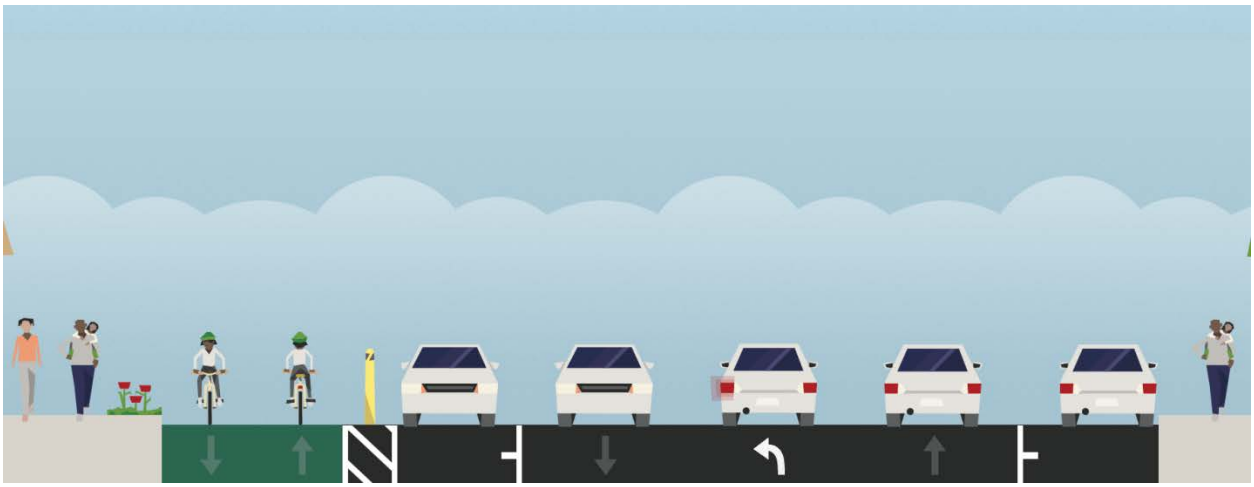
North of 102A Avenue, it is our understanding that two-way vehicle access is required for the Law Courts. A two-way protected bike lane from 102A Avenue to 103A Avenue provides connections to the Royal Alberta Museum and City Hall. This segment will require the removal of parking along the west side of 99 Street but parking can be retained along the east side of the street. The potential design for this segment of 99 Street at the intersection of 102A Avenue is illustrated in Figure 26. Again, north of this intersection, on-street parking can be provided along the east side of the street.

Figure 26 Potential 99 Street Design (at north leg of 102A Avenue intersection)



Extending the two-way protected bike lane along 99 Street south of 102 Avenue to Jasper Avenue provides connections to Rice Howard Way, the Shaw Conference Centre, and many hotels. A two-way protected bike lane can be provided while maintaining one vehicle lane in each direction and turn bays at Jasper Avenue. Parking can be maintained along both sides of the street. The potential design for this segment is illustrated in Figure 27.

Figure 27 Potential 99 Street Midblock Design (South of 102 Avenue)



4.5.7 103 Street

With the existing curb-to-curb width along 103 Street and the level of traffic volumes, a two-way protected bike lane along the west side of the street, one vehicle lane in each direction, and southbound right turn lanes can be installed (Figure 28). The southbound right turn lane for vehicles is used to separate right turning vehicles from people riding bikes along the protected lanes. At midblock locations, parking can be provided on both sides of the street (Figure 29).

Figure 28 Potential 103 Street Design at Intersections

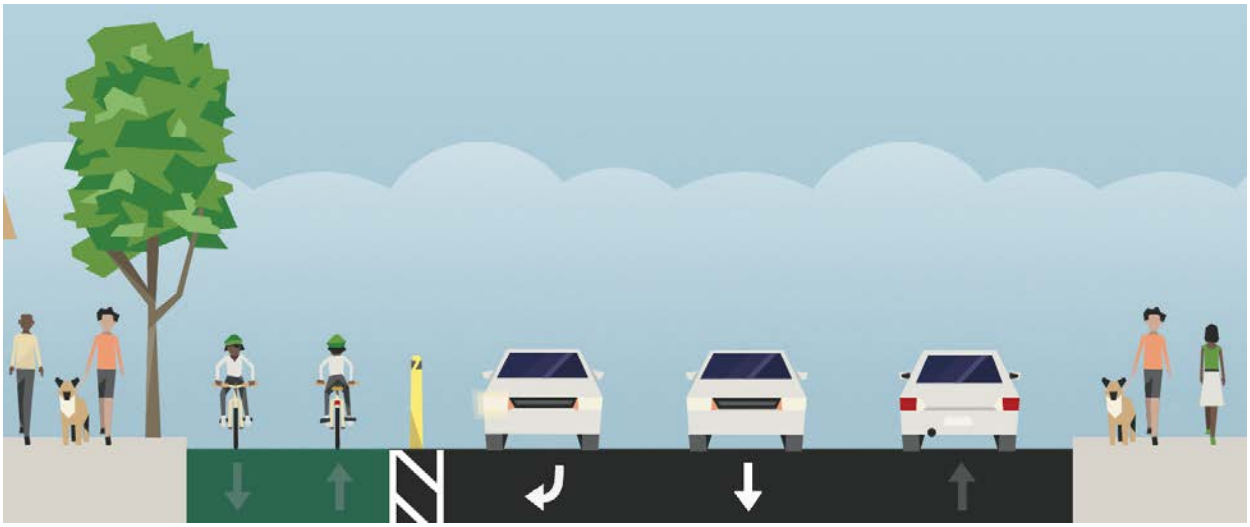
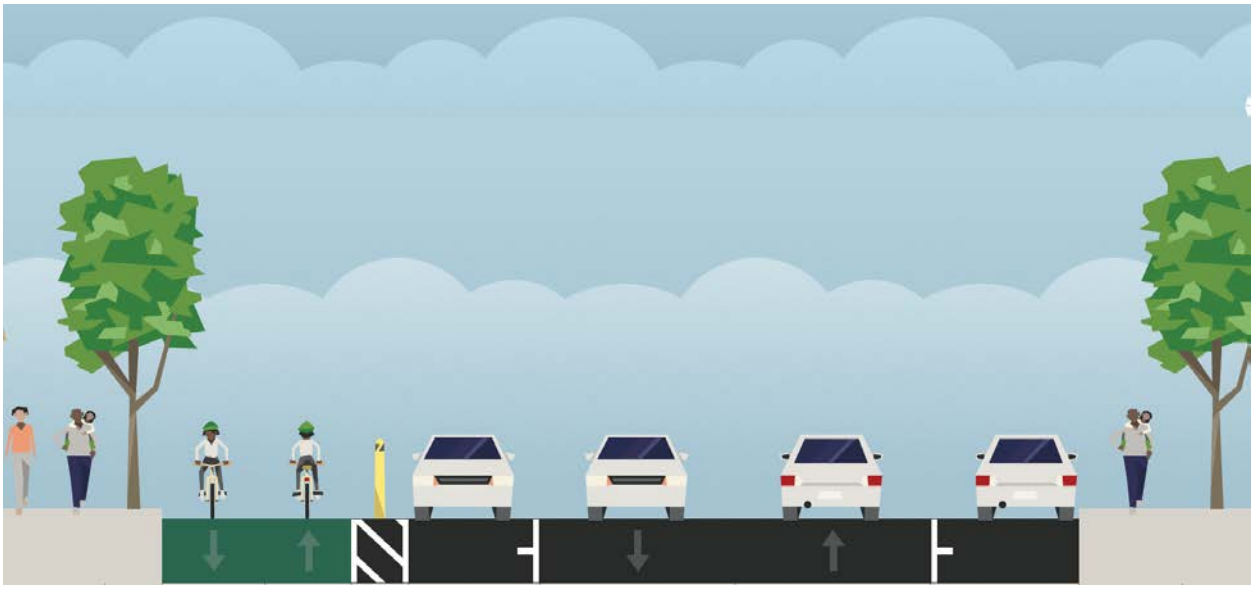


Figure 29 Potential 103 Street Design Midblock



4.5.8 106 Street

Like 103 Street, with the existing curb-to-curb width along 106 Street and the level of traffic volumes, a two-way protected bike lane along the west side of the street, one vehicle lane in each direction, and southbound right turn lanes can be installed (Figure 30). The southbound right turn lane for vehicles is used to separate right turning vehicles from people riding bikes along the protected lanes. At midblock locations (Figure 31), parking can be provided on both sides of the street even along the narrower portion of 106 Street south of Jasper Avenue due to existing parking pockets (though a few stalls may be lost due to curb-to-curb constraints closer to 100 Avenue).

The intersection of 106 Street and 104 Avenue requires a new traffic signal. This intersection is currently stop sign controlled and has a marked crosswalk across the 6 lanes of 104 Avenue. The intersection has a history of collisions involving people walking and the upgrade to a signal would control this conflict consistent with the City's Vision Zero policy.

Figure 30 Potential 106 Street Design at Intersections

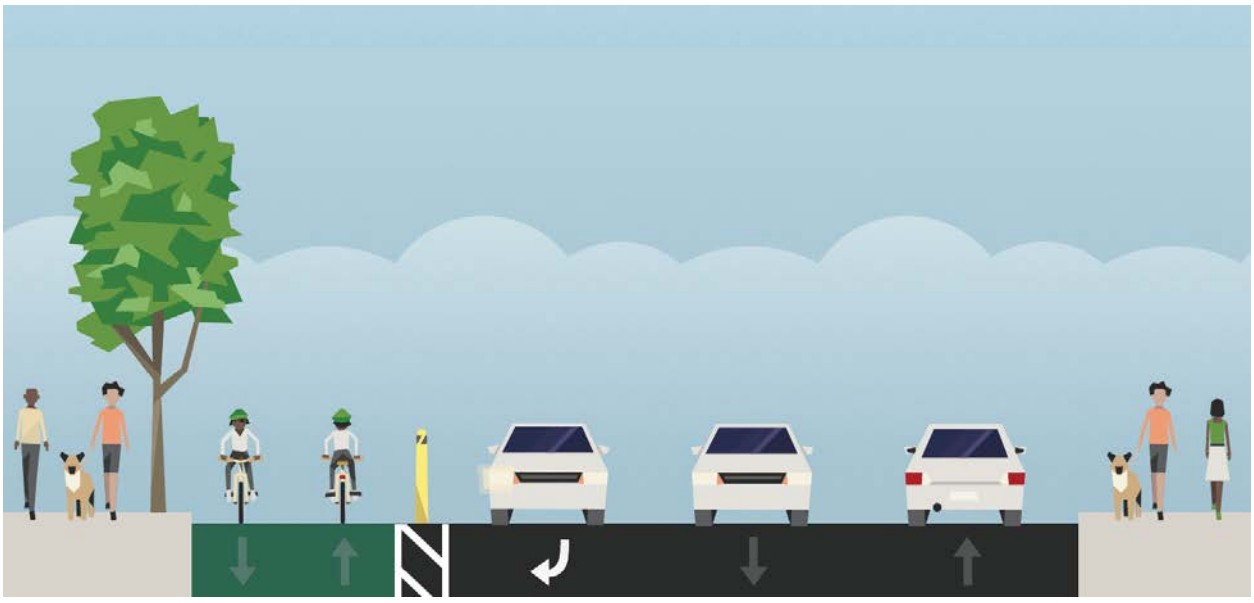
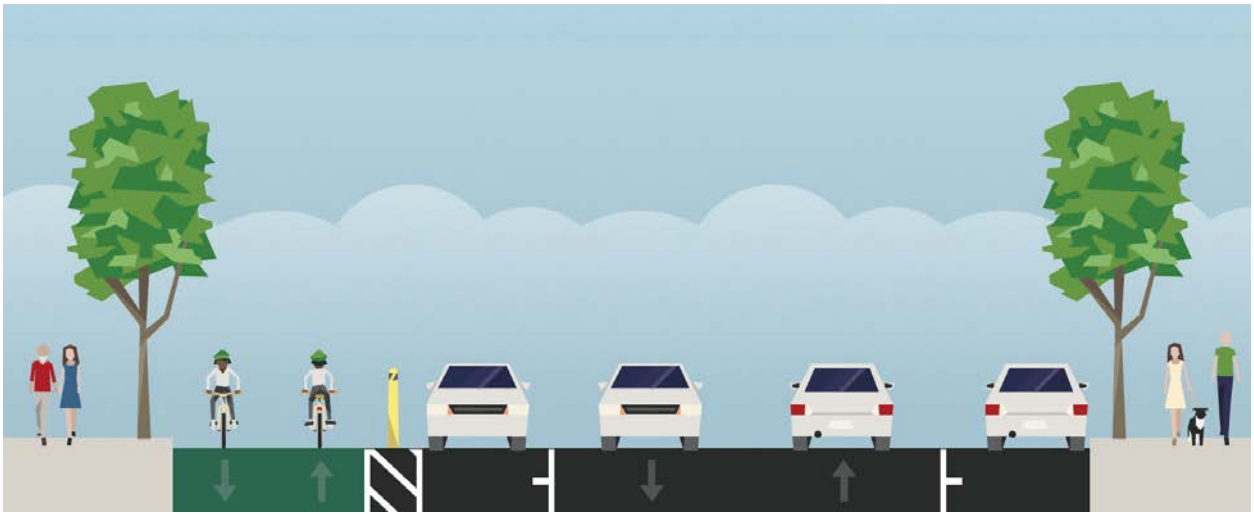


Figure 31 Potential 106 Street Design Midblock



4.5.9 107 Street (100 Avenue to 99 Avenue)

106 Street provides fewer conflicts and challenges as compared to 107 Street. However, 106 Street does not provide a direct connection to the Legislature and, thereby, River Valley Road and the High Level Bridge shared use paths. To provide access to these regional bike routes, the protected bike lane network includes a two-way protected bike lane along the west side of 107 Street from 100 Avenue to 99 Avenue. The protected bike lanes would transition to a shared use path south of 99 Avenue and into the Legislature grounds and shared paths connected to it. Figure 32 illustrates the potential design for 107 Street. Additional review of the protected bike lane buffer design would be required at this location due to the ETS bus operations along 107 Street and bus turning movements at the intersections of 100 Avenue and 99 Avenue. Providing the two-way protected bike lane along this block of 107 Street would require the removal of parking on the east side of the street which is already restricted at many locations along the street. Due to the age of the traffic signal controller and cabinet at 99 Avenue, this equipment requires replacement and should be completed with or without this project.

Figure 32 Potential 107 Street Design at North Side of 99 Avenue Intersection

4.5.10 110 Street (Railtown to 104 Avenue)

The Railtown shared use path currently extends from the High Level Bridge to approximately 100 m south of 104 Avenue and MacEwan University. Providing this connection will complete an all ages and abilities north-south route for the west side of Downtown. A two-way protected bike lane at this location along the west side of 110 Street could be accommodated with the removal of on-street parking. There is significant off-street parking for businesses in this area. Engagement with MacEwan University would also be beneficial to collaboratively design a connection through their campus to 105 Avenue.

5.0 FINANCIAL ASSESSMENT

The following presents a conceptual estimate of the cost of the proposed Edmonton Downtown Protected Bike Lane Network described in Sections 3.0 and 4.0 and illustrated in Figure 9.

5.1 CAPITAL COST

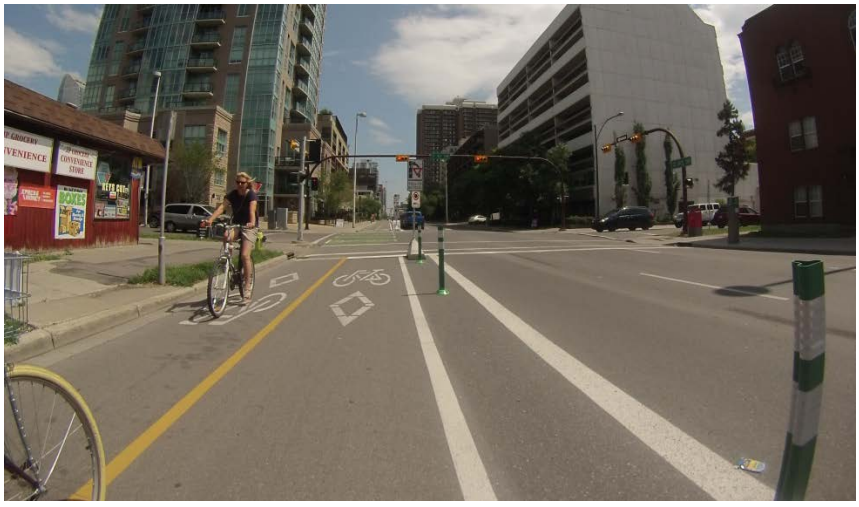
Capital costs have been estimated as described below. Capital costs relate to the infrastructure required along blocks and the markings at intersections based on an assessment of existing conditions and infrastructure, and the capital costs from the Calgary Centre City Cycle Track Network. It has been assumed that no additional capital costs will be required for snow clearing and removal equipment because the design of the routes allows the use of existing equipment. The cost estimates include purchase and installation, contingency, and design costs.

5.1.1 Midblock Costs/Linear Costs

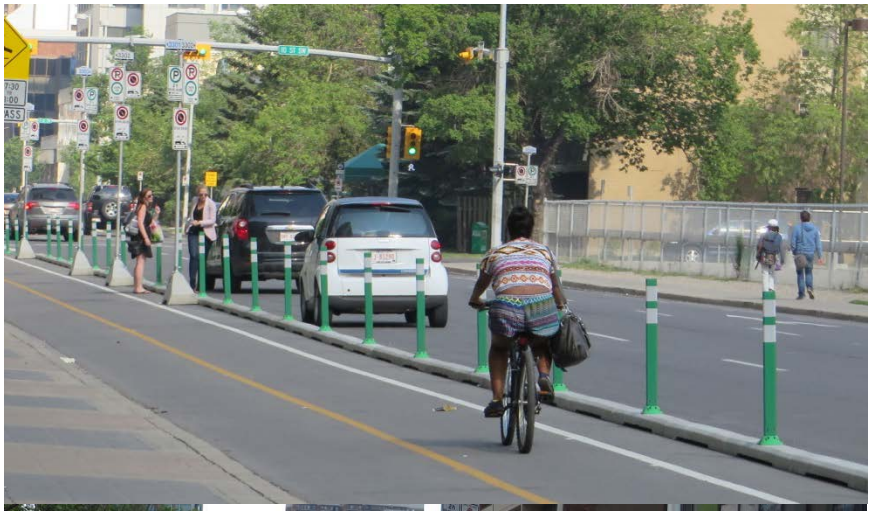
The midblock costs include removing existing pavement markings, adding pavement markings for bicycle lanes and vehicle lanes, and adding buffer infrastructure (e.g., plastic flexpost bollards). The costs of the pavement markings through the intersection (i.e., conflict zone markings) were calculated separately and combined with the midblock costs but not separated by route.

Three midblock cost estimates were prepared based on the following scenarios:

- Base: plastic flexpost bollards and paint



- Winter-Friendly: Base plus continuous concrete curb stops



- Enhanced: Winter-Friendly plus self-watering planters

The following unit costs were used to estimate midblock/linear costs of the network. These rates include purchase, install, contingency and design costs as well as removals of existing markings.

Table 3 Midblock/Linear Unit Costs

	Base	Winter-Friendly	Enhanced
Midblock Cost per lineal metre	$394	$456	$538
Intersection Cost per intersection		$11,354	

Applying these unit costs to the routes, we estimate the costs of the midblock and linear elements to equate to the totals summarized in Table 4.

Table 4 Midblock/Linear Costs per Route

	Quantity	Base	Winter-Friendly	Enhanced
Midblock Cost				
100 Avenue	770 m	$304,000	$351,000	$415,000
102 Avenue	820 m	$324,000	$374,000	$441,000
102 Avenue (Valley Line)	560 m		Part of Valley Line LRT	
102A Avenue	430 m	$170,000	$196,000	$232,000
104 Ave/103A Ave	1760 m	$81,000	$81,000	$81,000
96 Street	285 m	$193,000	$211,000	$234,000
99 Street	570 m	$225,000	$260,000	$307,000
103 Street	830 m	$328,000	$379,000	$447,000
106 Street & 107 Street	1005 m	$397,000	$458,000	$541,000
110 Street	80 m	$32,000	$37,000	$44,000
Intersection Cost				
Intersection Costs	30	$341,000	$341,000	$341,000
	TOTAL	**$2,395,000**	**$2,688,000**	**$3,083,000**

5.1.2 Intersection Costs

The existing traffic signal infrastructure was reviewed. A number of the controllers are aging and should be replaced through the signal renewal program with or without proceeding with the protected bike lane project. There are also two new traffic signals proposed for the network that should be installed for pedestrian safety even if the protected bike lanes are not implemented (i.e., at the 106 Street & 104 Avenue and 96 Street & Jasper Avenue intersections). A third new traffic signal is needed at 103 Street & 104 Avenue near the new Arena to facilitate this connection at-grade for people walking and cycling which is important for access to the Arena.

The following unit costs were used in the preparation of the capital cost estimate for intersection costs and include the purchase and installation of traffic signals as well as contingency and design costs.

Table 5 Intersection Unit Costs

	Component	Unit Cost
Renewal of Aging Infrastructure	Replace Cabinets and Traffic Controllers	$80,500
Infrastructure for Protected Bike Lanes	Bicycle Signal Installation, Cabling Upgrades, Reprogramming Signal Controllers, Communications Upgrades to Traffic Management Centre	$49,600
New Signals	New Traffic Signal	$402,500

The unit rates were then applied to the proposed protected bike lane network as summarized in Table 6. From the summary, about 33% of the intersection traffic signal costs are attributable to protected bike lane signal infrastructure. Approximately 35% is related to the installation of three new traffic signals and about 32% is related to replacing aging infrastructure that should be renewed.

Table 6 Intersection Costs for the Network

	Component	Quantity	Network Costs
Renewal of Aging Infrastructure	Replace Cabinets and Traffic Controllers	14	$1,127,000
Infrastructure for Protected Bike Lanes	Bicycle Signal Installation, Cabling Upgrades, Reprogramming Signal Controllers, Communications Upgrades to Traffic Management Centre	24	$1,190,400
New Signals	New Traffic Signals	3	$1,207,500
TOTAL			**$3,524,900**

5.1.3 Capital Cost Summary

Table 7 summarizes the capital costs for the Downtown Edmonton protected bike lane network. The winter-friendly design is approximately 5% more than the base design and the enhanced design would add a further 7% to the costs.

Table 7 Capital Costs for the Network by Route Design Option

Component	Base	Winter-Friendly	Enhanced
Midblock Costs	$2,054,000	$2,347,000	$2,742,000
Intersection Marking Costs	$341,000	$341,000	$341,000
Intersection Traffic Signal Costs (including bicycle signals, traffic signal renewal, and traffic safety components)	$3,524,900	$3,524,900	$3,524,900
TOTAL	**$5,919,900**	**$6,212,900**	**$6,607,900**

5.2 OPERATIONAL COST CONSIDERATIONS

The primary operating costs that we have prepared an estimate for is related to snow clearing and removal. There will be other operational costs related to education and evaluation that will be dependent on the approach taken by the City of Edmonton.

5.2.1 Snow Removal

The most critical aspect from Calgary's experience with winter maintenance of protected bike lanes over three years has been to clear snow as soon as possible. All protected bike lanes within Downtown are on the Priority 1 snow clearing network (which would be consistent with Edmonton's priority under the Snow and Ice Control Policy). In Calgary, this means that snow needs to be cleared within 24 hours of the end of snowfall.

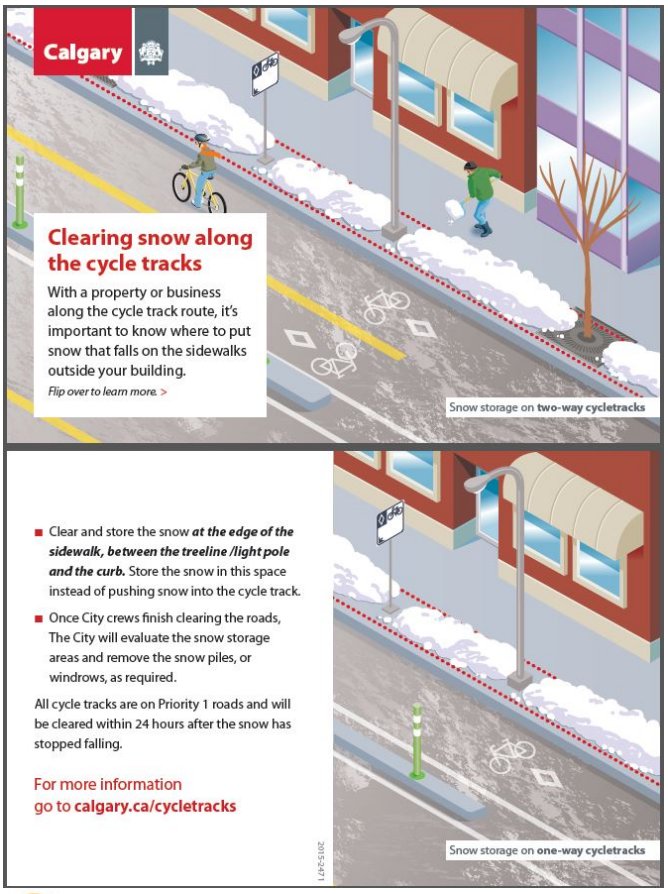
To achieve this target and limit the potential for ice and packed snow, Calgary dispatches equipment toward the beginning of a snow event for the protected bike lanes for a first pass. The first pass is used to create a clear-way for people riding bikes but will include some encroachment and areas requiring further clean-up. The first snow clearing pass moves the snow toward the curb and gutter, storing it in the gutter pan and on the furnishing zone/boulevard. Snow is not stored within the protected bike lane barrier area. Sidewalks are cleared by adjacent businesses and owners with snow also being stored within the furnishing zone adjacent

to the curb on the sidewalk. It is important to note that the barrier infrastructure is not removed for the winter season and is in place to maintain the physical separation for the bike lanes.

A second pass is then completed toward the end of the snow event to clean-up accesses and other areas and clear the snow away from the protected bike lanes as much as possible. This procedure reduces impacts from freeze-thaw cycles and has been shown to save money due to the significant effort required to remove ice should plowing not clear snow in a timely manner.

Snow removal from the protected bike lanes is coordinated with snow removal for the roads and completed at the same time. The City of Calgary general Twitter account is used to communicate snow clearing status including for cycle tracks. Just like travel lane snow clearing complaints, the City of Calgary also uses 311 as an avenue for identifying if the protected bike lanes are not adequately cleared. The City of Calgary has also created an infographic to educate and assist businesses, condominiums, their associated contractors, and others on how snow clearing should be completed associated with protected bike lanes (i.e., where to shovel and store snow): http://www.calgary.ca/Transportation/TP/PublishingImages/winter-cycling/SNIC%20postcard.JPG. This information can be given to people as postcards or viewed online and is available to Communications and Road Maintenance staff (Figure 33).

Figure 33 Snow Clearing Communications (Calgary)



As was the case for Calgary, snow clearing and removal for protected bike lanes would be something new for Edmonton crews. In early discussions between Calgary and Edmonton Roads Maintenance staff, facilitated by Stantec, it is apparent that narrower protected bike lanes (e.g., 2.1 m one-way protected bike lanes) create more challenges for snow clearing and removal than wider protected bike lanes (e.g., 3.1 m or wider two-way protected bike lanes). Facilities of 3.1 m and wider allow staff to clear them with equipment already available in the fleet. Narrower facilities require the purchase of specialized equipment to access the protected bike lanes. This may not be an issue for Edmonton as the proposed network consists of wider two-way protected bike lanes in response to operational and geometric constraints. If segments require narrower equipment, the use of shared use path equipment would be a viable option.

Prior to the implementation of the Centre City Cycle Track Network, Calgary had experimented with using contractors to conduct the snow and ice control for Calgary's first cycle track along 7th Street W for the 2013-14 winter season. This proved to be an expensive approach. Roads maintenance took over snow clearing/removal of 7th Street W for the following winter season and were able to provide this service for significantly less cost.

Based on the comparable length of the proposed Edmonton protected bike lane network and Calgary's Centre City Cycle Track Network and similar snowfall (i.e., 120 cm in Edmonton vs. 150 cm in Calgary on average), we have estimated that approximately $500,000 would be required annually to clear and remove snow. This cost is based on clearing snow within 24 hours along the protected bike lane network consistent with Calgary's service standard. For reference, during the 2015-16 winter season, Calgary spent about $162,000 on snow clearing and removal of their Centre City Cycle Track Network which includes routes with narrow one-way protected lanes that require additional time and associated cost to clear.

Finally, it is also important to note that the snow clearing approach in Edmonton currently causes significant damage to concrete curbs. We recommend a review of the snow clearing and removal procedures and changes made to limit the damage that is being caused. If a similar approach is taken to clearing snow from the cycle tracks, the low cost materials proposed under the "winter-friendly design" may not be sufficient to withstand being struck by blades from snow clearing equipment.

6.0 RECOMMENDATIONS

The following highlights the study's recommendations. Specific considerations for each route within the network can be found in Section 3.0, 4.0, and 5.0.

6.1 NETWORK

The findings of this study include a 7.1 km recommended network of protected bike routes. The network provides an all ages and abilities facility within 2 blocks of all major destinations within Downtown and connects to important regional bike routes that provide access to Downtown from surrounding neighbourhoods. This network is similar to Calgary's Network.

Figure 34 illustrates the Recommended Network. Protected bike lanes can be installed along all routes except 104 Avenue/103A Avenue which consists of an off-street shared use path. The protected bike lanes will be two-way facilities along one side of the street. Upgrades to existing outdated traffic signals and the installation of two new traffic signals will enhance crossings for walking and cycling, minimize conflicts between people driving and those walking and cycling, and may improve motor vehicle circulation and flow. The design of the routes allow for easier snow clearing and removal due to their width and proceeding with the "winter-friendly design" will further aid in the surface quality of the protected bike lanes during winter months (i.e., less debris and hazards). The potential designs can accommodate on-street parking and are consistent with concept and preliminary design plans that are approved for the Valley Line LRT.

Figure 34 Map of Recommended Network

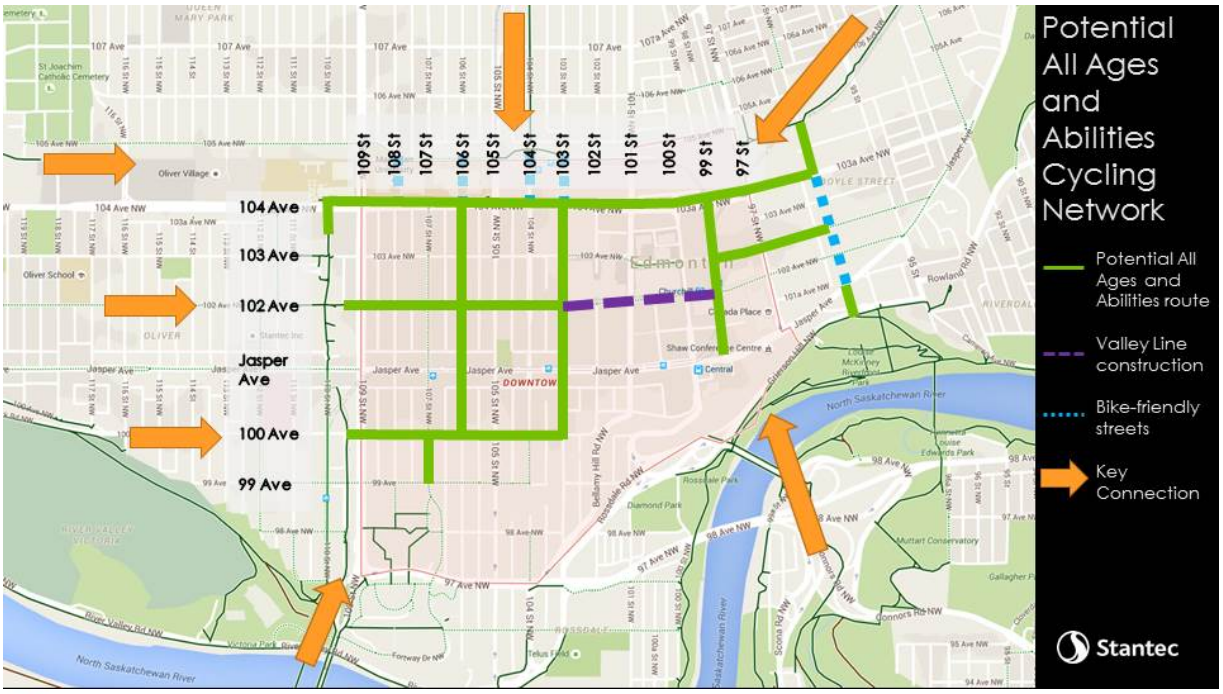


Table 8 summarizes the capital costs to implement the protected bike lanes based on a conceptual estimate and experience from Calgary's Centre City Cycle Track Network. To provide a system of protected bike lanes that controls conflicts, upgrades to the outdated traffic signal controllers/cabinets are required and additional traffic signal heads for bicycle signals and vehicle turn signals should be added. Additional detailed design may identify where these upgrades are not necessary, but they have been included in this study to provide a conservative cost estimate. With existing traffic volumes and small intersections at various locations, there may be opportunities to reduce this cost by using pedestrian signal phasing.

Table 8 Summary of Capital Costs for the Network

Component	Base	Winter-Friendly	Enhanced
Midblock Costs	$2,054,000	$2,347,000	$2,742,000
Intersection Marking Costs	$341,000	$341,000	$341,000
Intersection Traffic Signal Costs (including bicycle signals, traffic signal renewal, and traffic safety components)	$3,524,900	$3,524,900	$3,524,900
TOTAL	**$5,919,900**	**$6,212,900**	**$6,607,900**

The upgrades to outdated traffic signal infrastructure (much of it dating back to the 1980s) are likely already considered within an infrastructure renewal program and funding may be available through that budget. The addition of two new signals to provide an enhanced crossing for people walking and cycling at locations with histories of collisions may be part of a traffic safety program as part of the City's Vision Zero policy. A third new signal is proposed at the Arena to provide direct pedestrian access to the Arena across 104 Avenue. The budget to install the additional traffic signal infrastructure for bicycle travel and the midblock infrastructure may be available through a combination of existing funding programs related to traffic operations and signals, traffic safety, and active transportation.

In addition to these capital costs, it is estimated that $500,000 in annual operating funds may be required, again based on Calgary's experience, to clear and remove snow from the protected bike lanes within 24 hours (i.e., Priority 1).

6.2 IMPLEMENTATION

Assuming City Council votes to move forward on the Downtown Minimum Grid Protected Bike Lane Network outlined in this study, there are a number of additional steps to take as part of implementation.

6.2.1 Concept and Detailed Design Plans

Concept Design development of each street with a protected bike lane builds upon the cross sections that have been developed in this report and engages with various stakeholders to identify areas of concern or potential risk and develop a common understanding of the final designs that will be eventually put forward for construction. A review of the parking, accessible parking, and loading areas would be suitable at this stage to help identify where parking could be relocated to (if necessary) and identify loading zones that could be removed or relocated to accommodate the new protected bike lanes.

Following Concept Design, Detailed Design would be completed. It is recommended that approving authorities accept and review completed detailed designs as they are completed for each route while other routes are simultaneously still undergoing detailed design. Design packages (e.g., 60% and 90% Design) would be compiled and submitted to the City for workflow clarity. Elements in the design plans would include: plan, profile, and cross sectional views of the protected bike lanes, removals plan and pavement details, intersection treatments, signage and pavement marking plan, signal design, roadworks design, and construction work package details.

For a project of this scale, it is anticipated that about 200 drawing sheets would be required, which underscores the need to have a very clear approval process. Design discussions should be held at a number of design meetings, with bi-weekly Status Update Meetings being held with the City to ensure aspects of the design are progressing on schedule.

Based on the network opening in June 2017, efficient construction staging must be employed to meet the scheduled opening. As such, some construction work may need to be completed in Fall 2016. The design work should immediately focus on elements that may be fast tracked for early construction. Since these elements will not have been planned for and would likely not have resources allocated, the construction of these elements would need to be added to existing construction programs.

6.2.2 Supporting Programs

A number of supporting programs are likely required to ensure success of this project (Table 9).

Table 9 Description of Supporting Program Likely Required

Supporting Program	Description
Engagement Strategy	Engagement and communication planning is necessary to inform and engage the citizens and businesses in developing the protected bike lane network. Examples of topics to engage stakeholders on are local parking and loading activities, general awareness of the project, and specific design trade-offs. Engagement with stakeholders could be done through meetings, information sessions, committees, or intercept surveys. Key engagement and communication activities should be included in a detailed Communications and Engagement Plan. Since the routes are located on more local routes than commuter routes, engagement could likely be focused on local stakeholders.
Education Program	With the addition of a new transportation system to the downtown area, awareness and education around how to interact with the bicycle facilities will be required for people walking, people driving, as well as people riding their bicycles. This can be done through Bicycle Ambassadors having one-on-one conversations near the infrastructure, pamphlets or brochures of key information, and/or signs in and around Downtown. A multi-faceted education program would ensure the most penetration into the community and better learning outcomes. Bicycle Ambassadors were used in Calgary. Calgary had a budget of $120,000 in 2015 and $88,000 in 2016 for education, outreach, and awareness.
Winter Operations Plan	Although the bicycle infrastructure was designed to accommodate the existing snow clearing and removal equipment available in Edmonton, new protocols and procedures will likely need to be developed to clear the protected bike lanes during the winter seasons. One approach could be to develop a Winter Maintenance Guideline specific to the bicycle infrastructure; however, more engrained processes and procedures will need to be developed in the maintenance and operations groups of the City of Edmonton (see also Section 5.2.1).

6.3 SUGGESTED TIMELINE & CRITICAL PATH

Assuming an October 2016 approval of the protected bike lane network and completion of the network is sought for June/July 2017, an aggressive schedule is required. A high level design and construction schedule would be:

- Detailed Design: October 2016 – February 2017
- Tender: February – April 2017
- Start Construction: Beginning of May 2017
- Opening: End of June 2017 for all routes (staged opening as routes are finished)

To accomplish this schedule, a number of critical elements would need to be addressed immediately (i.e., as early as August, if possible), namely:

- Initiate Stakeholder Engagement on Conceptual Designs and/or Potential Designs
- Initiate Baseline Data Collection of Traffic Volumes (walking, cycling, vehicles)
- Initiate Detailed Design
- Initiate Signal Design
- Initiate Upgrading and Replacement of Outdated Signal Infrastructure

Other elements would soon fall on the critical path of delivering this project. With roadworks construction tendering for the project occurring no later than March to April 2017, it will be necessary to have the traffic signal infrastructure design, procurement, and installation follow a different schedule. We recommend that signal design and procurement should commence in September 2016 in order to meet the June 2017 opening. It may also be necessary to have a separate tender for the supply of the required roadworks materials to ensure all necessary components of the design are available at time of installation (e.g., City of Edmonton procurement of flexpost bollards).

Supporting elements of the project such as the Engagement Plan, Education Strategy, and Maintenance Strategy should be commenced in January/February 2017 in order to be implemented in conjunction with the opening of the network in June 2017. The Evaluation Strategy should be started in Fall 2016 to ensure sufficient baseline data can be collected.

Similar to the Calgary Cycle Track Network, due to the amount of construction required, it is likely that the opening of the protected bicycle network would be staged over a one month to six week period.

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