CITY OF VANCOUVER
CYCLING SAFETY STUDY

SUMMARY REPORT
January 22, 2015

Prepared by Urban Systems, in association with the Cycling in Cities Research Program at the University of British Columbia and Simon Fraser University

Reported cyclist collision data provided by ICBC

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1.0 Introduction

The City of Vancouver is one of the most bicycle-friendly cities in North America. It has an extensive bicycle network that is well used by residents and visitors, as well as one of the highest cycling mode shares among major North American cities. According to the 2011 Canadian National Household Survey, cycling accounts for approximately 4.4% of all trips to work in the City of Vancouver.

The City recognizes the critical role that cycling can play in creating green and livable communities, and is committed toward making cycling safe, convenient, and comfortable for people of all ages and abilities. The City’s Transportation Plan, Transportation 2040, sets a target that two-thirds of all trips by 2040 will be made by walking, cycling or transit. Transportation 2040 also sets a target to work towards zero traffic-related fatalities, and places a special emphasis on safety for vulnerable road users, including pedestrians and cyclists. One of the recommended actions in Transportation 2040 was the development of a city-wide Cycling Safety Study to provide a better understanding of cycling safety hotspots and concerns.

A wide range of engineering treatments can be used to improve cycling safety, such as protected bicycle lanes, buffered bicycle lanes, coloured conflict zone markings, and protected bicycle signal phases. In addition to engineering treatments, education and encouragement initiatives can help to raise awareness among bicycle users, pedestrians, and motorists about how to safely share the road and improve the behaviour of those driving and cycling.

The City has taken several significant steps in recent years to improve cycling safety, including the installation of a number of engineering treatments such as protected bicycle lanes, spot improvements at high collision intersections, installation of signage and pavement markings, traffic control upgrades at key intersections, and installation of coloured pavement markings in vehicle-bicycle conflict zones. The City also has an Active Transportation Policy Council to advise on matters that encourage and enhance cycling as a means of transportation, recreation and health. In addition, the City is developing an Active Transportation Promotion and Enabling Plan which identifies strategies that can help promote active transportation for all residents.

The Cycling Safety Study builds on these initiatives and provides critical information on key safety and design concerns within the bikeway network that, if addressed, can further position cycling as a safe, comfortable, and attractive transportation choice for people of all ages and abilities.

This study provides a comprehensive and objective review of the safety of cycling in the City of Vancouver and provides an action plan to address each of the identified cycling safety issues. This study involved an in-depth analysis of all
collisions reported to the Insurance Corporation of British Columbia (ICBC) involving bicycle users and motor vehicles in the City of Vancouver between 2007 and 2012. In addition, the study analyzed the injury data from bicycling crashes that resulted in treatment at a hospital emergency room in Vancouver in 2008 and 2009 from the Bicyclists’ Injuries and Cycling Environment (BICE) study conducted through the University of British Columbia Cycling and Cities program. Based on these datasets, the analysis examined WHERE reported cycling collisions and injury crashes took place, HOW they occurred, WHEN they took place, and WHO was involved.

2.0 Vancouver in Context

The ICBC data included 2,994 reported collisions involving bicycle users and motor vehicles between 2007 and 2012 in the City of Vancouver, equivalent to an average of approximately 500 reported cycling collisions per year. In comparison, there was an average of 50,145 total reported collisions in Vancouver per year over this period. As such, on average, approximately 1.0% of all reported motor vehicle collisions involved a bicycle user over this period.

The overall number of reported collisions involving bicycle users and motor vehicles in Vancouver has been relatively stable on an annual basis over the past fifteen years and beyond, although it should be noted that there was a pronounced increase in the number of reported cycling collisions in 2001, which is likely a result of the increased number of bicycle trips made during the transit strike.

Although the absolute number of reported cycling collisions has remained relatively stable since 1996, there has been a significant increase in the City’s population as well as the number of bicycle trips made over this period. As shown in Figure 1, although the number of daily cycling trips has steadily increased since 1999, this has not translated into an increase in the number of reported cycling collisions. As a result, the rate of cycling collisions in Vancouver has been steadily declining over the past fifteen years, as shown in Figure 2. In fact, the annual cycling collision rate in Vancouver decreased by approximately 59% between 1996 and 2012, from approximately 48 to 20 reported cycling collisions per million bicycle trips.

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i For the remainder of this report, the term “reported cycling collisions” has been used to refer to collisions reported to ICBC involving bicycle users and motor vehicles.
ii For the remainder of this report, the term “cycling injury crashes” has been used to refer to injury data from the BICE Study based on bicycling crashes that resulted in treatment at a hospital emergency room in Vancouver.
Figure 1
Annual Number of Reported Bicycle Collisions and Daily Bicycle Trips (1996-2012)

Figure 2
Cycling Collisions per Million Bicycle Trips (1996 – 2012)
Between 2007 and 2012, there were a total of four reported cycling fatalities in the City of Vancouver, resulting in an average of 0.7 fatalities per year. As seen in Figure 3, Vancouver had the lowest number of annual cycling fatalities when compared to other communities across Canada and internationally.

**Figure 3**
Average Number of Annual Cycling Fatalities in Canadian and International Peer Cities (2007-2012)


In addition, when comparing the average number of cycling fatalities to the number of annual bicycle trips, Vancouver has the lowest cycling fatality rate among North American cities (0.07 cycling fatalities per million annual bicycle trips), with the same cycling fatality rate as Berlin and Melbourne. This cycling fatality rate is comparable, albeit slightly higher, than world-leading cycling cities, including Amsterdam (0.05) and Copenhagen (0.04), as shown in Figure 4.
3.0 Summary of Findings

Overall cycling collision locations between 2007 and 2012 in the City of Vancouver are shown in Figure 5. The following section provides a brief summary of the key cycling safety issues that were identified based on the analysis of cycling collisions over the past six years in the City of Vancouver, including WHERE cycling collisions took place, HOW the collisions occurred, WHEN they took place, and WHO was involved.
Where

The highest number of reported cycling collisions was in the Downtown core and the Metro Core of Vancouver, with reported cycling collisions concentrated along several key corridors such as Burrard Street, Main Street, 10th Avenue, Commercial Drive and Cypress Street.

61 locations throughout the City had at least one reported cycling collision per year between 2007 and 2012; these 61 locations represented 4% of all reported cycling collision locations, but accounted for 20% of all reported cycling collisions.
The top five cycling collision locations were:

- Burrard Street at Pacific Street;
- Main Street at East 2nd Avenue;
- Clark Drive at East 10th Avenue;
- Pine Street at West 10th Avenue; and
- Burrard Street at Davie Street.

The City has made significant steps over the past several years to implement changes at each of these intersections, including intersection reconfigurations, addition of green conflict zone pavement markings, and changes in traffic control devices.

Many major streets had both high frequency and high likelihood of cycling collisions with motor vehicles, whereas certain local street bikeways showed high numbers of reported cycling collisions involving motor vehicles, but did not necessarily have a high likelihood of collisions with motor vehicle due to the relatively high cycling volumes along those corridors.

Certain locations and corridors had both high frequency and likelihood of cycling collisions. When both the frequency and likelihood of cycling collisions were compared for specific locations and corridors, a number of locations emerged, including Burrard Street, Commercial Drive, Clark Drive, Pacific Street, Cypress Street, Main Street, and 10th Avenue. The BICE study also found a high likelihood at some of these locations and included some sections of the Seawall (as seen in Table 1).
### Table 1
Cycling Injury Crashes at Intersections, Type of Intersection Control

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Burrard Street (West Hastings Street to Harwood Street)</td>
<td>Burrard &amp; Pacific, Burrard &amp; Davie</td>
<td>Burrard near Robson</td>
<td>Burrard Bridge</td>
</tr>
<tr>
<td>Commercial Drive (Adanac Street to East 12th Avenue)</td>
<td>Clark &amp; 10th</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clark Drive (Adanac Street to West 10th Avenue)</td>
<td>Clark &amp; 10th</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Street (Powell Street to West Kent Avenue)</td>
<td>Main &amp; 2nd</td>
<td>Main (16th to 25th)</td>
<td>Main (16th to 25th)</td>
</tr>
<tr>
<td>10th Avenue (Trafalgar Street to Victoria Drive)</td>
<td>10th &amp; Pine</td>
<td>10th (Main to Oak)</td>
<td>10th (Main to Oak)</td>
</tr>
<tr>
<td>Cypress Street (Cornwall Avenue to West 19th Avenue)</td>
<td>Cypress &amp; Cornwall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seawall (Plaza of Nations)</td>
<td>Seawall (Ontario to Cambie)</td>
<td></td>
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</tr>
</tbody>
</table>

- The majority (56%) of reported cycling collisions between 2007 and 2012 occurred on streets without designated bikeways. Injury crash data from the BICE study found similar results. Of the reported cycling collisions on streets without designated bikeways, the majority (71%) occurred on arterial streets, as shown below:

<table>
<thead>
<tr>
<th>Collisions on Streets without Designated Bikeways = 56%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial Streets</td>
</tr>
<tr>
<td>Local Streets</td>
</tr>
<tr>
<td>Collectors</td>
</tr>
</tbody>
</table>

- Streets with designated bikeways accounted for 44% of all reported cycling collisions. Local street bikeways had the highest proportion of reported collisions and injury crashes among all designated bikeway facility types. Although local street bikeways account for the majority of reported collisions (53%) and injury crashes (41%), they also make up nearly three quarters of the City’s bicycle network. As such, local street bikeways had a
lower proportion of collisions compared to their length. In contrast, shared use lanes, painted bicycle lanes, and protected bicycle lanes all had a higher ratio of collisions as compared to their length, as shown below:

<table>
<thead>
<tr>
<th>Bikeway Type</th>
<th>ICBC Data</th>
<th>BICE Data</th>
<th>Total Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Street Bikeways</td>
<td>53%</td>
<td>41%</td>
<td>72%</td>
</tr>
<tr>
<td>Painted Bicycle lanes</td>
<td>22%</td>
<td>12%</td>
<td>19%</td>
</tr>
<tr>
<td>Shared Use lanes</td>
<td>15%</td>
<td>9%</td>
<td>6%</td>
</tr>
<tr>
<td>Protected Bicycle lanes</td>
<td>11%</td>
<td>1%</td>
<td>3%</td>
</tr>
</tbody>
</table>

- Protected bicycle lanes had a higher proportion of collisions than would be expected based on their length. To understand these results, a detailed corridor analysis of the Dunsmuir Street and Hornby Street protected bicycle lanes was conducted. The results found that most of these collisions occurred on Dunsmuir Street and were a result of vehicles turning right and colliding with a bicycle user in locations with right turning restrictions or signage providing bicycle users with the right of way. It also showed that intersections with dedicated bicycle signals appeared to be the safest intersections. Enforcement of prohibited and yielded right turns by motor vehicles could greatly improve the safety of protected bicycle lanes by reducing the collisions.

- Intersections accounted for 50.5% of all reported ICBC cycling collisions between 2007 and 2012. Of these, signalized intersections accounted for nearly half (48%) of all reported intersection collisions, including 35% at full traffic signals and 13% at pedestrian and cyclist activated half signals. Collisions at two-way stops accounted for 31% of all intersection collisions and 17% of all reported cycling collisions. The BICE study found similar results, as 56% of all injury crashes with motor vehicles from the BICE study were at intersections.

- Traffic circles were present in approximately 8.5% of all reported cycling collisions at intersections. Traffic circles are only located at approximately 2% of intersections in the City; however, 66% of all traffic circles in the City are located on local street bikeways. Of the approximately 260 traffic circles in the City, only four locations had at least one reported cycling collision per year on average. Prior to the Cycling Safety Study being conducted, the City had already implemented changes at two of these four locations to address safety issues. These results indicate that collisions at locations with traffic circles may be a localized issue. In addition, the BICE Injury crash data found that approximately half of the injuries at traffic circles did not involve motor vehicles.
When bicycle volumes were taken into account by neighbourhood, neighbourhoods with the highest collision likelihoods were Sunset, Shaughnessy, Victoria-Fraserview and Killarney. This suggests that the neighbourhoods with the least amount of cycling and cycling infrastructure had the highest cycling collision likelihood.

**What & How**

The top ten types of reported cycling collisions accounted for 69% of all known collision types, while the top five accounted for 44%. The top types of reported cycling collisions are described below and shown in Figure 6:

1. **Doorings**: Vehicle and bicycle user collided mid-block as vehicle door was opening (15.2% of reported cycling collisions).
2. **Conflict Zones**: Vehicle and bicycle user collided mid-block as the vehicle as entering or exiting an alley, parking lot, or driveway (10.7%).
3. **Right Hooks**: Vehicle turned right at a signal as bicycle user crossed at signal with right-of-way (6.5%).
4. **Sidewalk Riding**: Bicycle user was riding on the sidewalk prior to collision (6.1%, including 2.7% mid-block and 3.4% intersection).
5. **Mid-Block**: Vehicle and bicycle user collided while travelling in the same direction (5.7%).
6. **Left Cross**: Vehicle turned left at a signal while a bicycle user entered intersection with right-of-way (5.4%).
7. **Intersections**: Vehicle proceeded straight through a signal when right-of-way was unclear (5.2%).
8. **Traffic Circles**: Vehicle and bicycle user collided in an intersection with a traffic circle (4.9%).
9. **Left Cross (Stop Signs)**: Vehicle turned left as a bicycle user crossed at two-way stop with right of way (4.6%).
10. **Two-Way Stops**: Vehicle went straight as bicycle user crossed at two-way stop with right-of-way (4.5%).
Approximately half (50.5%) of all reported collisions involving bicycle users and motor vehicles took place when the bicycle user was crossing an intersection. The majority of intersection collisions occurred when the cyclist was travelling straight through the intersection, while a vehicle turned either right or left. The top collision types for intersection and mid-block locations are shown in Table 2.

### Table 2

**Top Collision Types**

<table>
<thead>
<tr>
<th></th>
<th>Intersections – 50.5%</th>
<th>Mid-Block Collisions – 40.4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right turning vehicles</td>
<td>12.6%</td>
<td>Doorings – 15.2%</td>
</tr>
<tr>
<td>Left turning vehicles</td>
<td>14.9%</td>
<td>Driveways, alleyways, and parking lots – 10.7%</td>
</tr>
<tr>
<td>Traffic circles – 5%</td>
<td></td>
<td>Travelling the same direction – 5.7%</td>
</tr>
<tr>
<td>Sidewalk riding – 3.4%</td>
<td></td>
<td>Sidewalk riding – 2.7%</td>
</tr>
</tbody>
</table>

The most common type of reported cycling collisions were doorings, which occurs when a driver opens the motor vehicle door and a cyclist collides...
with it. Doorings occurred mostly on arterial streets without designated bikeways, particularly on sections of the street where there were attractive destinations, such as commercial high streets.

- In the majority of cases, when collisions occurred at mid-block conflict zones such as driveways, alleyways, and parking lots, the bicycle user was usually proceeding straight ahead and the motor vehicle failed to yield. The majority of these collisions occurred on arterial streets.

- Collisions involving right turning vehicles occurred mostly at signalized intersections, and 82% were on arterial streets.

- Collisions involving left turning vehicles occurred mostly at signalized intersections, and mostly on arterial streets.

- Traffic circles appear to be a localized issue for collisions with motor vehicles based on ICBC data as noted previously; however, when looking at the supporting BICE data it was found that approximately half of the injury crashes at traffic circles were with motor vehicles. This suggests that the design treatments and intersection geometry should be carefully considered with traffic circles.

- Collisions resulting from sidewalk riding were found to occur when the bicycle user entered the intersection from the sidewalk or crossed a conflict zone on a sidewalk; these are locations where the motor vehicle driver typically would not expect to be encountering a bicycle.

- In nearly 1,600 of the 2,994 collisions, ICBC data allowed the right-of-way to be evaluated. In approximately 93% of cases, the cyclist appeared to have the right-of-way.

- The majority of collisions at intersections occurred when the bicycle user was travelling with the right-of-way. These actions indicate that educational and enforcement campaigns directed to motor vehicle drivers would greatly benefit the safety of cyclists.

- **When**
  - Winter months (December, January and February) had a higher likelihood of cycling collisions, as the proportion of reported cycling collisions was higher than would be expected based on bicycle volumes during these months.
  - The highest proportion of cycling collisions occurred during the afternoon peak periods (between 4:00 pm and 7:00 pm), and this is also when the highest proportion of cycling volumes occurred.
A higher proportion of reported cycling collisions occurred when it was dark.

Bicycle users were particularly vulnerable when it was both dark and rainy, particularly during the winter months when these conditions are more prevalent.

Who

- Adults between the ages of 26 and 45 were involved in the majority of collisions involving motor vehicles, although this age group also accounted for the highest proportion of daily bicycle trips.
- Young adults between the ages 16 and 25 were significantly more likely to be involved in reported cycling collisions and cycling injuries than would be expected based on the proportion of bicycle trips made by this age group, as shown in Figure 7.
- Gender does not significantly affect the likelihood of being in a collision with a motor vehicle or being involved in an injury crash.

Figure 7

Proportion of Reported Motor Vehicle – Bicycle Collisions and Bicycle Trips by Age
Source: ICBC Collision Data (2007-2012), TransLink Trip Diary Survey (2011)
4.0 Action Plan

Based on the analysis of reported cycling collision data from ICBC and supported by the cycling injury crash data from the BICE study, this study identified the following twelve key cycling safety issues:

- Key Issue 1  Doorings
- Key Issue 2  Conflict Zones
- Key Issue 3  Right Hooks
- Key Issue 4  Left Crosses
- Key Issue 5  Sidewalk Cycling
- Key Issue 6  Two-way Stop Signs
- Key Issue 7  Non Motor Vehicle Collisions
- Key Issue 8  Collision Hotspots
- Key Issue 9  High Collision Locations
- Key Issue 10  Designated Bikeways
- Key Issue 11  PM Peak
- Key Issue 12  Adverse Weather and Low Light

The action plan addresses these twelve cycling safety issues, including a description of each issue as well as engineering, education and enforcement countermeasures recommended to address each issue.

**Key Issue 1  Doorings**

Doorings were the most common type of cycling collision in the City of Vancouver, representing approximately 15.2% of all reported cycling collisions. Doorings occur when bicycle users are struck by or strike a door of a parked motor vehicle, typically on the driver side. Approximately two-thirds (67%) of all doorings occurred on arterial streets without designated bikeways (such as Broadway, Commercial Drive and Main Street). In addition, approximately 20% of doorings occurred on local street bikeways such as 10th Avenue.

**Engineering** treatments to address doorings include: investigating the feasibility of providing buffered or protected bicycle lanes; considering removing on-street parking where feasible; ensuring that bikeways are on the passenger side of motor vehicle parking lanes; and seeking to provide an adequate buffer space between parking lanes and bicycle lanes if the bikeway is on the driver side of the motor vehicle.
**Education** measures to address doorings can include: education campaigns for drivers reminding them to look for bicycles before opening their door; education campaigns for bicycle users to raise awareness of the risk of dooroing and how to position themselves in the roadway; and encouraging ICBC and the Provincial government to add educational material regarding the importance of looking for bicycle users before opening the door in driver education and licensing.

**Key Issue 2  Conflict Zones**

Mid-block conflict zones such as driveways, parking lots and alleyways accounted for approximately 10.7% of all collisions involving bicycle users and motor vehicles. This type of collision occurred between a bicycle user and a motor vehicle entering or exiting an alleyway, parking lot, or driveway. As the bicycle users were proceeding straight ahead, motor vehicles were identified as failing to yield when they were pulling in or out of these locations. The majority (58%) of conflict zone collisions occurred on arterial streets. 56% of these arterial streets did not have designated bikeways. Several locations were identified as hot spots for collisions that occurred when drivers were entering or exiting an alleyway, parking lot, or driveway, including: Burrard Street, Main Street, Broadway, Kingsway, 1st Avenue, and 10th Avenue.

**Engineering** treatments to address conflict zone collisions include: continuing to provide and retrofit existing conflict zone pavement markings at driveways and alleyways that have high collisions involving bicycle users and motor vehicles; consider providing bikeways or upgraded existing bikeways on routes with conflict zones; providing warning or high bicycle collision location signage at driveways and alleyways that have high collisions involving bicycle users and motor vehicles and where there is no existing bikeway; and removing on-street parking immediately adjacent to high activity driveways and alleyways to ensure bicycle user visibility.

**Education** campaigns can be used to raise awareness of drivers to look for bicycle users when entering or exiting a parking lot or alleyway.

**Key Issue 3  Right Hooks**

Collisions involving right turning vehicles, also known as ‘right hooks’, accounted for approximately 12.6% of all reported cycling collisions. Most of the right hook collisions occurred in the downtown core. The majority of the right hooks occurred on arterial streets (82%), including 41% on arterial streets with no bikeways. Many of these collisions occurred at signalized intersections when the bicycle user was crossing with the signal. A higher than expected number of right hooks occurred on Dunsmuir Street after the protected bicycle lanes were installed and involved
motor vehicles making prohibited right turns and colliding with bicycle users or motor vehicles failing to yield to bicycles.

**Engineering** treatments to address right hook collisions include: prohibiting right turns on red at locations with high cycling volumes and/or locations with a high number of right hook collisions; using dedicated signal phasing to provide bicycle users a separate phase; pulling back the motor vehicle stop bar behind the stop bar for the bicycles to increase visibility of the bicycle users; implementing right turn only lanes for motor vehicles at intersections where there is sufficient space; considering installing protected intersections, which utilize a combination of bicycle signal phases and design elements as well as space allocation to help protect cyclists from turning vehicles; continuing to provide and retrofit green coloured conflict zone markings and dashed lane markings through intersections; and prohibiting all right turns where there is a high number of right hook collisions and where it is not feasible to provide a dedicated right turn only lane, particularly where the right turn crosses a bi-directional separated bicycle lane.

**Education**, such as, a road safety awareness campaign could be directed at both drivers and bicycle users, reminding them to look out for each other at intersections.

Regular **enforcement** of restricted motor vehicle right-turns by police should also be encouraged, with a focus on intersections with high numbers of cycling collisions or illegal motor vehicle movements, particularly Dunsmuir Street.

### Key Issue 4  Left Crosses

Collisions involving left turning vehicles at intersections, also known as left crosses, were the most common type of vehicle movement resulting in a reported cycling collision (14.9%). Similar to collisions involving right turning vehicles, many of these collisions occurred at signalized intersections when the bicycle user was crossing with the signal. Similar to other key issues, the majority of left cross collisions occurred on arterial streets, with 36% of left crosses occurring on arterial streets with no designated bikeways. The majority (77%) of left cross collisions occurred while the bicycle user and motorist were travelling in opposing directions on the same street.

**Engineering** treatments to address left cross collisions include: implementing uni-directional protected bikeways where possible; pursuing design options that discourage cycling the wrong way in a bikeway; implementing left turn only lanes where there is sufficient space; continuing to provide and retrofit green coloured conflict zone markings and dashed lane markings through intersections; and considering installing protected intersections at high collision intersections.
Educational campaigns can be developed that highlight the importance of vehicles being aware to look for bicycle users as they are making left turns and for bicycle users to make themselves more visible to motorists.

Key Issue 5  Sidewalk Cycling

Approximately 6% of reported cycling collisions occurred where the bicycle users were reportedly riding on the sidewalk prior to entering an intersection or conflict zone. Sidewalk cycling can create visibility challenges with motor vehicles who may not be expecting them at intersections or conflict zones, and also can create safety concerns with pedestrians and other sidewalk users. Due to the location of the incidents of sidewalk cycling, in many cases it is likely that bicycle users may be using sidewalks because there are insufficient and/or uncomfortable bicycle routes on the adjacent street. Most sidewalk cycling incidents resulted in two types of collisions: mid-block collisions as the motor vehicle was entering or exiting a driveway or alleyway, and intersection collisions where the motor vehicle was turning right.

The top collision locations where bicycle users were riding on the sidewalk include Kingsway, Hastings Street, Clark Drive, Main Street, Commercial Drive, Victoria Drive, and 10th Avenue. None of the arterial streets noted above have designated bicycle facilities, with the exception of Main Street, which has shared use lanes.

The feasibility of providing on-street bikeways where possible, on streets with high numbers of bicycle users on sidewalks, should be investigated.

Awareness and education campaigns directed to bicycle users can also be developed informing them that riding on the sidewalk poses its own risks, is not safe, and is illegal in most cases. Vehicles are not expecting bicycle users to be on sidewalks and are not looking for them, and there is increased likelihood of bicycle users colliding with pedestrians on the sidewalk.

Enforcement campaigns can highlight the risks of sidewalk cycling, particularly at conflict zones.

Key Issue 6  Two-Way Stops

Collisions at two-way stops involving all motor vehicle turning movements (right turns, left turns, and straight motor vehicle movements) accounted for 31% of all intersection collisions and 17% of all reported cycling collisions. In all cases where right of way could be determined for two-way stops most of the collisions (84%) occurred as a result of the vehicle not stopping at the stop sign while the bicycle users had the right of way (was on the major street that did not have the stop sign).
Engineering treatments to improve cycling safety at two-way stops include speed reduction treatments that slow all road users down as they are entering the intersection, such as curb extensions, raised crosswalks, and raised intersections; and remove on-street parking adjacent to the stop sign to improve bicycle user visibility. Other strategies can include education campaigns to watch for bicycle users in intersections, and enforcement for road users not stopping at stop signs, especially at high collision locations.

Key Issue 7 Non-Motor Vehicle Collisions

This key issue summarizes cycling injury crash results from the BICE study. It includes non-motor vehicle injury crashes between bicycle users and pedestrians, road infrastructure, and debris. Collisions between bicycle users and pedestrians are typically underreported or not reported at all. A number of studies and researchers have worked to better understand the characteristics and frequency of collisions between bicycle users and non-motor vehicles including collisions with pedestrians and animals etc. The BICE study found that a minority of injury crashes were a result of collisions with motor vehicles (37%), although another 10% involved avoidance manoeuvres to avoid a motor vehicle collision. It found that 12% of cycling injuries resulting in an emergency room visit were a result of bicycle users crashing because of surface conditions (holes, bumps, roots, debris, leaves, etc.), 11% were a result of infrastructure (curbs, bollards, posts, etc.), and 8% were a result of a collision with a cyclist, pedestrian or animal.

Engineering treatments to address non-motor vehicle collisions include: developing a reporting program with local partners to create a database of non-motor vehicle collisions and near misses; collaborating with Vancouver Coastal Health to improve the monitoring and analysis of cycling collisions and falls to supply pertinent and timely information about injuries to City of Vancouver; providing separate pedestrian and bicycle pathways instead of shared multi-use pathways where feasible; separating pedestrians and bicycle users at crosswalks; ensuring bikeways are well-maintained and clear of debris through ongoing maintenance and sweeping; continuing to monitor pavement quality on all bicycle facilities to ensure they have smooth surfaces; and ensuring that signage, poles and bollards are in appropriate locations so as not to create vertical or horizontal obstructions.

Key Issue 8 High Collision Corridors

Several corridors throughout the City were identified that had a high density (collisions/km) of reported cycling collisions. The top five collision corridors based on collision density included: Burrard Street (West Hastings Street to Harwood Street), Commercial Drive (Adanac Street to East 12th Avenue), Clark Drive...
(Adanac Street to West 10th Avenue), Pacific Street (Hornby Street to Homer Street), and Cypress Street (Cornwall Avenue to West 19th Avenue). In addition, high collision frequencies were also found on 10th Avenue (Trafalgar Street to Victoria Drive), Main Street (Powell Street to West Kent Avenue), and Broadway (Highbury Street to Commercial Drive). The highest collision corridors generally corresponded with streets with designated bikeways. This likely indicates that they have a high level of usage.

**Engineering** treatments include proactively addressing cycling safety issues along high collision corridors and continuing to monitor cycling safety at locations with high collision rates by: considering higher order bikeways on high collision corridors or, in cases where this is not possible provide more comfortable routes on parallel streets for all ages and abilities; considering collision prone corridors such as Main Street, Burrard Street, and Commercial Drive for complete streets policies and initiatives; and conducting corridor specific studies and/or in-service road safety reviews of high collision corridors to identify potential safety measures.

In addition, engineering measures should be complemented with a road safety awareness campaign to alert both motorists and bicycle users of the prevalence of cycling collisions along corridors and at intersections and encourage more caution in these areas. The City should also work with the VPD to perform **enforcement** actions along corridors with high occurrences of collisions to discourage unsafe behaviour on the part of both motorists and bicycle users.

**Key Issue 9  High Collision Locations**

It is also important to identify the specific high collision locations within the City of Vancouver. There were nineteen locations that had more than 10 reported collisions between 2007 and 2012 as identified by the ICBC data. Most of these collisions occurred at intersections that were controlled by a full signal (72%), followed by intersections with a half signal (17%) and a two-way stop (11%).

**Engineering** treatments to improve cycling safety at high collision locations include: installing dedicated bicycle signals with separate bicycle signal phasing where feasible and ensure all intersections have bicycle detection; continuing to provide green coloured conflict zone markings and dashed lane markings through intersections; implementing dedicated left turn and right turn only lanes for motor vehicles at intersections where there is sufficient space; providing a safe queuing area for bicycles at intersections; and installing full traffic signals at intersections where collision rates are high.
Key Issue 10  Designated Bikeways

This study has helped to identify some key collision locations based on the type of bike facility or designated bikeway. While the majority of collisions occurred on streets without designated bicycle facilities, there was still a significant percentage (44%) of collisions that occurred on bikeways. There were three main takeaways from the results of this study:

1. Arterial streets with no bicycle facilities were the most common location for collisions.
2. Collisions occurred frequently on shared use lanes, particularly Main Street. Main Street and 2nd Avenue had the second highest number of bicycle collisions for a single intersection, and Main Street and 10th Avenue was ranked seventh.
3. Local street bikeways had the highest number of reported collisions out of all types of designated bikeways within the City of Vancouver, but are also the most common. A fewer proportion of collisions occurred on local street bikeways as compared to their prevalence within the city’s bicycle network.

Engineering treatments include analyzing the feasibility of installing bikeways on corridors with high cycling collisions, especially on routes with important neighbourhood destinations such as shopping streets (ex. Broadway and Main Street).

Key Issue 11  PM Peak

The collision data indicated that the majority of reported cycling collisions occurred during the afternoon peak period. Reported cycling collisions were most common between 4:00 and 7:00 pm, which accounted for nearly a third (31%) of all reported cycling collisions. This is also when the highest proportion of cycling volumes occurred.

The prominence of cycling collisions in the evening peak period offers opportunities to efficiently improve safety, such as coordinating enforcement actions during this time period. This time period has been identified as a high activity period with high volumes of bicycle users, motorists and pedestrians.

Engineering treatments to address this issue include: providing more time for bicycle users at intersections by coordinating signal timings, decreasing the wait at push buttons, or installing bicycle-friendly signal timing; and providing more visibility for bicycle users at intersections by installing advance stop line or bike boxes. In addition, road safety educational awareness campaigns targeted at all road commuters can be developed to inform of the high collision rates in the afternoon.
peak periods and that all road users should exercise additional caution after a long work day. Finally, enforcement actions can be concentrated in the 4:00 to 7:00pm time period at collision hotspots and high risk locations.

Key Issue 12  Adverse Weather and Low Light

Research indicates that adverse weather and darker lighting conditions, which occur with shorter winter days, can increase the occurrence of cycling collisions. The number of bicycle trips is also significantly impacted by weather and seasonal conditions. The study found that a higher than expected number of collisions occurred in winter months, relative to the observed cycling volumes, particularly when it was dark and rainy.

Engineering treatments to address this issue include: improving street lighting at intersections with high collisions and on bikeways, particularly local street bikeways, and ensuring road surfaces on bikeways are skid resistant and provide adequate drainage to prevent water pooling and icy conditions.

Education campaigns can be developed to remind cyclists about additional equipment such as bicycle lights that can increase cyclist visibility as the days get shorter.

Summary

Based on the findings of this study, a number of corridors repeatedly emerged as having a high collision frequency and/or likelihood, and presented a range of cycling safety issues. Eight corridors in particular presented cycling safety issues as shown in Table 3. Safety reviews should be conducted on these corridors in the following priority:

- **Highest priority:** Main Street and Burrard Street
- **Moderate priority:** Commercial Drive, 10th Avenue, and Broadway.
- **Lower priority:** Clark Drive, Pacific Street and Cypress Street.

In addition to these high collision corridors, a number of specific locations were identified as having either high collision frequency or likelihood. Many of these locations correspond with the high collision corridors. At high collision intersections, a detailed intersection safety review should be conducted to identify cycling safety issues and mitigation measures.
### Table 3
**Top Collision Corridors (2007 – 2012)**
Source: ICBC Collision Data (2007-2012), Bicyclists’ Injuries and the Cycling Environment (BICE) Study (May 2008-Nov 2009)

<table>
<thead>
<tr>
<th>High Collision Corridors</th>
<th>Collision Frequency</th>
<th>Collision Density</th>
<th>Collision Likelihood</th>
<th>Collision Types</th>
<th>Key Collision Types</th>
<th>Bicycle Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Street</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>●</td>
<td>• Doorings • Conflict Zones • Bicycle Facilities • High Collision Locations</td>
<td>Shared Use Lane</td>
</tr>
<tr>
<td>Burrard Street</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>• Conflict Zones • Right Hooks • High Collision Locations</td>
<td>Painted Bicycle Lane</td>
</tr>
<tr>
<td>10th Avenue</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>• Doorings • Bicycle Facilities</td>
<td>Local Street Bikeway</td>
</tr>
<tr>
<td>Broadway</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>• Doorings • Bicycle Facilities</td>
<td>None</td>
</tr>
<tr>
<td>Pacific</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>• Right Hooks</td>
<td>Painted Bicycle lane</td>
</tr>
<tr>
<td>Clark Drive</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>• High Collision Location • Sidewalk</td>
<td>None/Protected Bikeway</td>
</tr>
<tr>
<td>Cypress Street</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td></td>
<td>Local Street Bikeway</td>
</tr>
<tr>
<td>Commercial Drive</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>• Doorings • Bicycle Facilities</td>
<td>None</td>
</tr>
</tbody>
</table>

- ● High collision ranking
- ○ Medium collision ranking
- ○ Low collision ranking
In addition to engineering treatments at high collision corridors and locations, there are a number of education and enforcement recommendations that should be developed:

- **Doorings** including campaigns targeted to motor vehicle drivers and passengers to be sure to look out for bicycle users before opening their door;
- **Sidewalk cycling**, including informing bicycle users of the potential hazards and collisions of riding on the sidewalks, and enforcement of illegal sidewalk cycling;
- **Parking lot and driveway entrances and exits**, including education campaigns for both bicycle users and motor vehicle drivers;
- **Passing**, including providing educational tools of the value of leaving space between bicycle users and vehicles when passing and waiting behind bicycle users as they are taking the lane to avoid doorings;
- Providing increased awareness of potential risk during the **afternoon commute and dark and rainy conditions**;
- Providing increased awareness of hazards at locations with **high proportion of right/left turning vehicles**;
- Increased enforcement of vehicles violating **right turn regulations**; and
- A **joint education campaign** for pedestrian and cyclist safety, providing awareness of the number of collisions that occur when motor vehicles are turning left and right.

The improvement of cycling safety within the City of Vancouver will require the involvement and coordination of a number of agencies involved in cycling-related infrastructure, operations, services, and enforcement. Some of these agencies include the City of Vancouver, ICBC, Vancouver Police Department (VPD), Vancouver Coastal Health (VCH), the BC Ministry of Health (MoH), TransLink, and the Vancouver School Board (VSB). Through a collaborative effort among these agencies focusing on a comprehensive range of strategies including engineering, education, and enforcement measures, the City can work to improve cycling safety and continue to be a leader in making cycling a safe, comfortable, and attractive mode of transportation for people of all ages and abilities in Vancouver.