SOUTHWEST MARINE DRIVE (GRANVILLE STREET TO MACDONALD STREET) IN-SERVICE ROAD SAFETY REVIEW - FALL 2016

PREPARED FOR

CITY OF VANCOUVER

URBAN systems

Contents

1.0 Introduction

The City of Vancouver is committed to improving safety for all road users. The City's long-term transportation plan, Transportation 2040, sets a target to work towards zero transportation-related fatalities. In addition, Transportation 2040 states that the City will coordinate and consider cycling improvements as part of all street capital projects and/or rehabilitation projects.

Southwest Marine Drive provides an important connection for people driving private vehicles, people driving trucks, and people cycling between UBC and the west side of Vancouver and beyond. It is a designated Truck Route, it is a transit route west of 49th Avenue and is part of the Major Road Network (MRN). Southwest Marine Drive is also a well-used bicycle route and has been a designated bicycle route since 1997. It intersects the Arbutus Corridor and provides connections from UBC to the City of Richmond, YVR and the Marine Drive Canada Line Station.

The City had identified that road rehabilitation was required for Southwest Marine Drive between Granville Street and Camosun Street, as current pavement conditions did not meet TransLink's MRN performance objectives. This planned road rehabilitation work provided the City with an opportunity to widen the road to upgrade the existing bicycle facilities as well as to provide some additional space for people walking. This also provided the City with an opportunity to provide other transportation and utility services along the Southwest Marine Drive corridor.

One of the key goals of the Southwest Marine Drive improvement project was to enhance transportation safety along the corridor for all road users, including people cycling and walking. This included providing consistent on-street bicycle lanes along the length of the corridor. While Southwest Marine Drive was a designated bicycle route prior to the work completed on the Southwest Marine Drive improvement project, the width and conditions of the bicycle lanes were inconsistent and undesirable. It is important to note that the scope of the improvement project was to provide improvements within the existing curb to curb right of way, road right of way was only widened in locations where there were no existing curbs.

This City is completing the Southwest Marine Drive improvement project in two parts. Work on the portion of Southwest Marine Drive between Granville Street and Macdonald Street began in May 2016 and was completed in September 2016 (**Figure 1)**. Work on Southwest Marine Drive between Macdonald Street and Camosun Street is expected to be completed in 2017.

The new bicycle lanes installed as part of the improvement project are typically 1.8 metres in width with a 0.6 metre buffer. The typical motor vehicle lane widths are approximately 3.3 metres, widening to approximately 3.5 metres, and up to 3.9 metres, at locations with horizontal curves. To provide additional separation between people driving and people cycling, concrete barriers and white plastic bollard posts were installed at inside curves of Southwest Marine Drive and at 'T-intersections'. These features were installed to keep motor vehicles within the travel lanes and to restrict them from passing on the right into the bicycle lane if a motor vehicle were to turn left onto a cross-street or driveways. On-street parking is permitted along some portions of Southwest Marine Drive. Where on-street parking is not permitted, no stopping regulations having been put in place.

Since the completion of the road work, the City has received some feedback from residents that the new road configuration has created some safety concerns, particularly regarding the visibility and location of the

barriers separating the bicycle lanes and the motor vehicle lanes. There have been reports that the barriers have been hit by motor vehicle drivers. The City has also received comments that the barriers appear to be located at unpredictable locations and that they constrain the motor vehicle lane width.

Figure 1: Southwest Marine Drive Study Area Context Map

The purpose of this study is to conduct an In-Service Road Safety Review (ISRSR) the Southwest Marine Drive improvement project between Granville Street and Macdonald Street. This review is being conducted as this portion of Southwest Marine Drive recently underwent a road rehabilitation and a sewer main infrastructure replacement project. The ISRSR was based on extensive field observations and site visits, to collect observations and investigate the following:

1. Comparison of before and after conditions based on pre-construction photos and Google Street View and what has recently been implemented;
2. Determine if the barriers require additional enhancements to help improve visibility; and
3. Identify any other design elements based on built conditions and constraints that would help improve safety or do not meet safety requirements on the project corridor (e.g. pavement markings, lines, alignment, configuration, etc.).

This report includes an assessment of identified safety issues along with suggested mitigation measures over the short-term as well as potential longer term solutions.

For the purpose of this report, Southwest Marine Drive is assumed to run in the east-west direction. All the other elements of the design are referred to relatively to this orientation.

2.0 Existing Conditions

2.1 Geometric Review

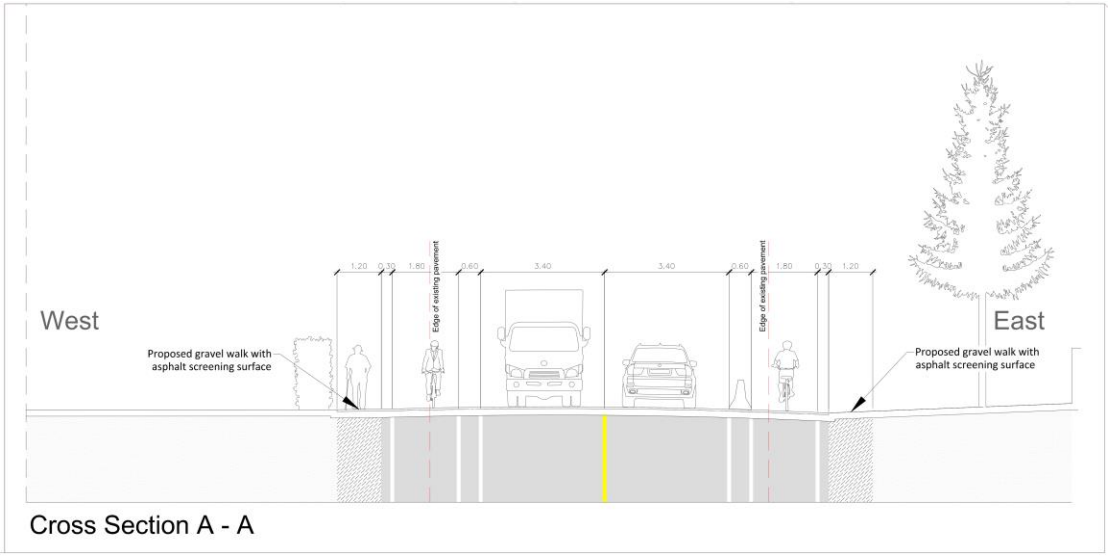
As noted previously, Southwest Marine Drive provides an important local and regional connection for people driving vehicles, people driving trucks, and people cycling. Southwest Marine Drive is classified as an arterial street forming part of the MRN, and is also a designated Truck Route. The portion of Southwest Marine Drive studied in this Safety Review is not a transit route; however, Southwest Marine Drive is a transit route west of West 49th Avenue. Despite not being a designated transit route, several 'Not in Service' buses were observed to be travelling along this portion of the corridor. NIS buses use this route to return to the Vancouver Transit Centre located south of Southwest Marine Drive off Hudson Street.

The following sections describe the corridor in further detail with regards to motor vehicles, bicycle facilities, pedestrian facilities, on-street parking, and intersections. It is important to note that the "existing conditions" now represent post construction with improved conditions. The Design Criteria as applicable for the study area was developed by the City of Vancouver for the Southwest Marine Drive Rehabilitation Project can be found in **Appendix A**.

Motor Vehicles

- The posted speed limit is 50 km/hour.
- Between East Boulevard and Macdonald Street, Southwest Marine Drive is generally a two-lane arterial road with one lane of traffic in each direction (**Figure 2**), with right turn lane at some intersections.
- In the eastbound direction between East Boulevard and Cornish Street, there is one motor vehicle lane and one shared use lane for people driving and cycling. East of Cornish Street, there are two motor vehicle lane lanes.
- In the westbound direction between Granville Street and Cornish Street, the motor vehicle lanes transition from two to one lane.
- Vehicle lanes are generally approximately 3.3 metres wide; however, at locations with horizontal curves, the lane width has typically been increased to 3.5 metres, and is as wide as 3.9 metres in some locations.

Figure 2: Typical Cross Section for Southwest Marine Drive (Source: City of Vancouver)



Cycling Facilities

- Buffered bicycle lanes are provided on both sides of the street along most of the corridor.
- Along most of the corridor where space is available, the bicycle lanes are 1.8 metres wide with a 0.6 metre painted buffer. However, there are a few locations where the bicycle lane width drops to 1.3 metres and further to 1.0 metres in some locations.
- In the eastbound direction, east of East Boulevard, the buffered bicycle lane transitions to a shared use lane marked with “sharrow” pavement markings.
- There are no bicycle facilities between Granville Street and Cornish Street.
- The bicycle facilities on Southwest Marine Drive are designed to connect to Arbutus Greenway to support eastbound to southbound movements.

Walking Facilities

- Facilities for people walking vary along the corridor.
- On the north side of Southwest Marine Drive between Angus Drive and Granville Street, concrete sidewalks are provided. These sidewalks were in place prior to construction and are considered pre-construction conditions. West of Angus Drive, the conditions vary between grass and gravel.
- On the south side of Southwest Marine Drive between Barnard Street and Granville Street, sidewalks are provided. Like the north side of the corridor, there is some space for people to walk on grass and gravel.
- Additional space for people walking has been provided at some locations along the corridor; however, the treatment is not continuous or consistent. Gravel walking space was not provided in areas where there was existing sufficient informal space of 1.2m (width).
- In general, there is more continuous and level space allocated to walking on the north side of the street than on the south.
- There are no marked pedestrian crossings within the study area, except at signalized intersections.

The second City Council Report pertaining to the upgrades along Southwest Marine Drive dated December 15, 2015, identified some additional localized improvements to address locations where people walking would otherwise share space with people biking. The City identifies in the Design Criteria developed for this project that the desired pedestrian facility (where feasible based on space constraints) consists of, at minimum, sidewalk infill or a new gravel walkway at a width of 1.2 metres (**Appendix A**). There are several locations where additional space for people walking has been provided; however, the facility is not consistent along the length of the corridor, or even the length of the block. This creates an inconsistent walking experience.

Parking

The City has permitted on-street parking at some select locations within the study area. In general, on-street parking has been permitted where it had been determined that:

- There was adequate space between the property line and the bicycle lanes to accommodate space for on-street parking and for people walking;
- The location of on-street parking did not negatively impact the safety of all road users; and
- Long blocks (greater than 200 metres) were present and no other on-street parking was available within a reasonable walking distance (which was assumed to be approximately 150 metres that does not require crossing Southwest Marine Drive at an unmarked or un-signalized crosswalk).

As part of the project, on-street parking was removed for the section between Wiltshire and Cornish St (both sides). On-street parking on the north side (Wiltshire Street to Angus Drive) is provided curbside. Along the remainder of the westbound direction and in the eastbound direction, where on-street parking is permitted, it is typically configured as asphalt or gravel milling parking pockets. On-street parking is restricted along the rest of the corridor except for these designated areas.

Intersections

There are 20 intersections within this study area, including the following four signalized intersections:

- Granville Street
- Cornish Street
- Angus Drive
- 57th Avenue

At all intersections where right turn motor vehicle movements are permitted, the bicycle lane has been dashed to designate that motor vehicle drivers can encroach into the bicycle lane to complete their right turning movement.

Left turn lanes are located at two intersections along the corridor:

- Cornish Street (westbound)
- Barnard Street (westbound) - This lane was added as part of the project.

As outlined in the December 1, 2015 Council Report, there is a building line requirement to preserve future transportation options on the corridor (approximately 5.2 metres past the property line on each side). Any

development must respect the building line and cannot place any structures within this area. Building lines are governed by the principle of not increasing vehicle capacity, but rather giving priority to pedestrians, bicycles, and transit. However, utilizing the space to provide an additional vehicle turning lane may help to enhance the safety of people walking and cycling along the corridor at some locations.

2.2 Operational Review

Motor Vehicles

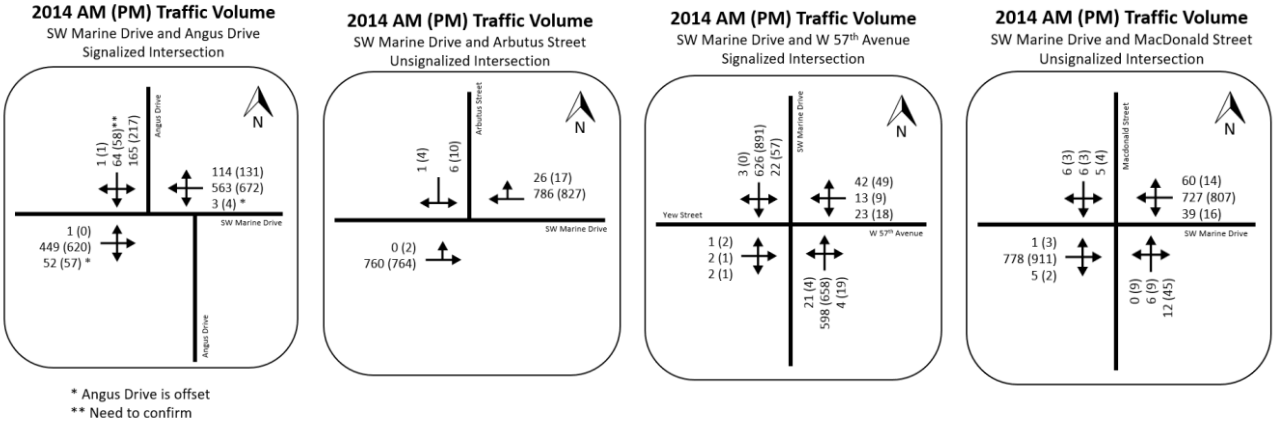
The City of Vancouver Council Report from December 1, 2015 stated that existing motor vehicle volumes on Southwest Marine Drive range between 15,000 and 25,000 vehicles per day (2014). These daily traffic volumes are similar to other arterial roads in the (such as West 41st Avenue, which is truck and transit route, and West 49th Avenue, which is not a truck route but is a transit route).

Turning Movements

The City of Vancouver provided turning movements for four intersections along the corridor for the AM and PM peak hour traffic volumes from September 2014 (**Figure 3**). The following observations can be made for each of these intersections:

- **Southwest Marine Drive and Angus Drive**
  - Signalized intersection
  - Angus Drive is offset
  - High number of right turn movements of vehicles travelling westbound on Southwest Marine Drive turning right on Angus Drive in the AM and PM peak
  - High number of left turn movements of vehicles travelling southbound on Angus Drive heading eastbound on Southwest Marine Drive in the AM and PM peak
- **Southwest Marine Drive and Arbutus Street**
  - Unsignalized T intersection
  - Insignificant turning volumes
- **Southwest Marine Drive and West 57th Avenue**
  - Signalized intersection
  - There is a higher number of vehicles making left turn movements from Southwest Marine Drive during the PM peak onto West 57th Avenue
- **Southwest Marine Drive and Macdonald Street**
  - Unsignalized intersection
  - High right turn movements in the AM for vehicles travelling westbound on Southwest Marine Drive turning right on Macdonald Street.

Figure 3: Intersection Turning Movements



The City of Vancouver collected motor vehicle speed data in November, 2016 at the following locations:

- ***2000 Block*** – West 62nd Avenue to West 64th Avenue (eastbound) between November 1 and 14, 2016;
- ***2100 Block*** – West 57th Avenue to W 62nd Avenue (eastbound and westbound) between November 8 and 11, 2016;
- ***2200 Block*** – West 57th Avenue to Yew Street (westbound) between November 8 and 11, 2016; and
- ***2600 Block*** – Marine Crescent to Macdonald Street (eastbound) between November 8 and 11, 2016.

A review of the speed data reveals the following:

- Generally, 85% percentile vehicle speeds range between 50 and 59 km/hour (2100 block westbound, 2200 block eastbound and 2600 block eastbound);
- Along the corridor, 85% percentile vehicle speeds on average were the highest between the 2100 block eastbound and 2000 block eastbound;
- Generally, higher 85% percentile vehicle speeds were observed on weekends and statutory holidays (Remembrance Day); and
- Between 9:00 pm and 4:00 am on weekends, approximately 80% of vehicles were travelling at speeds above 50 km/hour.

People Cycling

The City of Vancouver Council Report from December 1, 2015 stated that the Southwest Marine Drive bicycle route is a popular road cyclist training route with approximately 300 people cycling daily mid-week and approximately 450 cyclists on weekends (12-hour summer period). Strava Global Heatmap data indicates that a high number of people are cycling along the corridor as seen in **Figure 4.** The routes with

the darkest and thickest red lines have the higher concentration of people cycling. Routes with thin blue lines have fewer people cycling.

Figure 4: Strava Heat Map of the Study Area

People Walking

Based on observations and data from the AM and PM peak intersection count data available on VanMaps (various years), there are more people walking along the corridor at the eastern portion of the corridor closer to Granville Street.

2.3 Safety Review

Collision data was obtained through the CrashMaps website hosted by the Insurance Corporation of British Columbia (ICBC). Data was reviewed for the study area (Southwest Marine Drive between Granville Street and MacDonald Street) which looked at a five-year period between 2009 and 2013. It should be noted that this safety review reflects the pre-installation conditions. No post-installation collision data was available.

There were 758 reported collisions within the study area over the year period between 2009 and 2013, or an average of approximately 150 reported collisions per year (see **Table 1).** Approximately one third of these collisions (31.6%) resulted in a casualty.

Table 1: Number of All Collisions by Year and Severity (Source: ICBC CrashMaps)

Year	Casualty	Property Damage Only	Total
2009	41	119	**160**
2010	48	98	**146**
2011	40	82	**122**
2012	54	119	**173**
2013	57	100	**157**
Total	**240**	**518**	**758**

There was a total of 16 reported collisions involving people cycling and motor vehicles, and 9 reported collisions involving people walking and motor vehicles between 2009 and 2013 (see **Table 2**).

Table 2: Number of Collisions Involving People Walking and Cycling by Year (Source: ICBC CrashMaps)

Year	People Walking	People Cycling	Total
2009	0	3	**3**
2010	3	1	**4**
2011	1	4	**5**
2012	4	2	**6**
2013	1	6	**7**
Total	**9**	**16**	**25**

The location with the greatest number of reported collisions was by far the intersection with Granville Street, which accounted for 473 reported collisions between 2009 and 2013 (see **Figure 5**). Other top collision locations included Angus Drive (33 collisions), Macdonald Street (31 collisions), and West 57th Avenue/Yew Street (30 collisions). As seen in **Figure 6,** the top collision locations for people walking and cycling are Southwest Marine Drive and Granville Street and Macdonald Street.

Figure 5: Location of Reported ICBC Collisions – 2009 - 2013 (Source: ICBC CrashMaps)

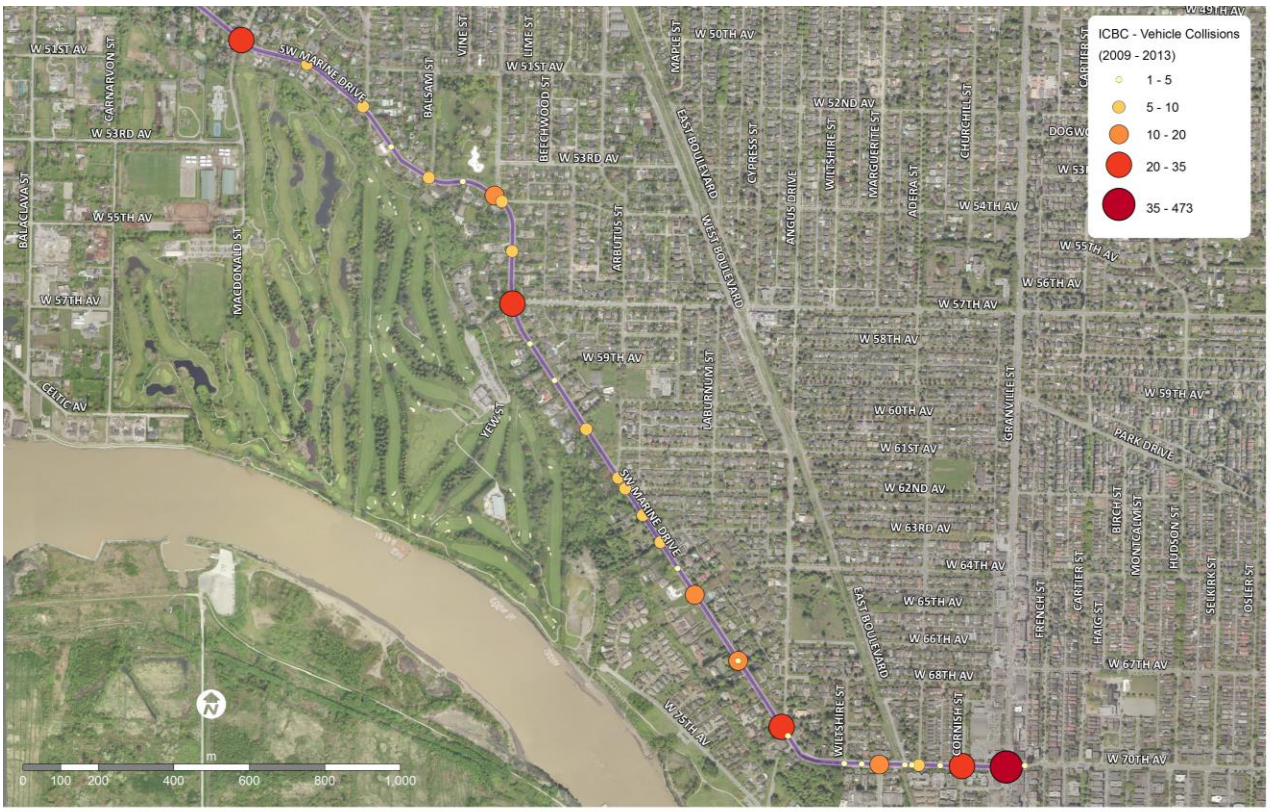


Figure 6: Location of Collisions Involving People Walking and Cycling – 2009 – 2013 (Source: ICBC CrashMaps)

2.4 Resident Feedback Review

The City provided a summary of the feedback they have received from residents and users of Southwest Marine Drive since the construction along this segment of the corridor was completed. This feedback is summarized below:

- Concrete Barriers / Plastic Delineator Posts
    - The visibility of these objects is limited
    - Object markers are being knocked over or turned
    - Plastic bollards are being hit, are bent over or completely missing (Marine Crescent and Maple Grove Park)
    - The new design is causing delays for eastbound vehicle travel (Southwest Marine Drive at Angus Drive)
    - Vehicles are trying to pass on the left (over the centre line), when there are slower vehicles travelling in front.
- Southwest Marine Drive and Macdonald Street
    - More people walking are crossing at this intersection
    - Accessing Southlands after dropping off their Car2Go
- On-Street Parking
    - Too many regulation signs

    - Some vehicles are parking temporary in the bike lanes because there is nowhere else to stop (e.g. gardeners, couriers)
- Approach Mixing Zones (Right Turn Movements)
    - Potential conflict between people driving and people cycling.

Prior to approval of the project (the first council report) noted that some of the key concerns identified by the public during engagement for this project included:

- A feeling that there was a lack of provisions for pedestrians, such as sidewalks and pedestrian crossings particularly between Balaclava Street and West 57th Avenue.
- Concern that the project does not implement an all-ages-and-abilities (AAA) bikeway as part of the upgrade.
- Potential removal of on-street parking and regulation of on-street parking.
- Overall concerns regarding existing traffic volumes, including heavy truck volumes as well as vehicle speeds along Southwest Marine Drive.
- Concerns regarding project construction impacts and the potential for increased traffic shortcutting through adjacent neighbourhoods.

3.0 In-Service Road Safety Review Process

3.1 In-Service Road Safety Review Objectives

An In-Service Road Safety Review (ISRSR) is a process for systematically checking the safety of an existing road, based on sound road safety engineering principles and undertaken from the road users' perspectives. Formal traffic safety reviews or ISRSRs are typically undertaken at problematic locations when the traffic safety issues are unknown and/or politically driven. These studies aid in the identification (or confirmation) of the traffic safety issues and probable causes, which lead to a better refinement of possible mitigation measures. An ISRSR is defined as follows:

"An In-Service Road Safety Review is an in-depth engineering study of an existing road using road safety principles with the purpose of identifying cost-effective countermeasures that would improve road safety and operations for all road users."

The objectives of the ISRSR are to identify design elements which may have a negative impact on the safety performance of the facility and to suggest corrective measures, based on built (post-construction) conditions and design constraints, for consideration by the City of Vancouver at this stage. The corrective measures suggested in this report are conceptual, and as such, reflect the nature of a solution, which may or may not be adopted by the City of Vancouver. In other words, it is the responsibility of the City of Vancouver to respond to the review findings in a way that the City deems appropriate. Hence, the selection of specific solutions for the identified safety issues resides with the City, and not with the road safety auditors.

3.2 Audit Process

The ISRSR was carried out following the procedures described in the Transportation Association of Canada's (TAC) Canadian Guide to ISRSR, January 2004. The ISRSR included the following steps:

1. **Start-up Meeting** – A meeting was held in-person between the City of Vancouver and the ISRSR team on Wednesday November 2, 2016. Background information concerning scope of the project was provided at this time.
2. **Collect and Review Background Information** –All available project information was obtained and reviewed, including all designs, past traffic studies, bicycle, pedestrian and motor vehicle volumes (where available), collision data, speed reviews, signage and pavement marking drawings, and any other studies or data deemed necessary from the detail design team and/or construction engineer.
3. **Site Inspection** – The ISRSR team undertook the first site inspection on Wednesday November 2, 2016. The project site was inspected on foot and in a motor vehicle. A second site visit was completed on Wednesday November 16, 2016 in the evening to observe conditions of the roadway at night. A third site visit was completed on Tuesday December 13, 2016. Video and photo documentation of safety issues was collected during all three site visits.
4. **Project Team Workshop** – The ISRSR team held an independent workshop to assess safety issues and identify mitigation measures.

5. **In-Service Road Safety Review Report** – This report was prepared to document the findings of the study.

6. **Completion Meeting** – If necessary, a completion meeting will be held to discuss the audit findings and suggestions.

7. **Response Report** – An ISRSR report should be responded to in a formal written response which documents the actions to be taken by the City of Vancouver to address the safety issues identified by the ISRSR Team. The response report would then become part of the overall project documentation. A decision to reject an audit finding or suggestion should always be accompanied by justification or substantiating reasons detailed in the response report. Where a finding is accepted, the City of Vancouver should also document the specific solution/action to be taken to correct the identified safety issue/s, if different from the auditor's suggestion.

   The City of Vancouver is under no obligation to accept all the audit findings and/or its suggestions. Also, it is not the role of the auditor to agree or approve of the City of Vancouver's responses to the audit. Rather, the audit provides the opportunity to highlight potential safety issues and have them formally considered by the City of Vancouver, in conjunction with all other project considerations.

4.0 Audit Findings and Suggestions

This section summarizes the identified the identified safety issues and suggested improvements for all users of Southwest Marine Drive:

Key Issues:

- Issue 1: Bicycle Facility Type and Width
- Issue 2: Separation
- Issue 3: Mixing Zones
- Issue 4: Perceived Motor Vehicle Lane Widths
- Issue 6: Walking Facilities
- Issue 7: Driveways
- Issue 8: Signage and Pavement Markings
- Issue 9: Lighting
- Issue 10: Maintenance, Drainage and Debris
- Issue 11: Speeding

These issues are described in further detail below along with suggested improvements.

Issue 1: Bicycle Facility Type and Width

In most circumstances throughout the corridor the bicycle lanes are 1.8 metres in width, which satisfies recommended width guidelines published by the Transportation Association of Canada and other national and international guidelines on bicycle facility design. In addition, the presence of a 0.6 metre buffer in most sections increases the comfort of the bicycle facility for many users by providing increased separation. However, the lack of continuous physical separation throughout the corridor along with the relatively high traffic volumes, high presence of trucks, and high traffic speeds at some time periods, does not result in a bicycle facility that would be considered comfortable for people of all ages and abilities. The following specific issues regarding bicycle facility type and width were identified.

Shared Use Lanes

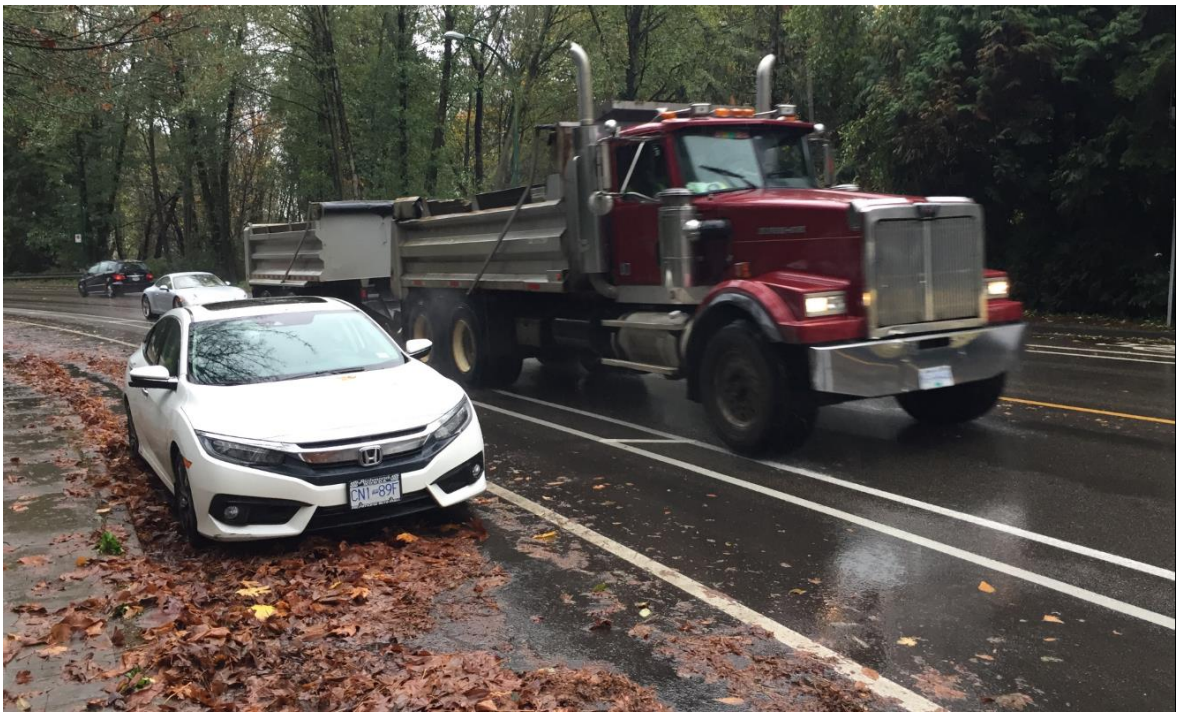
As noted in **Section 2.0 Existing Conditions**, buffered bicycle lanes are located on both sides of the street along most of the corridor. However, in the eastbound direction (south side) east of East Boulevard, the buffered bicycle lane transitions to a shared use lane and then further transitions to a combined right turn lane/shared use lane at Cornish Street / Southwest Marine Drive (north-south). The shared use lane is marked with 'sharrow' pavement markings. Based on traffic counts from 2006, there are approximately 7,000 vehicles per day travelling along this portion of the corridor, along with a posted speed limit of 50 km/hour. Current national and international bicycle facility design guidance suggests that shared use lanes

are not desirable for these traffic volumes and speeds. As a result, the shared use bicycle facility type presents a potential safety issue due to the volume and speed of motor vehicles travelling along the corridor.

Bicycle Lanes Adjacent to On-Street Parking

As noted previously, curbside on-street parking is permitted in the westbound direction (north side) of Southwest Marine Drive between Barnard Street and Angus Drive. Between Wiltshire Street and Angus Drive, the bicycle lane is 1.5 metres with a 0.6 metre buffer between the bicycle lane and the motor vehicle travel lane. The width of on-street parking is 2.3 metres, with no buffer between parked cars and the bicycle lane. At these locations, people cycling in the bicycle lanes are travelling in the 'door zone'. Where the road curves, motor vehicles were observed to be encroaching into the bicycle lane buffer and motor vehicles were not parking directly against the curb, likely due to the leaves and debris in the parking lane, as seen in **Figure 7**. This scenario creates a potential dooring safety issue for people cycling.

Figure 7: Curbside Parking creates a Dooring Safety Issue



Narrow Bicycle Lane Width

Along most of the corridor where space is available, the bicycle lanes are 1.8 metres wide with a 0.6 metre painted buffer. However, as noted previously the bicycle lane width narrows to 1.3 metres in several locations, and narrows further to 1.0 metres in some locations. It is important to note that while the bike lane width narrows there is a consistent painted buffer of 0.6 metres adjacent to the bicycle lane. Warning signs are provided at these locations advising people cycling that the width narrows; however, these locations become constrained and are below recommended guidelines published by the Transportation Association of Canada and other national and international bicycle facility design guidelines.

The 100% design drawings provided by the City indicate that as part of the typical cross section, 0.3 metres of space should generally be provided between the centre of the painted white line closest to the edge of the asphalt and the edge of the asphalt itself. Along the corridor, however, the width of this space varies and in some locations, it appears to be less than 0.3 metres and in others it appears wider, which in some cases results in the narrowing of the bicycle lane (**Figure 8**).

Figure 8: Example of a Location Where the Width of The Bicycle Lane is Below 1.5 Metres

Suggestions:

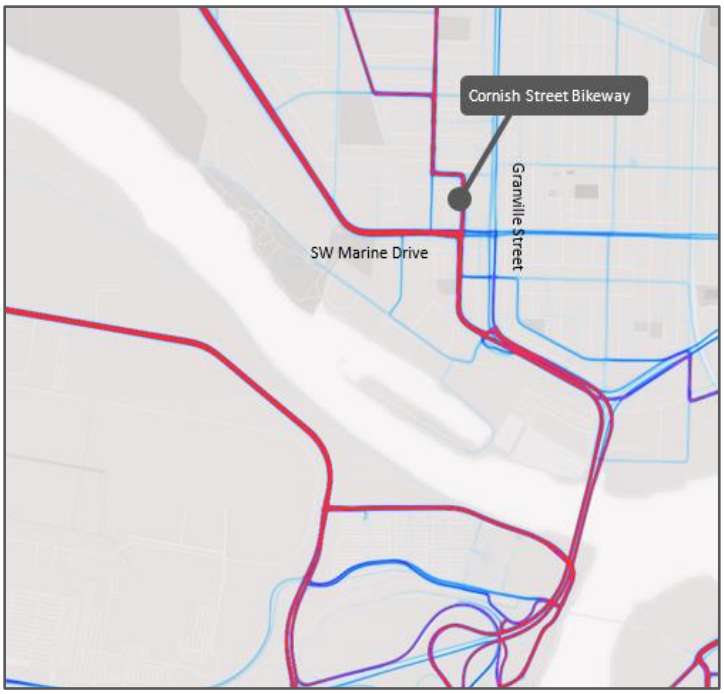
Shared Use Lane Eastbound between East Boulevard and Cornish Street

- Consider restricting right turn motor vehicle movements from eastbound Southwest Marine Drive onto southbound Southwest Marine Drive (Cornish Street Local Street Bikeway) utilizing the space of the existing right turn lane and widening the road into the boulevard to provide space for the bicycle lane to continue to the Cornish Street intersection.

  The 100% design drawings provided by the City identifies Cornish Street as a local street bikeway. Therefore, preventing motor vehicle drivers from turning right onto southbound Southwest Marine Drive would reduce the volume of motor vehicles travelling along this portion of the street and reduce the number of motor vehicles using this route as a shortcut to avoid the Granville Street intersection.

  As seen in **Figure 9** below, Strava Global Heatmap data indicates that a high number of people cycling are using Cornish Street/Southwest Marine Drive as a bicycle route to access the Arthur Laing Bridge. This helps to confirm the important role this corridor plays in the bicycle network.

Figure 9: Strava Global Heat Map – Bicycle Ridership



Bicycle Lane Adjacent to Parking

Some potential mitigation measures for the safety issues associated with doorings include:

- Consider reconfiguring the on-street parking and bicycle lane to provide a parking protected bicycle lane. However, this would require switching the location of the bicycle lane to be curbside, and providing on-street parking between the bicycle lane and the motor vehicle lane. To safely provide sufficient space for a buffer between the bicycle lane and parked cars and between parked cars and the motor vehicle lane, additional space would be required through widening the width of the road.

- Alternatively, consider restricting parking along this portion of the corridor to address this safety issue.

Narrow Bicycle Lane Width

At locations where the bicycle lane width is narrow, the City may consider widening the bicycle lane utilizing the additional space between the edge of the asphalt and the painted white line, as seen at other locations along the corridor and in **Figure 10**.

Where there are nearby obstructions such as utility poles, consider installing reflective tape or obstruction signage to ensure these obstructions are visible. Some locations identified where additional tape and signage could be installed include:

- In the westbound direction between Angus Drive and 64th Avenue where there is no curb separation (in front of 1955 and 1925 Southwest Marine Drive).
- In the westbound direction between 57th Avenue and 54th Avenue

Figure 10: Example of White Lane Line Adjacent to the Edge of the Asphalt

Issue 2: Separation

Physical separation between motor vehicles and bicycle users has been provided at select locations along the corridor to prevent through motor vehicle traffic from using the bicycle lane to pass turning motor vehicles, and to prevent motor vehicles turning right from intersecting streets from turning into the bicycle lane. Physical separation has been provided either in the form of concrete barriers or plastic bollards. As outlined in the Design Criteria developed for the corridor (**Appendix A**), concrete barriers have been provided under the following circumstances:

- Farside signalized intersection locations; and
- T-intersections.

Extra protection/barriers were not provided at intersections with high or low right turn volumes at nearside/approach locations on Southwest Marine Drive as per the City's stated guidelines and current practices at other protected bicycle lanes in the City (such as bicycle facilities on Hornby Street and Dunsmuir Street). The cited reasons why barriers were not provided include:

- Good visibility of cyclists is of vital importance.
- When turning motor vehicle volumes are greater than 150 vehicles per hour
- Turn bays are recommended with yield-on turn control conditions to enable drivers to pull out of through traffic stream and to provide clearer information to people cycling.

The table below outlines some of the characteristics associated with the two types of physical separation that have been used.

Flexible Plastic Delineator Posts	Concrete Barriers
• Removable • Spacing is dependent on road characteristics, along Southwest Marine Drive they are installed at 5 metre intervals • Low cost, though may require frequent replacement due to damage • Limited impact on sightlines • Increases user comfort, but does not offer physical protection	• Can provide a continuous barrier • Durable • Provides a high level of protection • Recommended on corridors with vehicles travelling at high speeds • Increases user comfort and provides physical protection

Some of the safety issues associated with the physical separation that has been used along the corridor include:

- **Broken and knocked over plastic bollards.** Plastic bollards had been knocked over or broken at several locations along the corridor as seen in **Figure 12,** including around the curve near Maple Grove Park and east of Macdonald Street. The damage to the plastic bollards was most significant between West 57th Avenue and Macdonald Street. It is important to note that most of the bollards are located along this segment of the corridor.

- **Shifted concrete barriers.** The concrete barriers that have been used on Southwest Marine Drive were observed to have shifted at some locations into the bicycle lane (**Figure 11**). They were also seen to have cracked and broken apart. The following safety issues were identified:
    - The shifting, broken and cracked concrete barriers create debris and a tripping hazard in the bicycle lane.
    - The marks and damage to the concrete barriers indicate that motor vehicles have collided with the barriers (**Figure 13**). This could be an indication the barriers are not visible.

- **Lack of physical separation.** At locations where there are no concrete barriers, including locations that have bollards, people cycling are at risk to side-swipe related collisions/conflicts if the motorists encroach into the adjacent bicycle lane.

- **Location of barriers is sporadic and inconsistent.** On long stretches of the corridor where there are no concrete barriers, the barriers can seem to appear unexpectedly, especially at night and in poor weather conditions. This may be due to the apparent inconsistent and sporadic placement of the barriers and low visibility. This was noted to be a concern particularly when travelling on Southwest Marine Drive in the westbound direction between Barnard Street and the barriers located in front of Lot #2191. At this location specifically, the concrete barriers are spaced over 1 kilometre apart, resulting in unpredictability to road users when the barriers do appear.

- **Visibility of barriers.** The City has received feedback from residents and road users that the visibility of the concrete barriers is poor in low light and poor weather conditions. The ISRSR Team

also noted during their site visits that the visibility of concrete barriers was limited along the corridor. Some of the key locations with low visibility identified by the team were:

- The barriers west of West 57th Avenue, which are challenging to see for motor vehicle drivers making right turns onto Southwest Marine Drive from West 57th Street;
- The barriers on the north side of the Southwest Marine Drive between West 54th Avenue and Yew Street;
- The barriers on the north side of Southwest Marine Drive in front of lot #2191; and
- The barriers on the north side of the street in front of Maple Grove Park. As seen in **Figure 14,** an orange plastic traffic cone has been placed at the nose of the barrier to increase visibility.

Figure 12: Damage to Plastic Bollards

Figure 11: Shifting Concrete Barriers

Figure 13: Broken and Scuffed Concrete Barriers

Figure 14: Example of a Traffic Cone Added in Front of Barrier to Increase Barrier Visibility

Suggestions:

- The City can continue to work to ensure the roadway and bicycle lanes are clear of debris including damaged plastic bollards (see recommendations specific to maintenance identified in **Issue 10**). See also **Issue 4** regarding motor vehicle lane widths and vehicle encroachment.
- Consider installing additional concrete barriers, where feasible at the farside of intersections. This can help to raise awareness and serve as a more consistent reminder of the presence of barriers and the bicycle lane along the corridor it can also make the placement of the barriers more predictable. Vehicles turning onto Southwest Marine Drive from a side street may not be aware of the presence of cement barriers or the bicycle lane along the corridor. Additional barriers are suggested on the farside of intersections in the westbound direction between Barnard Street and east of 57th Avenue. When determining placement of additional barriers, the City should review turning movements, volumes, sightlines, and ensuring there is an adequate turning path space at these locations.

  Due to potential conflicts with people walking in the bicycle lanes, additional barriers should only be placed at locations where additional space for people walking has been provided.
- Consider enhancing the visibility of the concrete barriers along the corridor. Some suggestions to enhance visibility include:
  - Paint the bullnose of the barrier with yellow paint such as the treatment used on the cement diverter at Southwest Marine Drive and Cornish Street (**Figure 15**).

Figure 15: Example of Yellow Paint Used to Enhance Visibility

- Apply a strip of reflective tape to the bullnose and along the side of the barrier.
- Install one or more plastic bollards in advance of the concrete barrier where feasible.

- Consider installing concrete barriers and/or plastic bollards more consistently along Southwest Marine Drive to avoid long stretches with no physical separation, particularly in sections of the corridor where there are no vertical or horizontal curves to make the presence of barriers more predictable.

Issue 3: Mixing Zones

At signalized and unsignalized intersections along the corridor, the bicycle lanes have been dashed leading up to the intersection to allow motor vehicle drivers to make right turns from the shared bicycle/right turn lane. It is important to note that the mixing zones have existed for at least a decade along this corridor and were not installed as part of this project. The following safety issues were identified at these mixing zones:

- There are no signage or pavement markings along the corridor to indicate that this space is intended to be shared. There are no right turn pavement markings for vehicles in the curb side lane or signage for motor vehicle drivers informing them to yield to cyclists as the enter the bicycle lane. As a result, users may not realize that the space is shared.

- As noted in **Issue 1**, shared space for bicycles and motor vehicles is not desirable as there is an increased potential for conflict. This safety issue can be exacerbated if the presence of other road users is unexpected or behaviours are unanticipated as noted above.

- At Southwest Marine Drive and Angus Drive, the ISRSR Team observed motor vehicles crossing the buffered bicycle lane prior to the dashed line to enter the right turn lane early and avoid waiting behind other stopped vehicles, as seen in **Figure 16**.

- At both signalized and non-signalized intersections when there was no congestion, vehicles were observed to be making right turns from the through lane (**Figure 17**). Because the shared right turn lanes are not being used consistently, this results in unpredictable behaviour as

people cycling and driving may be unaware that the vehicle is preparing to make a turning movement particularly if motor vehicle drivers are not using their vehicle turn signal.

Figure 16: Vehicle Encroaching into the Bicycle Lane (Southwest Marine Drive and Angus Drive)

Figure 17: Vehicle not using the Mixing Zone to Make Right Turn Movement (Southwest Marine Drive and Angus Drive)

Suggestions:

- The City may consider installing a Turning Vehicle Yield to Bicycles Sign (RB-37) to advise motor vehicle drivers they are crossing and travelling in a designated bicycle lane.

- Consider adding bollards prior to the dashed line to raise awareness of the presence of the bicycle lane to motor vehicle drivers and make it more clear that they are about to enter a bicycle lane. This treatment will also help to prevent motor vehicles from entering bicycle the lane early.

- The City can continue to review the volume of right turn motor vehicle movements at intersections along the corridor. At intersections where right turn volumes are low, the City can consider eliminating the shared right turn lane. It was observed by the team that at intersection locations where there was no congestion, motor vehicle drivers were making right turn movements from the through lane.

- Over the long term, as the City monitors intersection turning movements along the corridor, the City can consider opportunities to widen the road into the boulevard to provide a separated right turn lane for motor vehicle drivers and a bicycle lane for people cycling at locations where turning volumes are high.

Issue 4: Perceived Motor Vehicle Lane Width

The typical motor vehicle lane widths along Southwest Marine Drive are 3.3 metres. It is our understanding that the recently approved 2016 Transportation Association of Canada's Geometric Design Guidelines state that a lane width of 3.3 metres is an appropriate width for streets where larger trucks or buses are expected to regularly use the lane. Along portions of the corridor with horizontal curves, the City has increased the width of the lanes to 3.5 metres where feasible.

Between East of West 54th Avenue and Macdonald Street, there are several horizontal curves in the road, which are often compounded with vertical curves that impact sightlines. Based on the 100% design drawings provided by the City, the motor vehicle lane widths in this section range between 3.3 metres to 3.9 metres. As noted, lane widths are the widest at locations where there are vertical and horizontal curves. However, there are several locations along this portion of the corridor as observed by ISRSR Team where the lane widths felt narrow particularly when passing a larger vehicle and at locations where there where physical barriers separating the bicycle lane. Images below show incidents of vehicles encroaching into the centre line and the bicycle lane buffer while driving along Southwest Marine Drive (**Figure 18**, **Figure 19** and **Figure 20**). While **Figure 19** and **Figure 20** illustrate that motor vehicle drivers are encroaching into the bicycle lane and into the cement barrier, they also show that at these specific locations there is sufficient lane width. Motor vehicle drivers may be encroaching into the bicycle lane because they just passed a larger vehicle encroaching on the centre, they are travelling at higher speeds, and the road geometry.

Observed damage to the plastic bollards and concrete barriers along this portion of the corridor also indicates that current motor vehicle lane widths may be constrained in some locations in relation to the vertical and horizontal curves in the road and the speed motor vehicles are travelling.

Figure 18: Vehicle Encroaching onto the Centre Line While Navigating a Curve in the Road

Figure 19: Vehicle Encroaching into the Bicycle Lane While Navigating a Curve in the Road

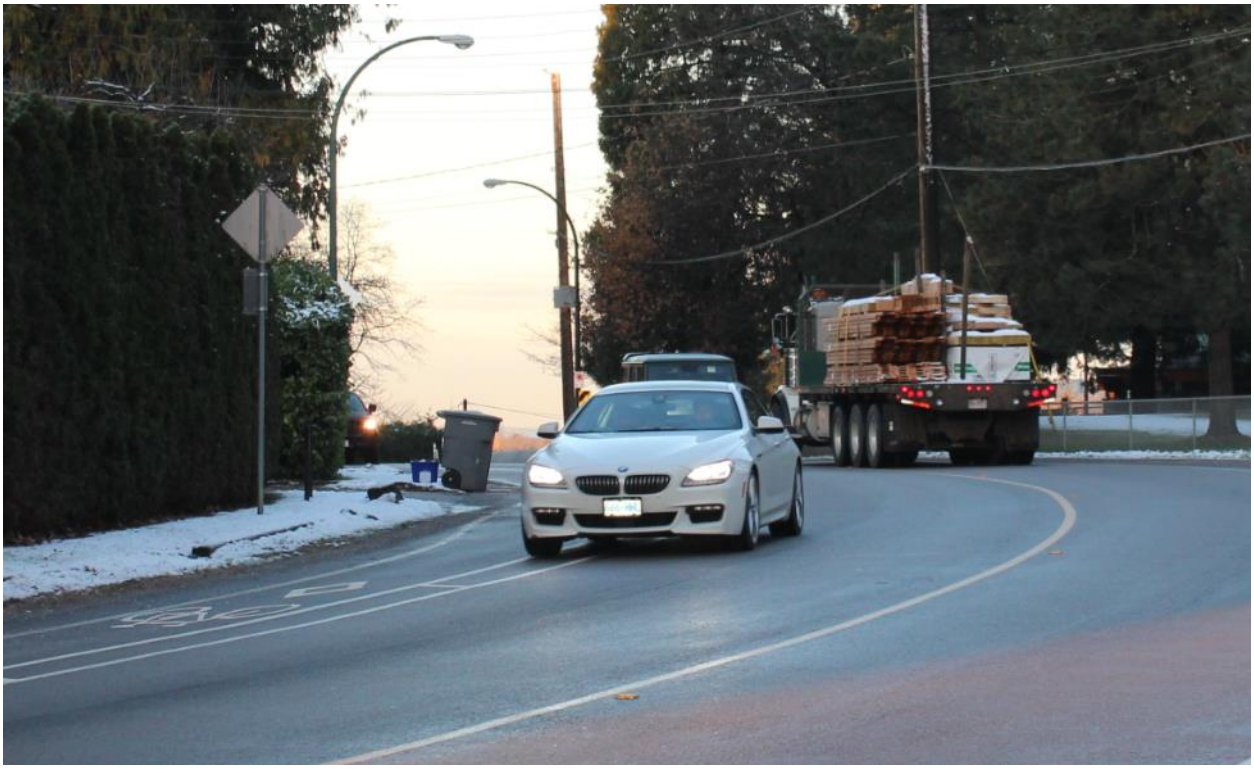


Figure 20: Vehicle Encroaching into the Concrete Barrier While Navigating a Curve in the Road

Suggestion:

The following suggestions have been provided to address vehicles encroaching out of their designated lane between East of West 54th Avenue to Macdonald Street:

- Consider providing warning signage where the road is winding, particularly between 54th Avenue and Marine Crescent to encourage motor vehicle drivers to reduce speed through this portion of the corridor due to the curves in the road and the changes in topography.
- Alternatively, the City could consider installing speed feedback boards along this section of the corridor. Research on the effectiveness of speed reader boards suggests that the boards are effective in reducing the speed mostly in short term. Over the long term, they are less effective, however research shows that speeds still tend to be slower if a "Slow Down" warning message is still in place. The City of Calgary has found that using a temporary SLOWS trailer and moving it around on a two-week basis was effective at slowing down vehicle speeds at locations it was used[1][2].

Issue 6: Walking Facilities

The walking facilities provided on Southwest Marine Drive vary along the length of the corridor from concrete sidewalk, to a gravel or grassy walking space, to limited or no space at all. In cases with limited

[1] Mishra & Churchill. *'Slow down' or 'Not to slow down' – A before-after study on effectiveness of SLOWS Trailers in Calgary*. CITE 2016
[2] Hildebrand, Mason, Paradis & Hazzard. *Long-Term Effectiveness of Radar Speed Display Boards in School Zones.* University of New Brunswick, Transportation Group (2014)

or no pedestrian accommodation, pedestrians are required to walk in the bicycle lane. These conditions create a variety of safety issues mainly for people walking and cycling along the corridor, with conflicts between people walking and people cycling in the same space. The following safety issues related to walking facilities where identified by the ISRSR Team:

- **Lack of walking facilities**. In many locations, no formal pedestrian facilities are provided. In other locations, gravel or grass has been provided. However, walking on the grass or gravel space may not be a practical option for people walking of all ages and abilities, particularly for individuals needing a smooth, level surface to travel along. Along much of the corridor, the walking facilities are not accessible due to a lack of smooth surface or curb let-downs. On rainy days, grass can be slippery and generally unpleasant to walk along. Because of this, and in locations where there is no space for people to walk, people were observed to be walking in the bicycle lane instead (**Figure 21** and **Figure 22**).

  People walking on the bicycle lane is a potential safety concern if they are not expected or visible to people cycling. At locations where concrete barriers an additional challenge is created where there is no space for people cycling to pass people walking in the bicycle lane.

  The lack of walking facilities along Southwest Marine Drive and walking within the bicycle lane does not create the perception of a comfortable environment for people walking along the corridor.

- **Overgrown vegetation.** There were several locations where there was a concrete sidewalk or designated place for people to walk along the corridor, but where overgrown vegetation and hedges reduced the width of the walkway, while also reducing sightlines from the driveway and potentially creating some potential CPTED concerns (**Figure 23**).

- **Limited designated crossing locations.** Designated crossing locations are limited for people walking along this corridor. Crossing Southwest Marine Drive can be challenging due to high vehicle volumes, speeds and the vertical and horizontal curves in the road. The lack of designated crossings can result in an increased number of incidents of people jaywalking and was outlined in the previous reports to Council.

Figure 21: Lack of Walking Facilities Resulting in People Walking in Bicycle Lane

Figure 22: Grass Walking Space

Figure 23: Overgrown Vegetation Adjacent to Sidewalk

Suggestions:

- **Lack of walking facilities**. Consider opportunities to provide a continuous concrete or gravel pathway on at least one side of the street consistently throughout the corridor. Based on current conditions, the north side of the street is recommended as there are already walking facilities or space for walking facilities along much of that side of the street. Continuous paved or gravel walking facilities would enhance the accessibility of the corridor and provide a designated space for people to walk would help to reduce potential conflicts between people walking and cycling. Grass is not considered a suitable facility for people walking, particularly when considering walking

for all ages and abilities and through all seasons. The installation of a continuous walking facility could potentially impact existing trees, vegetation and utility poles.

- **Overgrown vegetation.** Consider working with Bylaw Enforcement and homeowners to ensure that where walking space is provided, vegetation including shrubs and hedges is maintained to ensure adequate walking space is provided and sightlines are maintained.

- **Limited designated crossing locations.** The City can consider reviewing locations along Southwest Marine Drive where an additional pedestrian crossings may be warranted.

Issue 7: Driveways

There are several private residential driveways located along the Southwest Marine Drive corridor; however, there were no significant safety issues observed at many of these locations.

Safety issues were observed at driveways located at intersections, such as those located at Southwest Marine Drive and West 57th Avenue/Yew Street. At this locations when motor vehicle drivers were travelling into the driveways their actions were unpredictable and unexpected by the ISRSR Team.

Suggestions:

- Consider relocating and pushing back the stop bar at Southwest Marine Drive and West 57th Avenue/Yew Street in the eastbound direction to avoid vehicles from blocking the driveway.

Issue 8: Signage and Pavement Markings

Overall, the signage and pavement markings provided along the corridor provide good instructions and guidance to road users of the operations, obstructions and regulations along the corridor. The ISRSR Team did note some potential safety issues associated with the signage and pavement markings, as outlined below:

- **Missing 'sharrow' pavement markings**. In the right turn lane on Southwest Marine Drive approaching Cornish Street (eastbound), green boxes have been painted in the turn lane but the 'sharrow' bike stencils have not been installed. Based on discussions with City staff, it is understood that this is because of weather conditions and that these will be painted in the spring.

- **Cycling hazards and obstructions.** There is limited obstruction signage for objects that are a potential hazard for people cycling along the corridor, including utility poles that are located within 0.3 metres of the painted white line closest to the edge of the asphalt roadway (**Figure 24** and **Figure 25**).

  While the 100% design drawings provided by the City indicate that a space of 0.3 metres should be provided between the bicycle lane line closest to the edge of the asphalt roadway and the edge

of the roadway, this is not consistently the case along the length of the corridor. This can create a potential safety issue when there are obstructions within proximity of the bicycle lane.

Figure 24: Example of Object within 30cm of Bicycle Lane

Figure 25: Example of Object within 30cm Bicycle Lane

- **People walking in the bicycle lane.** As noted above, when discussing issues related to a lack of walking facilities along the corridor, people walking are often doing so in the marked bicycle lane due to a lack of appropriate alternative. This can create potential conflict between users if the presence of people walking in the bicycle lane is unexpected.

Suggestions:

- When weather permits, install 'sharrow' pavement markings in the right turn lane on Southwest Marine Drive approaching Cornish Street.

- Consider installing reflective tape or obstruction signage on utility poles and other potential obstructions within 0.3 metres of the centre of the painted line closest to the edge of the roadway at the following locations:
    - In the westbound direction between Angus Drive and 64th Avenue where there is no curb separation (in front of 1955 and 1925 Southwest Marine Drive.
    - In the westbound direction between 57th Avenue and 54th Avenue

Issue 9: Lighting

Overhead street lighting is located along the corridor on both sides of the street and, in most cases, overhead lighting is within proximity of locations where concrete barriers and bollards have been installed

along the corridor. There are some locations where barriers have been installed where lighting is limited including:

- Southwest Marine Drive at Yew Street (east of Maple Grove Park) – eastbound direction
- Southwest Marine Drive at West 57th Street – westbound direction
- Southwest Marine Drive at Barnard Street – westbound direction

It was also noted during the site visit that at dusk, prior to the overhead lights being activated, visibility can be challenging along the corridor and this is exacerbated in poor weather conditions (**Figure 26**). Due to the unexpected location of some of the barriers (as discussed in **Issue 2**) and the limited visibility the presence of bollards and concrete barriers can present a potential safety issue.

Additionally, viability of people walking and cycling along the corridor is also restricted by the lighting along the corridor. The lack of continuous facilities for people walking (as outlined in **Issue 6**) can create a safety issue as people cycling may not be able to see people walking.

Figure 26: Lighting Along Southwest Marine Drive at Dusk

Suggestion:

- Enhance visibility of concrete barriers and bollards based on the recommendations provided to address **Issue 2**.

- Consider installing additional overhead lighting where feasible to ensure the visibility of bollards, concrete barriers and people walking and cycling at the locations noted above, particularly at intersections and where there are horizontal and vertical curves in the road geometry.

Issue 10: Maintenance, Drainage and Debris

During the three site visits, the ISRSR team identified maintenance as potential safety issues. These issues were mainly identified within the bicycle facilities and would present safety issues for people cycling and walking within these facilities. Some of the maintenance related safety issues identified included:

- Drainage and the presence of water and ice within the bicycle lane as seen in **Figure 27,** creates a slippery surface and a potential hazard for people walking and cycling.
- Leaves and other vegetation accumulating in the bicycle lane creates an uneven slick surface, as seen in **Figure 28**.
- Overgrown vegetation creates a vertical obstruction in the bicycle lane, as seen in **Figure 29**.
- Other debris including knocked over signage, bollards and debris from vehicles, as seen in **Figure 30**.
- The ISRSR team visited the corridor on a Tuesday where garbage collection occurred and witnessed garbage and recycling bins left in the bicycle lane creating obstructions along the route, as seen in **Figure 31**.

These maintenance related issues create potential tripping and slipping hazards for people walking and cycling along the corridor.

Figure 27: Bicycle Lane Covered by Ice

Figure 28 : Bicycle Lane Covered by Leaves and Vegetation

Figure 29: Trees Obstructing the Bicycle Lane

Figure 30: Signs and Other Debris in the Bicycle Lane Overgrown

Suggestion:

- **Ensure that the pathways are a smoothly paved surface and kept free of debris.** It is suggested that the City continue to coordinate bicycle facility maintenance with other road operations and maintenance activities including sweeping, salting and debris removal as well as repairs. Sweeping should occur multiple times though the year particularly in the fall and the spring to clear the accumulated debris collected over these months.

- The City could also consider reminding residents and garbage collectors not to obstruct the bicycle lane with garbage and recycling bins and provide information that outlines where bins should be placed out of the way of the bicycle lane.

Figure 31: Garbage Bin Obstructing Bicycle Lane

Issue 11: Speeding

The review of speed data collected by the City of Vancouver during the Month of November, 2016 indicates that there are some potential safety issues associated with speeding motor vehicles along the corridor, particularly during non-peak periods and overnight on weekends and holidays. Speeding creates potential safety issues for all road users and has been documented in feedback from residents and stakeholders.

Suggestion:

- Increased enforcement by the Vancouver Police Department particularly at times and locations where speeding has been identified as an issue (overnight on weekends).
- Consider installing speed reader boards to advise motor vehicle drivers of the speed at which they are travelling. As discussed in Issue 4: Motor Vehicle Lane Widths, speed reader boards are recommended along the portion of the corridor between west of West 54th Avenue and Macdonald Street. Based on research it is recommended that temporary boards are used and the location is changed on occasion for increased effectiveness.

Appendix 1: Design Criteria

Design Criteria

Criterion	Desirable or Min/Max	Notes
Pedestrian Facility	Minimum sidewalk infill/gravel walk width of 1.2m	
Protected Bike Lane	Extra Protection/barriers are not considered at high or low right turn intersection nearside/approach locations on SW Marine Dr based on guidelines and current CoV practice (eg. Hornby and Dunsmuir): • Good visibility of cyclists is of vital importance • When turning traffic volumes are greater than 150 vehicles/hr • Turn bays are recommended with yield-on turn control conditions to enable drivers to pull out of through traffic stream and to provide clearer information to people cycling. Extra protection/barriers are considered at the following to prevent through vehicle traffic to pass in the bike lane and right turning vehicles from intersecting street to turn into the bike lane: • Farside signalized intersection locations • T-intersections Barrier treatment type is a combination of low concrete gravity barrier and bollards (at a spacing of 5.0m) to ensure safe sightlines and visibility.	
Solid Painted Bike Lane Line	Streets and Traffic Bylaw (#2849) condition #43 Driving on Streets Lined for Traffic (1) Double Lines will be changed to add clarity and accommodate the solid painted bike lane line to provide formal legal access to residential driveways and/or curb side on-street parking.	

	The Motor Vehicle Act (#156) allows crossing the solid painted bike lane lines. Retain solid painted bike lane line through residential driveways and curb side on-street parking.	
Buffer Painted Line	Provision of painted gored area within the standard painted buffer lines. Use spacing of 4.0m for 0.6m buffer width.	For reference, W King Edward Av used a spacing of 8.0m for 0.9m buffer width
On-Street Parking	Provision of on-street parking on SW Marine Dr where: • There is adequate space between property line and bike lane to accommodate a parking space and pedestrian space • The location does not negatively impact the safety of all road users, particularly vulnerable road users • There are long blocks (>200m) and no other on-street parking is available within a reasonable walking distance, typically about 150m that does not require crossing SW Marine Dr at an unmarked or unsignalized crosswalk • On-street parking provision is not required if there is lane access	
Sanitation	Accommodate design vehicle ACX64 Class 8 at protected bike lane locations.	Design vehicle with side arms that pick up residential garbage bins.

Resident Feedback

Design Element or Location	Comments	Notes
Concrete barriers / bollards	• Visibility • Object markers getting knocked or turned. • Bollards are being hit (eg. Marine Cr, Maple Grove Park) • Causing delays for eastbound SW Marine Dr at Angus Dr • Some vehicles try to pass on the left (over the centre line), when slower vehicle or sanitation vehicle in front	
SW Marine Dr/Macdonald St	• Accessing Southlands via Car2Go and pedestrians crossing the intersection	
On-street parking	• Too many regulated signs • Some vehicles parked temporarily in the bike lane (eg. gardeners, couriers)	
Approach Mixing Zones	• Potential conflicts between vehicles/cyclists	