



CENTRE CITY CYCLE TRACK NETWORK PILOT PROJECT

IN-SERVICE ROAD
SAFETY REVIEW

TRANSPORTATION
ASSOCIATION OF CANADA
ROAD SAFETY ENGINEERING
AWARD SUBMISSION

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SUBMITTED FOR:

CITY OF CALGARY
CENTRE CITY CYCLE TRACK NETWORK PILOT PROJECT
IN-SERVICE ROAD SAFETY REVIEW

SUBMITTED BY:



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INTRODUCTION

The City of Calgary is committed to making cycling a safe, convenient, and attractive mobility choice for people of all ages and abilities. Promoting and encouraging cycling as part of a multi-modal transportation system can help the City plan for and accommodate growth, improve road safety, reduce automobile dependence, increase physical activity levels, improve public health, reduce infrastructure demands, and create a more livable and vibrant community.

In 2011, Calgary City Council adopted the Cycling Strategy, which aims to plan, design and build more bikeways to comfortably accommodate people who currently cycle and to encourage more people to cycle. The Cycling Strategy includes a vision that Calgary will become one of the premier cycling cities in North America.

In April 2014, Calgary City Council approved the development of the Centre City Cycle Track Network as a pilot project to provide Calgarians with more transportation choices downtown. The Centre City Cycle Track Network Pilot Project was opened in June 2015.

As the network was approved as a pilot project, the City was required to carefully monitor and evaluate the operation and safety of the network for people walking, cycling and driving. The cycle tracks were evaluated on over 80 performance measures, including safety, satisfaction for all road users, and impact to business. The evaluation results were presented to City Council in December 2016 following the 18-month pilot period, where Council voted to make the cycle tracks in the Centre City permanent.

As part of the evaluation and monitoring of the pilot project, the City of Calgary retained Urban Systems to conduct an In-Service Road Safety Review (ISRSR) of the Centre City Cycle Track Network Pilot Project. The objectives of the ISRSR were:

- 1 To obtain input from key internal and external stakeholders about their experience with the safety of the cycle track network.
- 2 To conduct on-site observations to provide an assessment of existing infrastructure, behaviour of all road users, and human factors.
- 3 To identify safety issues and develop mitigation measures.

The ISRSR was conducted over six months and involved multiple site visits throughout the entire cycle track network during both daytime and nighttime conditions by foot, bicycle and motor vehicle. Stakeholder input was a critical part of the process, and the project team met with internal and external stakeholder groups at two separate occasions to discuss existing safety issues and proposed mitigation measures.

Based on observations and stakeholder feedback, the final report documented the identified safety issues and presented suggested mitigation measures to address the safety issues for the City's consideration. The suggested mitigation measures focused on addressing issues associated with the existing temporary facilities, but also considered opportunities associated with potential upgrades to permanent facilities, and considerations for potential future cycle track projects.

The ISRSR concluded that, while there were a range of identified safety issues, the Centre City Cycle Track Network was designed to meet, or exceed, the leading national and international best practices in cycle track design. Discussions with stakeholders and observations by the project team found that the provision of cycle tracks significantly improved both real and perceived safety for all road users along the study corridors. In addition, the cycle tracks have resulted in significant increases in cycling volumes in the Centre City, which has further contributed to increased safety through "Safety in Numbers".

The City of Calgary is currently actively implementing the high priority recommendations of the study. In doing so, it is anticipated that the resulting safety improvements will make cycling a safer and more comfortable transportation option for people of all ages and abilities, which will in turn lead to further behaviour change and continue to increase the number of cycling trips made in Calgary.

The City of Calgary and Urban Systems are very excited to submit this nomination for a Transportation Association of Canada (TAC) 2017 Technical Excellence Award in the Road Safety Engineering Award category for our work on the Centre City Cycle Track Network Pilot Project ISRSR. The Centre City Cycle Track Network's method of implementation as a pilot project using adjustable measures was innovative and is highly transferable to other communities. Communities across North America are now using the Calgary case study as a model and approach to develop their cycle track networks. In addition, the ISRSR was innovative, as it involved a comprehensive review of an entire network and was focused primarily on the safety of vulnerable road users. In addition, it was based on a combination of rigorous technical analysis, extensive field observations, and input from stakeholders. The results and insights gained from this study provide comprehensive, innovative and ground-breaking results and are highly transferable to other communities and the transportation profession as a whole by providing a detailed understanding of cycling safety issues, which can help to inform the design of better, safer cycling facilities in other communities.

REALIZED OR ANTICIPATED BENEFITS

Anticipated Safety Benefits

A cycle track is an exclusive bicycle facility that is physically separated from both motor vehicles and people walking. Cycle tracks provide a predictable space and minimize potential conflicts between people who walk, cycle, and drive. Cycle tracks can take many different forms, but they all share common elements - they provide space located within the road right-of-way that is intended to be used exclusively for bicycles, and is physically separated from motor vehicle travel lanes, parking lanes, and sidewalks.

Cities across North America are increasingly focusing on cycle tracks when it comes to promoting cycling. Cycle tracks are an important component of a high quality bicycle network that is comfortable and safe for people of all ages and abilities. Research and evidence from other cities indicates that cycle tracks and the act of separating bicycle users from vehicles has been found to improve safety for people cycling as well as overall corridor safety for all road users. For example, a study of bicycle facilities in Toronto and Vancouver by Teschke et al. (2012) found that cycle tracks are by far the safest type of bicycle infrastructure and had the lowest injury risk among all types of bicycle facilities studied, with approximately nine times lower collision risk than major streets with no bicycle infrastructure (see [Figure 1](#) and [Figure 2](#)).

Lusk et al. (2013) analyzed and compared 19 cycle tracks in the United States and collected extensive data on cycle track design, usage, and crash history. The study found that the risk of bicycle-vehicle crashes is lower on cycle tracks than rates on roadways. Six of the 19 cycle tracks studied were two-way cycle tracks on one side of the street. There was a 28% lower injury rate on streets with cycle tracks than on alternative routes without cycle tracks, resulting in a relative risk of 0.72 compared to nearby streets.

These results have been supported by findings in other North American cities, such as New York City, where after the installation of cycle tracks on 8th Avenue the rate of crashes with injuries decreased by 30% on the section of the street with a cycle track and 56% after the installation of the 9th Avenue section. In another New York example, after the implementation of the two-way cycle track at Prospect Park West, there was a 62% decrease in crashes with injuries. In 2012, City of Vancouver staff reported a decrease of approximately 20% in all collisions, including motor vehicles, cyclists and pedestrians on Hornby Street and Dunsmuir Street after implementation of two-way cycle tracks. As noted above, these reductions in collision rates

have occurred as ridership along these routes has increased, indicating that cycle tracks not only reduce vehicle collisions of all types but they also provide facilities that bicycle users want to use.

In addition to the safety benefits of physically separating users, cycle tracks help to address some of the most common safety concerns resulting from the following types of cycling and motor vehicle interactions:

- **Doorings:** When a person cycling is struck by the door of a vehicle as it is opening.
- **Right hooks:** When a person cycling is struck by the right side of a vehicle as it makes a right turn.
- **Left crosses:** When a person cycling is struck head on by a vehicle turning left at an intersection.
- **Sidewalk cycling:** When a person cycling on a sidewalk is involved in a collision with a pedestrian or struck by a vehicle while transitioning to the roadway.

Based on this research and evidence from other cities, it was anticipated that the Centre City Cycle Track Network would result in significant safety benefits.

Identified Safety Issues

The ISRSR identified specific safety issues through site visits and discussions with stakeholders and based on a review of international best practices in cycle track design. These issues were categorized into the following eight themes, with a number of suggested mitigation measures to address each safety issue.

CORRIDOR TREATMENTS – Corridor treatments refer to the direction (bi-directional or uni-directional), width of the facility and buffer, and safety concerns with facilities that are shared spaces and/or sidewalks. Suggested mitigation measures for corridor treatments included: increasing the width of the facility, providing a more permanent form of separation, or providing an on-street bicycle facility rather than a shared sidewalk over the long-term. This will provide increased space and separation between different road users reducing potential conflicts.

END POINTS AND TRANSITIONS – End points and transitions refer to locations where the cycle track ends or where it transitions to a different type of facility. These are some of the most complex locations within a bicycle network, as it is difficult to end a facility that transitions people cycling into a safe position to enter a new type of bicycle facility or share the road with motor vehicles. Mitigation measures suggested for consideration included: alternative intersection designs, increased signage, education campaigns, and continuing the cycling facility through the intersection.

CYCLE TRACK CONVERGENCE – Cycle track convergence refers to locations where two cycle tracks intersect. These are locations where people cycling may be making turning movements that require riding across crosswalks in potential conflict with people walking or finding a space to wait to make the turning movement without obstructing other road users. Suggested mitigation measures included: reconfiguring the intersection design, providing additional physical separation in the intersection, and continuing to refine the bike box and bike turn box education campaign.

INTERSECTIONS – Intersections are an important component of a cycle track network, as they are complex locations where there is the greatest potential for conflict between all road users. Suggested mitigation measures included: protected turning phasing, restricting turning movements, right turn on red restrictions, and installing bicycle detection.

PARKING AND LOADING ZONES – On-street motor vehicle parking can present some safety issues, including potential doorings. People may also be crossing or stopping in the cycle track to access their

vehicle or a parking metre. Suggested mitigation measures included: increasing the width of the cycle track buffer, elevating the cycle track at loading zones or locating parking metres on a raised median in the street buffer or on the sidewalk near a crosswalk where space is available.

CONFLICT ZONES – Conflict zones are locations where the cycle track intersects an alleyway, driveway, or loading zone. At these locations visibility and awareness of the bicycle facility may be low, resulting in motor vehicle drivers not stopping before entering. Pavement markings at conflict zones can raise awareness of these potential conflict areas for both people cycling and motor vehicle drivers. Suggested mitigation measures included: installing a raised cycle track and sidewalk and installing hidden driveway signage for people cycling and driving.

TRANSIT INTEGRATION – There are a number of different designs that can be used to integrate cycle tracks with bus stops that separate and raise awareness of all road users. Suggested mitigation measures included: integrating the bus stop and the cycle track facility to provide a continuous cycle track facility or consider routing the cycle track behind the bus stop.

MULTI-LOCATION SAFETY ISSUES – Several multi-location safety issues were also identified. These multi-location safety issues were more general and applied to all of the corridors in the study area, and could also be applicable to other cycle tracks the City designs and installs in the future.

Throughout the pilot project, the City reviewed locations where incidents occurred and adjusted the design when an issue was identified. This included additional dashed green paint at alleys and driveways, parking changes to improve sight lines for turning vehicles, or additional signage.

Realized Safety Benefits

Through the comprehensive monitoring and evaluation of the pilot project, the City has been able to quantify the realized safety benefits of the Centre City Cycle Track Network Pilot Project. As noted previously, the cycle track network was evaluated on over 80 performance measures, including safety. Key findings are summarized below.

INCREASED RIDERSHIP – Bicycle use significantly increased as a result of the pilot project. Prior to the pilot project, people cycling in the Centre City had little dedicated infrastructure to ride on, leading to only confident cyclists be comfortable riding with traffic. Bicycle use tripled compared to before the pilot project, indicating that the increased comfort and perceived safety provided by the cycle tracks was very successful in attracting new users (see [Figure 3](#)).

REDUCED OVERALL COLLISIONS – When considering overall collisions, the total number of absolute reported collisions decreased throughout the network overall, and stayed the same or decreased on each individual cycle track corridor, demonstrating that the cycle track network improved safety for all road users (see [Table 1](#)).

REDUCED CYCLING COLLISION RATE – Although it is too early to evaluate the before-after collision situation, recent collision numbers indicate that there was a slight increase in the number of reported bicycle related collisions during the pilot project. This is not unexpected based on the increase in the number of people cycling along the corridors. Despite an increase in the number of collisions, however, the overall cycling collision rate has actually decreased following the pilot project due to increased ridership (see [Figure 4](#)). This trend supports the “safety in numbers” principle. Safety in numbers refers to a phenomenon that as

the proportion of trips by bicycle increases, the cycling fatality rates decrease. This has been observed by researchers in a number of cities with a high bicycle mode share. The evidence suggests that as levels of cycling increase, cycling injury and fatality rates per-trip and per-kilometre travelled decrease substantially.

REDUCED SIDEWALK CYCLING – Sidewalk cycling has been shown to present multiple safety issues, including potential conflicts with people walking on sidewalks, as well as issues at intersections where motorists are not anticipating people to be cycling. The cycle track network resulted in significant reductions in sidewalk cycling, which helps to improve safety for people walking as well as people cycling (see [Table 2](#)).

Reduced cycling against traffic flow – Prior to the cycle track network, more people had been observed to be cycling in the roadway against the flow of traffic. The number of people cycling against the flow of traffic was nearly eliminated on all cycle track corridors through the pilot project, contributing to improved predictability and resulting in improved safety for all users (see [Table 3](#)).

Changes in demographics and increased comfort – The cycle tracks have created a comfortable cycling experience for people of all ages and abilities, and the City has seen an increase in the number of women and children cycling downtown. The number of women cycling in the Centre City increased from 22% in 2014 to 30% in 2016, while the number of children increased from 0.1% to 1.3%. In addition, the following results were among the key findings of an Ipsos Telephone survey completed after the installation of the cycle tracks:

- **77% of people cycling** say cycle tracks have made the cycling experience better downtown and 65% prefer to cycle on streets with cycle tracks.
- **57% of people surveyed** who had tried the cycle tracks, said they started cycling in the Centre City after 2011.

Perception of safety – The Ipsos Telephone Survey also found that 90% of people walking, cycling and driving reported feeling safe travelling on the cycle track corridors after the cycle tracks were installed. Notably, people cycling in particular reported a significant increase in their perceived safety, as 91% of people cycling reported feeling safe on the cycle track network after they were installed, compared with 68% before hand (see [Figure 5](#)).

During the pilot, many adjustments were made to improve safety such as adding dashed green pavement markings at driveways, improving signage or pulling back parking to improve sightlines at alleys or driveways. The City is now actively moving forward with implementing the high priority recommendations of the study. In doing so, it is anticipated that this will further contribute to improving safety for cyclists as well as all road users by focusing on specific measures to address identified safety issues. It is anticipated that the high priority recommendations will help to reduce the frequency and rate of cycling collisions, and will also help to reduce the severity of collisions in Calgary by targeting vulnerable road users who are the most likely be killed or seriously injured when involved in a collision.

DEGREE OF INNOVATION

This project had a number of innovative components. Firstly, implementing the cycle track network all at one time was a unique and innovative approach. Implementing the network as a pilot project, using adjustable measures, was a ground-breaking model that is now being replicated by communities across North America. This provided the City with design flexibility, and allowed the City to adjust the corridors throughout the course of the pilot project to respond to traffic safety and operational concerns as they

arose. In addition, by implementing the network at once, the City experienced greater increases in ridership than it would have seen if each corridor were implemented independently.

In addition, cycling safety is an under-researched topic in North America and around the world, and there remains limited empirical evidence about the safety of cycle tracks in North America. This project demonstrates the realized perceived and actual safety benefits of the implementation of the cycle track network. These benefits can now be used to help other cities justify investments in cycle tracks. In addition, the cycling safety issues identified through this study can help to inform the City's cycle track designs moving forward, and can help inform other cities.

This project was also innovative in that it focused on the review of a complete network, as opposed to an individual corridor. This provided for a comprehensive understanding of how implementing cycle tracks together as a network can help provide significant safety benefits.

The study also involved extensive consultation with stakeholders which is not always a component of In-Service Road Safety Reviews. The project team met with both internal and external stakeholder groups at two separate occasions to discuss existing safety issues and proposed mitigation measures. This stakeholder input was critical to ensure the project team understood safety issues from the perspective of users, and that the mitigation measures would help address their concerns.

Finally, the study involved comprehensive monitoring of both real and perceived safety of the cycle track network using a wide range of indicators, including before and after data. This data was critical to demonstrate the success of the cycle track network and helped provide Council with an evidence-based safety rationale to approve making the cycle track network permanent. The monitoring and evaluation that was used for this project is an example that can be used by other communities.

TRANSFERABILITY

The results and insights gained from this study are highly transferable to other communities and the transportation profession as a whole by providing a detailed understanding of cycling safety issues, which can help to inform the design of better, safer cycling facilities in other communities. The safety issues and recommendations identified in this report can be applied to facilities implemented elsewhere and offer important design considerations for other communities.

After the success of the City of Calgary Centre City Cycle Track Network Pilot Project, many other communities (including the City of Edmonton, City of Winnipeg, and City of Toronto) are moving forward with installing pilot or adjustable bicycle facilities as a way to implement new infrastructure. The ISRSR was an important component of the evaluation of the performance of the cycle track network. The methodology used for both the implementation of the cycle track network and the ISRSR is transferable to other municipalities. These can be used as a case study to help monitor the performance of the facilities for all road users, review before and after safety data for all road users – including both perceived and real safety, and ensure that any safety concerns are addressed quickly and efficiently as either spot improvements or more significant adjustments to the design.

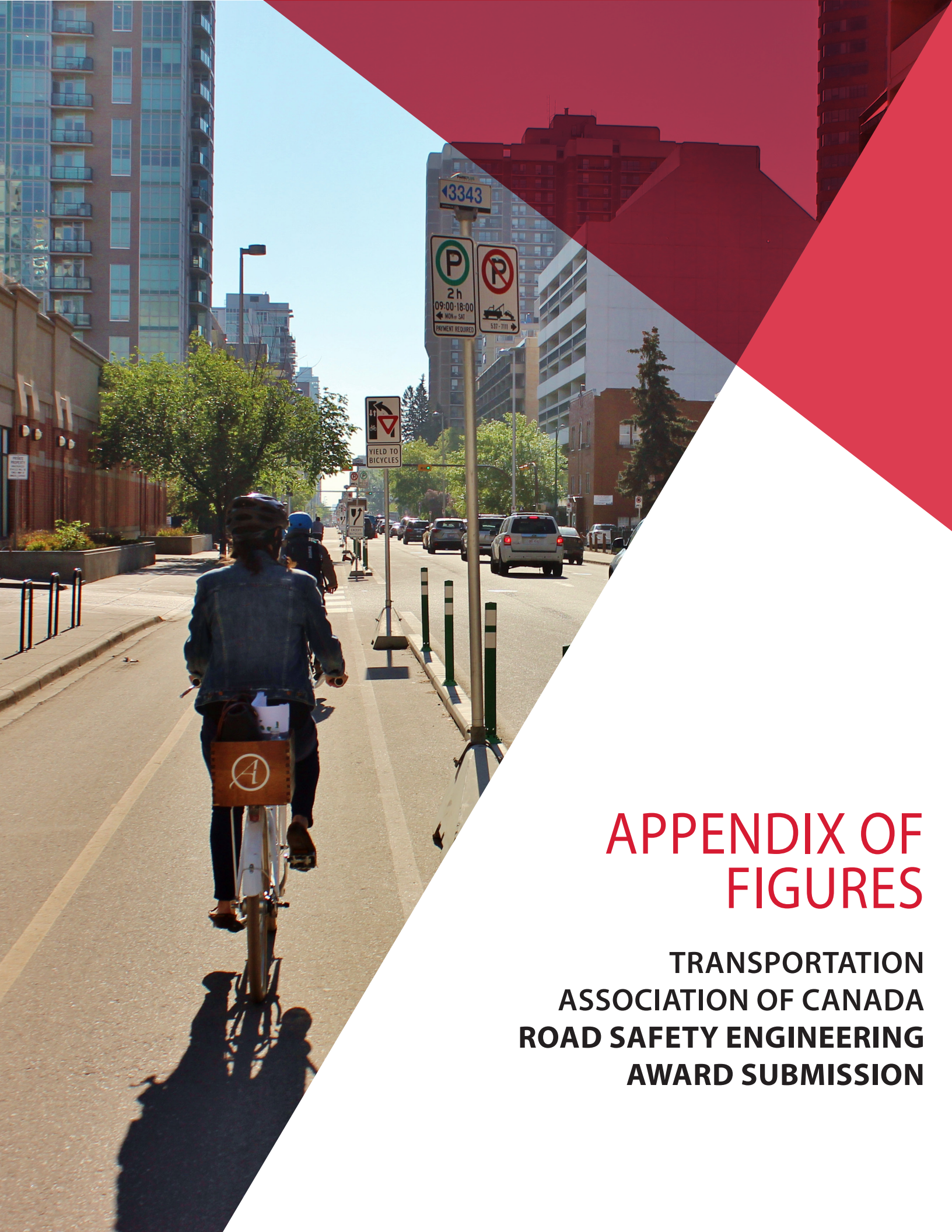
As part of the monitoring process the City collected detailed data before, during and after implementation to ensure they could provide a comprehensive assessment of the impact of the cycle track network based

on a number of factors including, road safety, the number of cycling trips, winter maintenance, the impact to business, parking and traffic delays. The data collection strategy and monitoring process provided the City with the quantitative data needed to present performance measures to Council.

The innovative approach to the implementation of the cycle tracks and the monitoring process, including the In-Service Road Safety Review of the pilot cycle track network are transferable to other cities looking to better understand the impact new cycling infrastructure has on all road users.

CONCLUSION

Concern for safety is one of the most important deterrents to increasing cycling. By conducting this project, the City is demonstrating its commitment to a sustainable transportation system and the high degree of importance placed on vulnerable road users in creating a safe, multi-modal transportation system. By focusing on targeted improvements to improve cycling safety. The City can help to make cycling more convenient, attractive, safe, and normal way to travel through the City. This project will help the City to achieve its targets related to increasing the mode share of sustainable transportation and reducing traffic related injuries and fatalities.



APPENDIX OF FIGURES

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Figure 1 - Relative Injury Risk on Different Bicycle Infrastructure
 Source: UBC Cycling in Cities Program

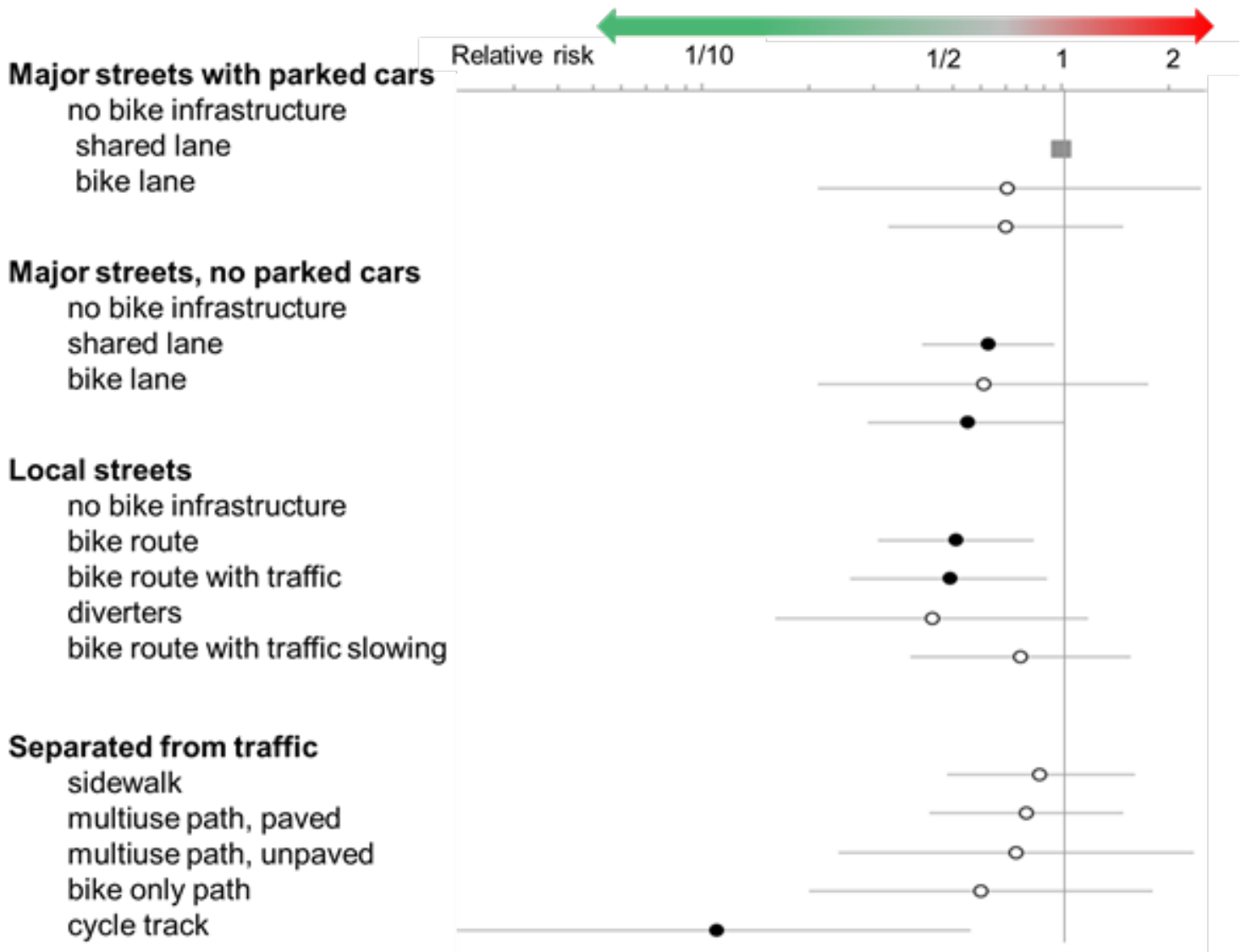


Figure 2 - Route Preference and Safety Matrix for Different Bicycle Infrastructure
 Source: UBC Cycling in Cities Program

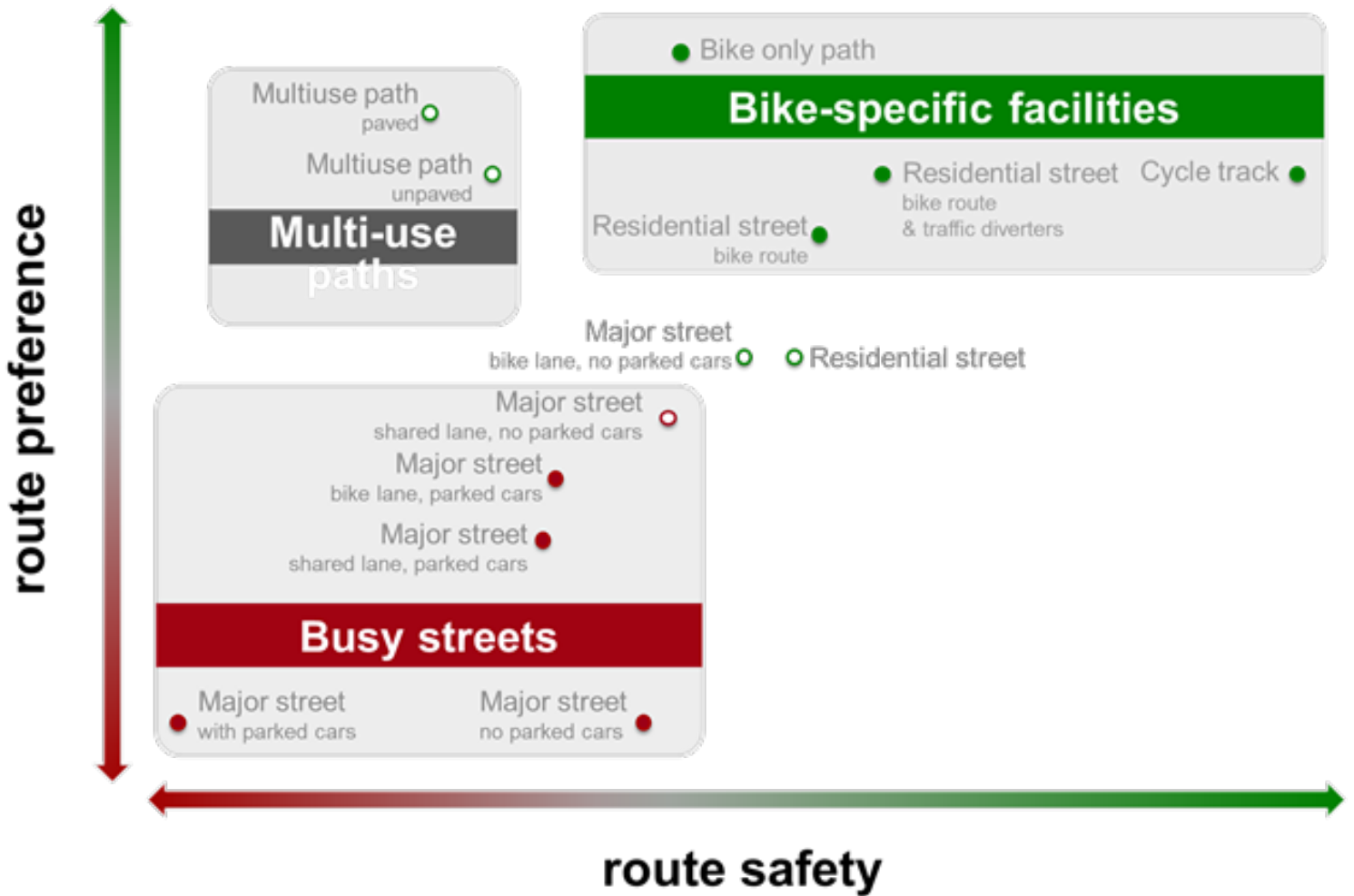


Figure 3 - Daily Bicycle Trips on Cycle Track Corridors
 Source: City of Calgary

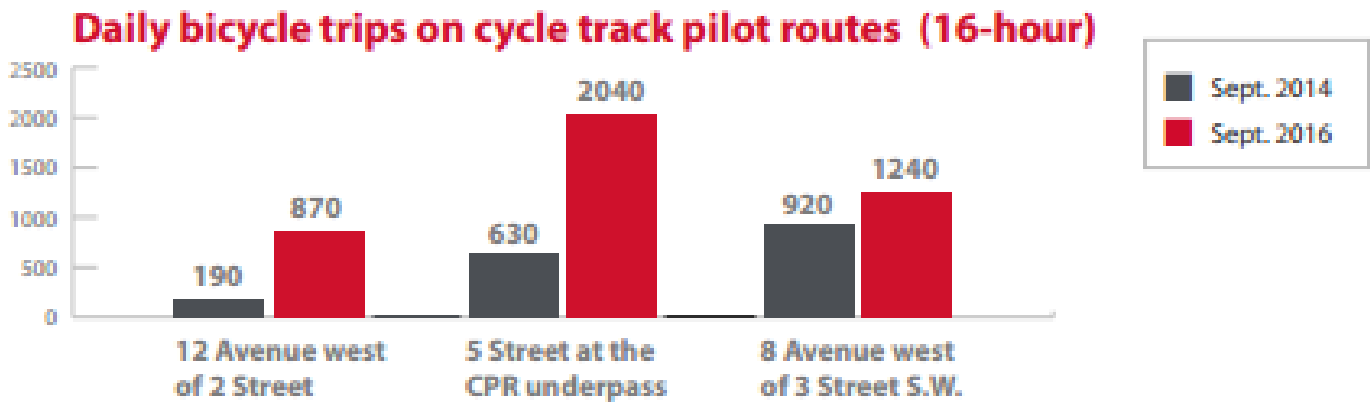


Figure 4 - Reported Cycling Collisions and Cycling Collision Rate (2009-2016)
 Source: City of Calgary

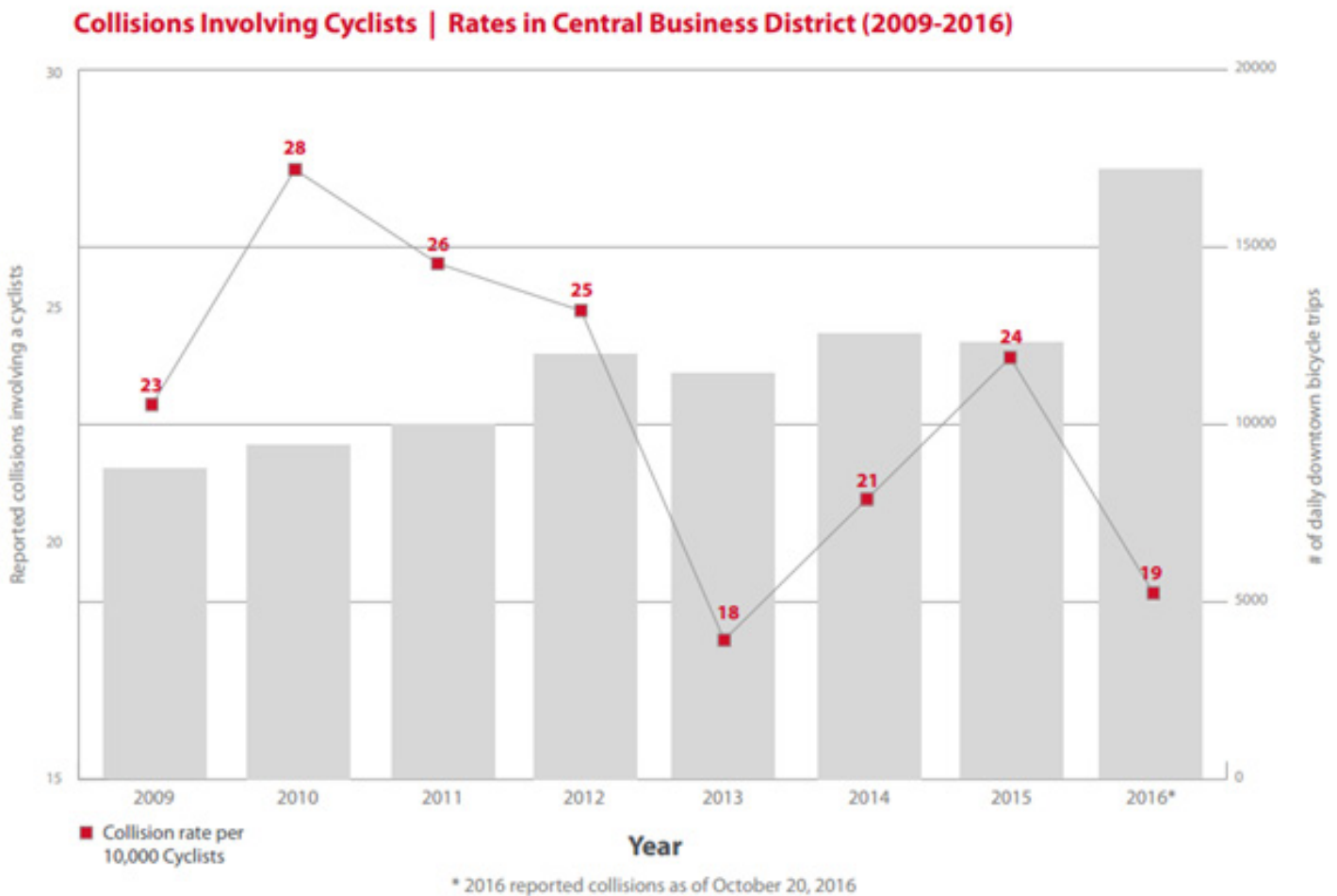


Figure 5 - Perception of Safety Before and After Cycle Track Network Installation
Source: City of Calgary

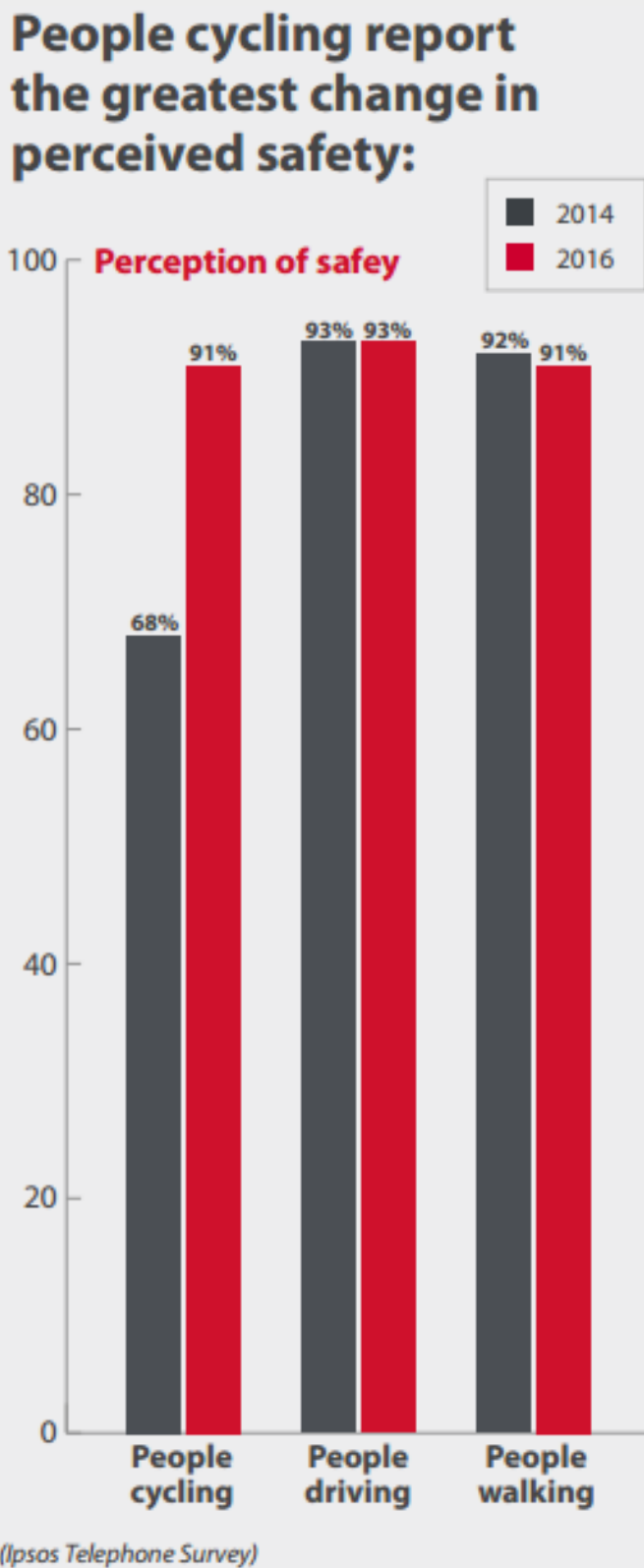


Table 1 - Average Annual Collisions Before and After the Cycle Track Network

Source: City of Calgary

CORRIDOR	AVERAGE ANNUAL COLLISIONS BEFORE CYCLE TRACK NETWORK	AVERAGE ANNUAL COLLISIONS AFTER CYCLE TRACK NETWORK
5 Street S.W.	178	140
12 Avenue S	153	133
8 Avenue S.W.	63	63
Stephen Avenue Shared Space	24	30

Table 2 - Incidences of Sidewalk Cycling Before and After the Cycle Track Network

Source: City of Calgary

CORRIDOR	PERCENT OF BICYCLE USERS BEFORE CYCLE TRACK NETWORK	PERCENT OF BICYCLE USERS AFTER CYCLE TRACK NETWORK
5 Street S.W.	19%	1.3%
12 Avenue S	23%	3.3%
8 Avenue S.W.	7%	1.5%

Table 3 - Incidence of Cycling Against Traffic Flow Before and After the Cycle Track Network

Source: City of Calgary

CORRIDOR	AVERAGE ANNUAL COLLISIONS BEFORE CYCLE TRACK NETWORK	AVERAGE ANNUAL COLLISIONS AFTER CYCLE TRACK NETWORK
5 Street S.W.	2%	0%
12 Avenue S	5%	0%
8 Avenue S.W.	3%	0.1%