Schedule 2 to the Minutes of the Public Works & Transportation Committee meeting of Richmond City Council held on Wednesday, February 21, 2018.

WATT Consulting Group

RIVER ROAD (NO. 6 TO WESTMINSTER HIGHWAY) CITY OF RICHMOND

Traffic Operations Safety Review

Prepared for:	City of Richmond
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EXECUTIVE SUMMARY

The following Executive Summary is updated from the February 6, 2018 version and Addendum No. 1.

Study Purpose and Background

Watt Consulting Group was retained by the City of Richmond to undertake an independent traffic operations and safety review of the River Road corridor from No. 6 Road to Westminster Highway. The study was commissioned in response to safety concerns raised by the public, particularly related to off-road crashes and to crashes involving cyclists. The study is also supported by ICBC, who may contribute funding to the implementation of the proposed options.

Method Used

The review generally followed the method recommended in the Transportation Association of Canada's *Canadian Guide to In-service Road Safety Reviews.* This method clearly identifies a problem statement then identifies countermeasures to address the issues identified.

Site visits were conducted on January 17 and 18, 2018 – both at night and in the daytime and by bike riding the corridor and driving the corridor. Crash records from the Insurance Corporation of British Columbia were reviewed for the six years between 2011 and 2016 (inclusive). The predominant crash types were identified along with the higher-crash locations. Actual vehicle operational speed profiles were also reviewed.

This study considered a broad range of countermeasures to address the identified collision issues, including countermeasures previously proposed by City staff, ICBC staff, as well as several proposed by members of the public. Additional collision-reduction countermeasures were proposed by WATT, resulting in the evaluation of a total of 29 measures.

Findings

On average, 20 crashes were recorded annually along the corridor. The crash data indicated the highest number of crashes are at the following locations:

- No. 6 Road and River Road (22 percent of total collisions), and
- River Road and Westminster Highway curve and intersection (21 percent of total collisions).

Of known collision configuration types, 33 percent were single vehicle off-road crashes, 9 percent were single vehicle – damage by debris, 31 percent were side impact or side-swipe crashes, and eight crashes involved cyclists (11 percent). The remainder were rear-end (13 percent) or head-on (3 percent).

In terms of severity, 37 percent of the crashes were injury collisions and one percent were fatal collisions, which is typical for urban two-lane arterial roads when compared to the British Columbia average. One fatal collision occurred in 2016 involving a cyclist, and a second fatal collision occurred more recently outside the crash record period, involving a single vehicle going off-road.

The analysis indicates that most of the crashes were occurring on weekdays in the daytime, with very few collisions at night. Seasonal patterns for collisions were not evident.

The roadway design consists generally narrow lanes of variable width. There is also limited or no road-side shoulder in most areas. There is a steep drop-off to a ditch on the south side of the road in many areas which would be non-recoverable should a vehicle leave the roadway. There are utility poles, fire hydrants, trees, and fences close to the road in many areas.

Cyclist "Single File" signage was clear and implemented at a high frequency, however the additional messaging sign to drivers to change lanes to pass are difficult to read and comprehend at-speed and are contradictory to the double yellow centreline used along most of the corridor. Staff has a plan to revise the double yellow centreline to single broken lines at select locations to allow passing where safe.

Speed data was reviewed and generally the 85th percentile of the speeds measured was over 70 kilometers per hour. These travel speeds are considered high as the posted speed is 50 kilometres per hour (or 30 kilometres per hour for trucks) and the geometry of the road is not well-able to accommodate such high speeds. The rural nature of the road and area nonetheless may encourage some motorists to drive faster than is safe for conditions. A significant contributing cause of the crashes (both frequency and severity) is likely that drivers are traveling driving faster than the speed best-suited for the physical conditions. The road has an Average Annual Daily Traffic volume (AADT) of approximately 3,000 vehicles per day.

The corridor was found to be well-lit at night even in wet and rainy conditions, with most pavement markings being quite visible.

Problem Statement

The review of crash records identified four distinct collision patterns. After discussion with staff, it was confirmed that these four collision patterns are the issues that should be addressed with any safety countermeasures:

- **single vehicle crashes – off-road;**
- **single vehicle crashes – damage from debris;**
- **side impact and sideswipe crashes; and**
- **cyclist-involved crashes.**

In addition, the high travel speeds along the corridor are a concern given the characteristics of the roadway.

Proposed Countermeasures

The proposed countermeasures were evaluated to assess whether they addressed the identified collision issues described above. In general, the proposed measures include:

- a package of sign and pavement marking improvements that provide consistent messages to drivers and cyclists;
- improved maintenance, particularly to remove debris;
- improvements to reduce off-road crashes such as increasing the pavement friction (to help motorists maintain control) at the two 90 degree curves;
- measures to guide drivers through the two 90-degree turns.

To reduce the frequency and severity of all of the four identified collision issues, solutions are proposed to better align the operating speeds with the road conditions. Changes would either:

- improve the road conditions to accommodate the actual vehicles operating speeds, or
- reduce operating speeds to a more appropriate level relative to the road conditions.

Improving Road Conditions

The road is classified as a secondary arterial which suggests that the road surface should be widened to standard, shoulders installed, and roadside hazards located sufficiently far from the edge of road or protected. As well, given the nature of the road adjacent the River and the recreational use it attracts, pedestrian and cycling facilities (and possibly equestrian facilities) should be considered. It is acknowledged that these improvements would come at a high cost and likely be done when the dyke is re-built and therefore an interim option should be considered.

Reducing Operating Speeds

Reducing the vehicle operating speeds through traffic calming, regulation, and enforcement can be a cost-effective option which can be implemented relatively quickly. Reducing speeds can be achieved through physical measures that require vehicles to slow down, but may also include other traffic control elements that better reflect conditions.

Speed humps are a proven effective means of maintaining a lower operational speed whilst other speed calming measures and techniques do not have reliable results. Speed humps are appropriate on local roads however the modification of speed humps to create a "speed cushion" are more appropriate on collector and arterial roads such as River Road, particularly to accommodate emergency vehicles such as fire and ambulance. Cushions provide a softer vertical deflection compared to speed humps, and are typically installed with gaps to allow wider wheelbase emergency vehicles more easy passage while still requiring passenger vehicles to ride over the hump. Cyclists are not typically bothered by speed humps or cushions and this is evident by the existing installation of speed humps on the corridor. With cyclists "taking the lane" by driving single file in the middle of the lane they will have the option of driving over the speed hump or using the gap in the cushion without adversely affecting other traffic.

Speed reader boards can also be effective in reducing speeds and alerting drivers they are going too fast for conditions. However, their effectiveness is more when first installed and gradually reduces over time, suggesting that movable devices be installed and their location be changed from time to time.

Recommendations

It is recommended that the City develop a long-term plan to widen River Road to a 50 km/h design speed and to provide for shoulders, and separate recreational users from general traffic (cyclists, pedestrians, equestrians).

In the interim, it is recommended that the City implement measures to reduce operating speeds and mitigate the occurrence of the four key collision types. Proposed measures include the installation of a series of speed cushions to minimize excessive speeds and keep motorists within an appropriate speed to share the road single file with cyclists (40 km/h or less). Speeds should be reduced further at the No. 6 Road and the Westminster Highway 90-degree curves. The speed cushions should be accompanied with appropriate speed hump warning signs, regulatory 30 km/h signs for all (including trucks), 20 km/h advisory speeds should be posted on 90 degree curve ahead signs at the two 90 degree curves. Speed reader boards should be installed, and should be movable so that different areas along the corridor can be benefited. Additional measures listed below should also be implemented as part of the short term and/or interim approach.

ICBC is a project partner, and funding from ICBC is likely available for many of the recommended measures.

TABLE ES-1: Summary of Proposed Countermeasures

Proposed Countermeasure	Justification and Benefit	Time Frame	Estimated Cost
Sign and Pavement Marking Updates (including conversion to single broken yellow centreline, addition of sharrow stencils, and signage improvements). High end estimate assumed conversion of up to 7000m of double yellow to single broken markings, sharrows spaced at 75m for the entire corridor, and up to 40 new signs.	To clarify shared use motorist-cyclist nature of the road and to create clear and consistent messaging along the corridor. Narrow (shared) road and high motorists speeds create speed differential and safety risk. **Target:** Reduce cyclist collisions.	Short Term	$67,000 to $180,000

Proposed Countermeasure	Justification and Benefit	Time Frame	Estimated Cost
Speed Reader Boards (assuming four boards). Recommend that the boards be movable, to reduce driver complacency and allow for flexibility in application at areas of concern.	Speed reader boards provide direct feedback to drivers vis-à-vis posted speed limit and road conditions and can reduce speeds. Observed speeds are currently faster than are safe for road conditions. **Target:** Reduce speed-related collisions.	Short Term	$50,000 to $60,000
Curve Treatments, including chevron warning signs (possible LED enhancements). These would be installed at the 90 degree curves.	Provide enhanced warning and guidance through sharp curves where collision frequency is higher. Sharp curves may be unexpected after long, relatively straight and unimpeded approach. **Target:** Reduce off-road collisions.	Short Term	$15,000 to $50,000
Pavement Treatments – to increase friction (assumed 800 lane-metres of application; assumed 200m length per lane at each curve)	Provide increased driver control through sharp curves where collision frequency is higher. Sharp curves may be unexpected after a long, relatively straight and unimpeded approach. **Target:** Reduce off-road collisions.	Short Term	$425,000 to $500,000
Education (for both drivers and cyclists, regarding shared roads and single file operations. Could include informational material or presentations to cycling groups.)	May increase driver understanding and behaviour toward cyclists, and cyclists understanding towards driver behaviour, regarding desirable single file and passing behaviour. **Target:** Reduce cyclist collisions	Short Term	Not estimated

Proposed Countermeasure	Justification and Benefit	Time Frame	Estimated Cost
Increase Maintenance (more frequent debris clearing / street sweeping, and/or re-striping of pavement markings).	Reduce potential for collisions involving debris, or off-road collisions in areas where markings may be faded or obscured. Debris was a noted factor in some single vehicle collisions. **Target:** Reduce debris-related and off-road collisions.	Short Term	Not estimated
Traffic Calming – Speed Cushions Reduce posted speed limit to 30 km/h for all vehicles with traffic calming comprising 43 speed cushions: • 13 sets of 3 speed cushions spaced at 100 m between the curves with a minimum of 400 m between each set • 1 set of 3 speed cushions on No. 6 Road approaching River Road, and • 1 speed cushion on River Road approaching Westminster Highway. If the above speed cushions do not achieve 40 km/h operating speeds, then 11 additional sets of 3 speed cushions (33) can be installed between the gaps for a combined total of 76 speed cushions.	This design will minimize excessive speeds and keep motorists within an appropriate speed to share the road with cyclists. Speed cushions have lesser response time impacts to emergency vehicles than speed humps. Narrow (shared) road and high motorists speeds create speed differential and safety risk for cyclists. Observed motorist speeds are currently faster than are safe for road conditions. **Target:** Reduce cyclist collisions, reduce off-road collisions, and reduce sideswipe collisions.	Interim	$325,000 to $350,000 for initial installation of 43 speed cushions. $250,000 to $275,000 for Phase 2 installation of 33 speed cushions (if required).
Re-Build Dyke and Road	Design would match the secondary arterial roadway classification, and accommodate all road users. **Target:** Reduce all collisions.	Long Term	Not estimated

Proposed Countermeasure	Justification and Benefit	Time Frame	Estimated Cost
Enforcement	Enforcing vehicle speeds and other rules of the road (e.g. passing behaviour) can improve safety. The benefits, however, lessen over time unless enforcement is frequent or continual (which may be prohibitive). **Target:** Reduce all collisions.	Short and Long Term	Not estimated

1.0 INTRODUCTION

Watt Consulting Group was retained by the City of Richmond to conduct a traffic operations safety review (TOSR) for the section of River Road between No. 6 Road and Westminster Highway. The study was commissioned in response to safety concerns raised by the public, particularly related to off-road crashes and to crashes involving cyclists. The study is also supported by ICBC, who may contribute funding to the implementation of the proposed options.

A traffic operations safety review is a structured review of existing road facilities that analyzes collision history, traffic operations, geometric characteristics, and an assessment of human factors, through in-field and analytical reviews. The TOSR is multi-modal in scope, and considers all road users, travel modes and the interactions between users. Based on the review of these categories, several countermeasures are proposed which may lower safety risk, and a recommendation is made regarding countermeasure implementation.

1.1 STUDY APPROACH

The TAC *Canadian Guide to In-service Road Safety Reviews* was used as the basis for the study approach. This was complimented with consideration of other relevant guides, such as:

- FHWA Bikeway Safety Guide
- TAC Geometric Design Guide for Canadian Roads
- TAC Manual of Uniform Traffic Control Guidelines for Canada

The assessment considered four key areas: collision analysis, operations analysis, geometric analysis, and human factors analysis. Included within these areas were considerations for asset condition / maintenance as related to road safety. The study process included input and general direction from City staff, including meetings, data provision, and feedback at key stages. This study considered a broad range of countermeasures to address the identified collision issues, including countermeasures previously proposed by City staff, ICBC staff, and members of the public, as well as additional collision-reduction countermeasures proposed by WATT.

2.0 STUDY AREA OVERVIEW

The study area is shown in **Figure 1**. River Road is a two-lane secondary arterial road on a dyke bordering the Fraser River. It is rural in design and adjacent land uses, with no curbs or sidewalks. The posted speed limit is generally 50 km/h, except 30 km/h for trucks, although there is also section in the middle of the corridor that currently has speed humps installed, and in this area the posted speed limit is 30 km/h for all users. The road serves area residents and businesses (including commercial/industrial land uses along the western portion of River Road). The road also serves as a popular touring cyclist route on weekends. It is designated as an informal cycling route - shared lane facility per the City's Recreational Trails & Cycling Map. It is

also identified as an on-street connector segment for several of the City's scenic routes and trails (for cyclists and motorists alike)[1].

Figure 1: Study Area

2.1 BACKGROUND TRAFFIC CONDITIONS

Traffic volumes and speeds were reviewed for the corridor. Data was provided by the City for two locations along the corridor (19000 block and 21000 block of River Road).

The road has an Average Annual Daily Traffic volume (AADT) of approximately 3,000 vehicles per day at both locations. This volume is in the range of a typical rural collector road per the Transportation Association of Canada (5,000 vehicles/day or less for rural collector roads). Classification data was not readily available from the traffic count data. Anecdotally there was a high volume of trucks near the west end of River Road, near No. 6 Road. To the east there is a truck weight limit of 9 tonnes, which should restrict the number of heavy vehicles on this segment of road.

In terms of vehicle speeds, the 85th percentile of the speeds measured were generally over 70 kilometers per hour. These travel speeds are considered high as the posted speed is 50 kilometres per hour (or 30 kilometres per hour for trucks) and the geometry of the road is not well-able to accommodate such high speeds (see Section 4.1). The rural nature of the road and area nonetheless may encourage some motorists to drive faster than is safe for conditions. A

[1] https://www.richmond.ca/parks/trails/highlights/exploring.htm

significant contributing cause of the crashes (both frequency and severity) is likely that drivers are traveling driving faster than the speed best-suited for the physical conditions. In particular some vehicles were observed to drive and pass other motorists at excessive speeds during the site visits in the east portion of River Road.

This review did not focus on the capacity performance of the road nor its intersections, as volumes are relatively low and delay was not considered to be a relevant issue by the City.

3.0 COLLISION ANALYSIS

Collision data for the study area were obtained via City of Richmond staff, and are based on ICBC-reported collisions, for the six-year period from 2011 to 2016. The dataset includes a number attributes that can be used to investigate characteristics, possible contributing factors, and trends.

3.1 COLLISION DISTRIBUTION

The 2011-2016 annual collision distribution is shown in **Figure 2**. On average, 20 collisions per year were recorded for the study area over the six-year period (121 collisions in total over 6 years). Although the number varies each year, no discernable trend is apparent.

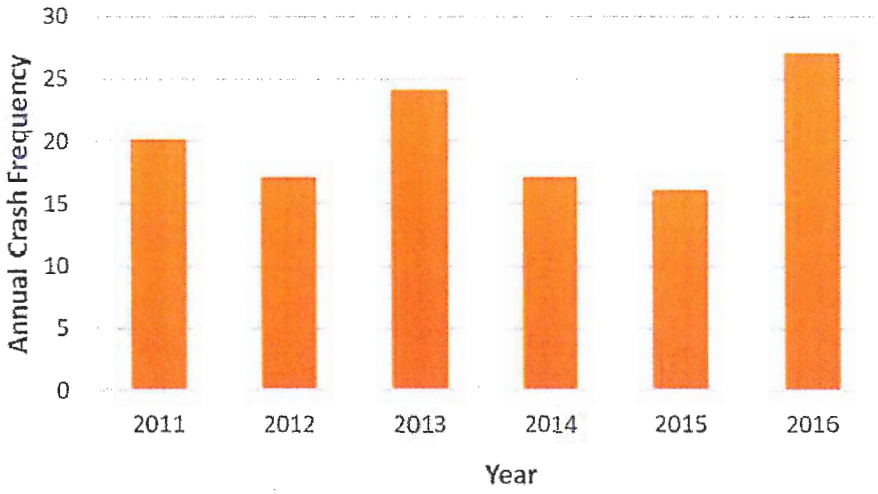


Figure 2: 2011-2016 Annual Collision Distribution

The 2011-2016 monthly collision distribution is shown in **Figure 3**. The highest number of crashes occurred in May, followed by December. The higher frequency for December crashes may be due to icy or snowy conditions.

Figure 3: 2011-2016 Monthly Collision Distribution

The 2011-2016 daily collision distribution is shown in **Figure 4**. The data indicates that the weekdays experienced the highest numbers of crashes.

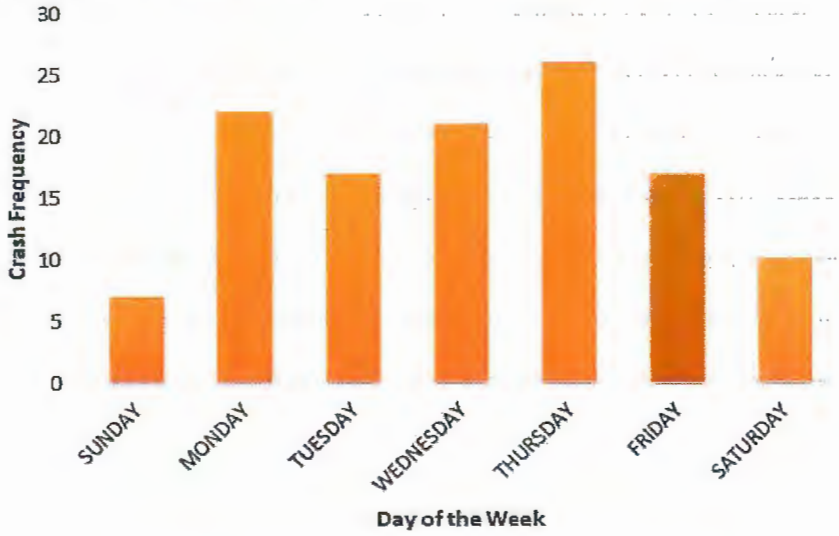


Figure 4: 2011-2016 Daily Collision Distribution

The 2011-2016 time-of-day distribution of the recorded collisions is shown in **Figure 5**. Higher collision frequencies occurred during the daytime, generally between 6:00 am and 6:00 pm.

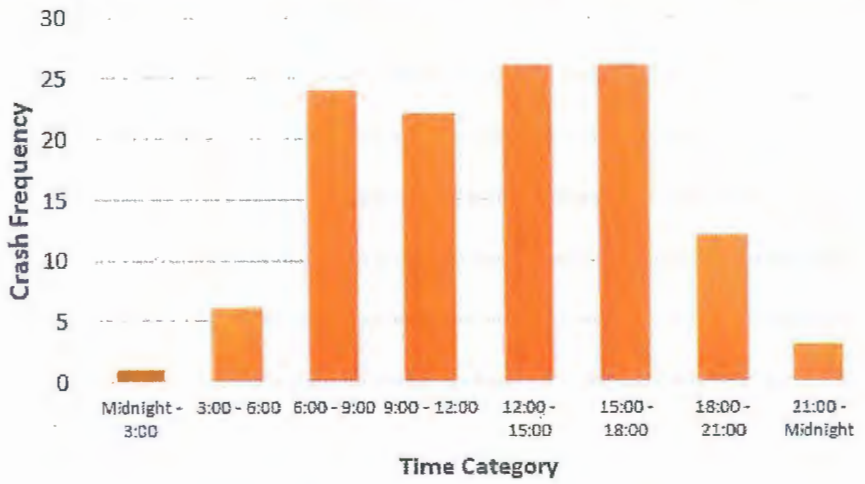


Figure 5: 2011-2016 Time-of-Day Collision Distribution

The 2011-2016 collision severity of the recorded crashes is illustrated in **Figure 6**. Slightly more than one-third of the crashes were injury or fatal collisions. This is consistent with the provincial average for similar roads (urban two-lane roads with AADT between 0 and 5,000 vehicles/day) and so collisions on River Road are not considered more severe than elsewhere in British Columbia. The data included one fatal collision that occurred in 2016 involving a cyclist. A second fatal collision occurred more recently outside the crash record period, involving a single vehicle going off-road.

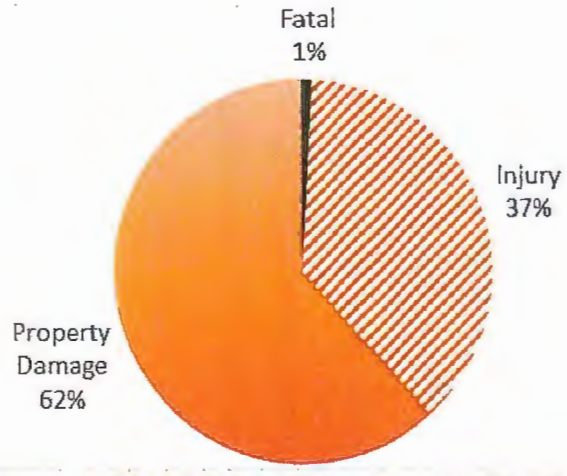


Figure 6: 2011-2016 Collision Severity Distribution

The configuration of crashes as assessed by ICBC for the 2011-2016 collision dataset is illustrated in **Figure 7**. There were 51 collision records omitted from this analysis where the configuration was unclear and/or the reports of the reporting parties conflicted.

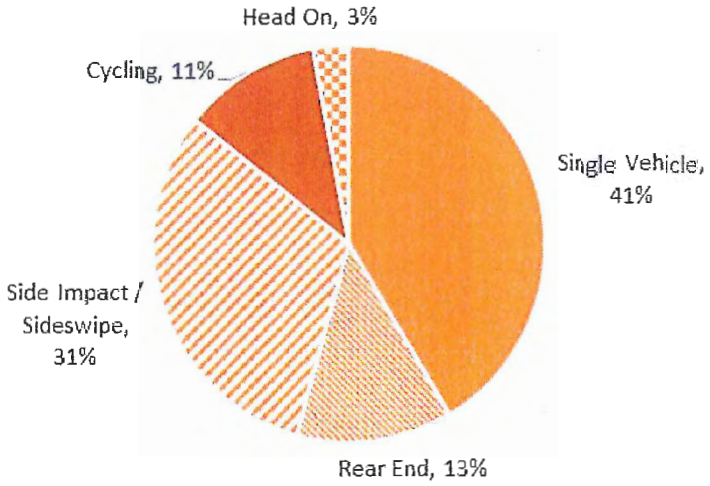


Figure 7: Collision Configuration Distribution

Of known collision configuration types, the greatest proportion (41 percent) of crashes were single vehicle collisions. Approximately one-fifth of these were caused when a vehicle was damaged when driving over a rock or a concrete. The remaining were caused by a vehicle leaving the road (in some cases due to weather-related surface conditions, some due to debris such as sand that contributed to the vehicle departing the roadway).

The next-highest group of crashes involved a side impact or side-swipe configuration (31 percent). Several rear-end crashes occurred (13 percent), although this is a relatively low percentage when compared to a typical roadway, and many of these were side-street rear-ends at River Road (as opposed to rear-ends along River Road). Cyclists were involved in 11 percent of crashes where the configuration was known.

Heavy vehicles were involved in 17 percent of corridor crashes (of which 20 percent were injury collisions).

Summary

The analysis of the collision distributions indicates that most of the crashes occurred on weekdays in the daytime, with few collisions at night. Seasonal patterns for collisions were not evident. The severity of the collisions was found to be typical when compared to other provincial roads. The critical collision patterns were found to be:

- single vehicle crashes – off-road;
- single vehicle crashes – damage from debris;
- side impact and sideswipe crashes; and
- cyclist-involved crashes.

3.2 COLLISION MAP

Key collision locations are summarized below in terms of total collisions in six years and the collision frequency (collisions/year). Collision rate (collisions per million entering vehicles) was not estimated as complete intersection traffic data was unavailable.

Figure 8 shows the collision diagram.

In the study corridor, the locations with the highest frequency of collisions are:

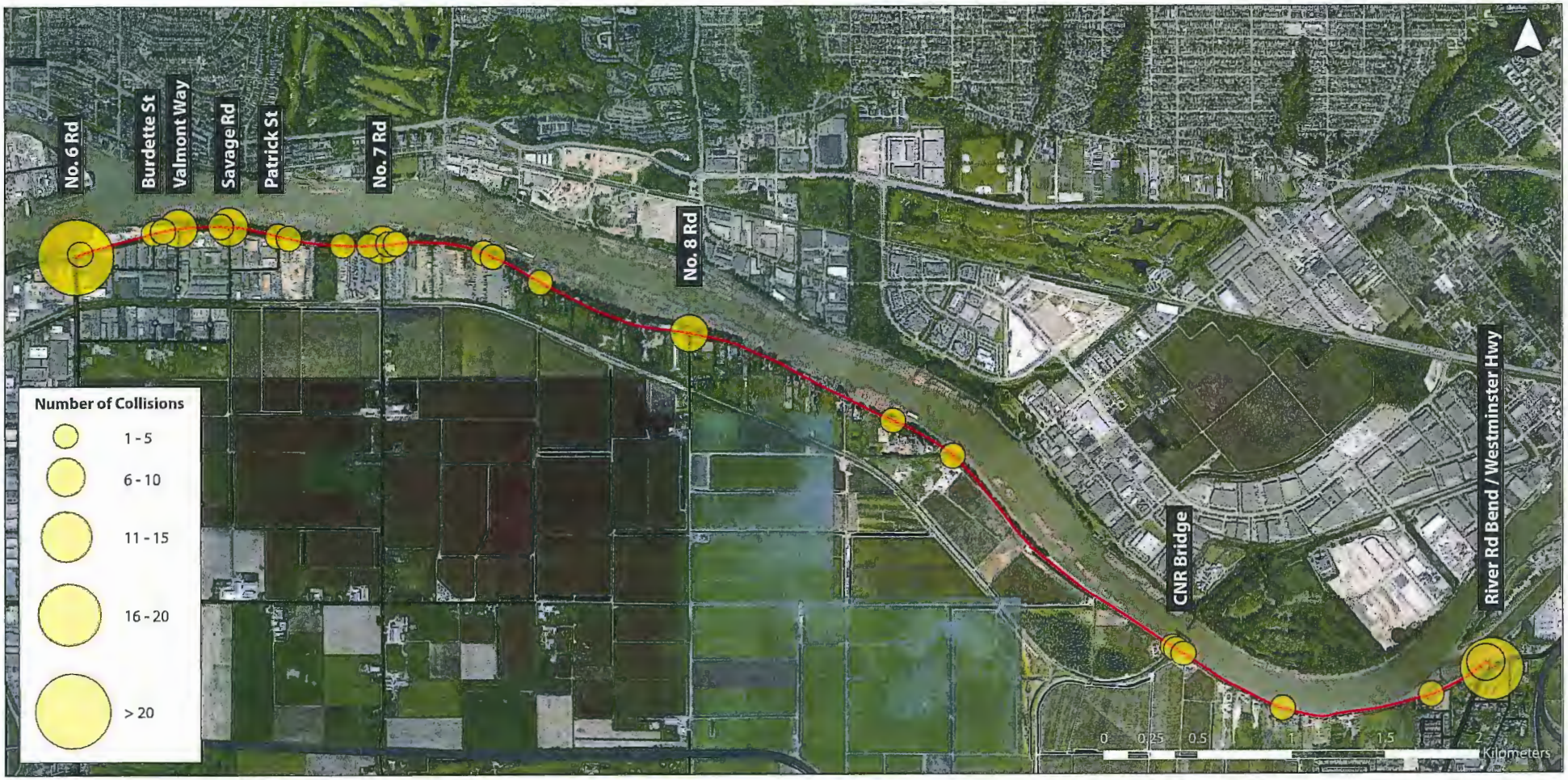
- No. 6 Road and River Road (22 percent of total collisions), and
- River Road and Westminster Highway curve and intersection (21 percent of total collisions).

Other than the curve locations, there are in general no other specific locations that are notably higher in collision frequency than others. There are, however, more collisions in the western half of the corridor than the eastern half.

Cyclist collisions occur at locations along the corridor, although there are more cyclist collisions in the vicinity of the curve at Westminster Highway than other areas of the corridor (two at or near the curve, as well as one at Westminster Highway itself).

Frequency of Reported Collisions, 2011–2016

River Road (No. 6 Road to Westminster Highway), Richmond



City of Richmond
River Road Traffic Safety and Operational Review
Project No: 2331 | Date: February 14, 2018 | Drawn By: VN

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4.0 MULTI-MODAL SAFETY ANALYSIS

The operational, geometric, and human factor elements were considered for the corridor and key intersections for all travel modes. This was done via site visits, aerial photos and mapping, and data and reports as received from the City. For the site visits, daytime conditions were observed by vehicle on January 17 and 18, 2018, and by bicycle on January 18, 2018. Evening conditions were observed by vehicle on January 17, 2018. Due to the time of year it was not possible to observe peak weekend cycling activity and conditions.

4.1 GEOMETRY

The roadway design is a two-lane rural road cross-section, with generally narrow lanes of variable width. There is also limited or no road-side shoulder in most areas. There is a steep drop-off to a ditch on the south side of the road in many areas which would be non-recoverable should a vehicle leave the roadway. There are utility poles, fire hydrants, trees, and fences close to the road in many areas (less than one metre away from edge of pavement in some cases).

River Road Looking East (west of No. 7 Road). Narrow Road, Minimal Shoulder, Steep Ditch to the Right. Fence near Road to the Left

River Road Looking East (near No. 6 Road). Utility pole close to edge of road.

The rural road cross section (with no sidewalks or curbs) along with rural and undeveloped nature of the area (particularly east of No. 7 Road) can inherently promote higher speeds, in particular as there is no traffic control to stop vehicles along the length of the 8.3km corridor nor are there many intersections. The speeds that result are, however, in excess of what is safe for motorists given the roadside hazards, and are in excess of what is safe for a single-file shared roadway with cyclists.

The geometry at the curves at No. 6 Road and near Westminster Highway is abrupt and sharp. These curves have Advisory Warning Speeds of 20 km/h which is appropriate given the sharp curve geometry. In consideration of a roadway designation of secondary arterial it is not desirable to have such sharp curves, however land acquisition would be required to provide larger radius curves with design speeds closer to that to the majority of the corridor. In addition, the abrupt curves can serve as a "gateway" transition onto the rural River Road from the more urban approach roads at either end of the corridor.

The geometry of specific intersections was not identified or apparent as a concern, and generally typical for rural intersections in Richmond and the lower mainland.

4.2 OPERATIONS

4.2.1 OPERATING SPEEDS

As noted in Section 2.1, 85th percentile speed are in excess of the posted speed limit for general vehicles (50km/h) and even moreso for the 30 km/h speed limit for trucks. The speed differential between high-speed motorists and cyclists is likely greater than between motorists-motorists or motorist-trucks. This speed differential can contribute not only to the occurrence of collisions but to the severity as well.

4.2.2 SIGNAGE

Cycling Signage

The City has recently installed Share the Road – Single File signage at frequent intervals along the corridor. The sign is the TAC version of the sign, and is appropriate given the lane widths of the road. In addition, the signs are accompanied with additional warning signs: one identifies "Single File – Change Lanes to Pass When Safe", and the other "Caution – High Cycling Activity on Weekends". The intent of these signs is to appropriately warn motorists and cyclists of proper roadway operations, however there are some potential safety concerns based on the current signage design:

- The text is small and difficult to read, and the messages are long. This can make it very difficult for motorists to interpret the message while driving by at speed. This is exacerbated by combining multiple messages on the same pole.
- The message to change lanes to pass when safe does not match the majority of the pavement markings along the corridor, which are (in most areas) double yellow. This prohibits lane changing, which is contradictory to the warning signage message.

It should also be noted that there are some curved areas of the road where passing sight distance may not be met at 50 km/h. Further work is necessary to identify all of these locations.

Cycling Single File Signage – Text Difficult to Read and Interpret At-speed

Signage Instructing to Change Lanes to Pass when Safe, but Double Yellow Marking Contradicts This

In terms of cycling comfort, during the site visit ride-through, motorists were generally respectful when approaching and passing cyclists.

Truck Speed Limit Signage

The truck speed limit signs were used in some locations but not consistently throughout the corridor. In particular they were not noticed at either end when entering the corridor

Other Signage

Additional signage observations were noted that may not have a major safety implication but nonetheless be inconsistent or have impacts on driver comprehension and safety to some degree, as follows:

- Horse Crossing warning signage; one isolated instance observed, and not particularly obvious why or to what extent this warning signage is applicable for.
- Truck signage near No. 7 Rd (westbound) was confusing (overloaded pole included a green permitted truck sign, a turn restriction sign, and a weight restriction 9T sign), which is intended to restrict westbound trucks from using No.7 Rd.
- A few relic "share the road – side by side" signs still installed. These appear to be lower reflectivity than the single file signs.

4.2.3 NIGHT CONDITIONS / LIGHTING

During the evening visit, the road surface was wet, and there were periods of rain during the evening site visit. Key observations include:

- Signage was very reflective (specifically the Single File and Posted Speed Limit signs)
- Centreline markings, edge line markings, and raised reflectors very visible for majority of corridor. There were a few pockets nearer to the west end where edgeline was not present or visible, or where centreline marking was worn.

- Lighting was good and frequent for entire corridor. Approximately 5 lights were out (should be addressed) but the overall frequency and intensity of lighting provided coverage even in those locations.
- The short section of centreline pickets – these pickets were not visible or reflective; did not see or notice until almost right beside them

Therefore, the corridor was found to be well-lit at night even in wet and rainy conditions, with most pavement markings being quite visible.

5.0 COUNTERMEASURES

5.1 COUNTERMEASURE TARGETS

To reduce the frequency and severity of all of the four identified collision issues, solutions should better align the operating speeds with the road conditions. Changes would either:

- improve the road conditions to accommodate the actual vehicles operating speeds, or
- reduce operating speeds to a more appropriate level relative to the road conditions.

Improving Road Conditions

The road is classified as a secondary arterial which suggests that the road surface should be widened to standard, shoulders installed, and roadside hazards located sufficiently far from the edge of road or protected. As well, given the nature of the road adjacent the river and the recreational use it attracts, pedestrian and cycling facilities (and possibly equestrian facilities) should be considered. It is acknowledged that these improvements would come at a high cost and likely be done when the dyke is re-built and therefore an interim option should be considered.

Reducing Operating Speeds

Reducing the vehicle operating speeds through traffic calming, regulation, and enforcement can be a cost-effective option which can be implemented relatively quickly. Reducing speeds can be achieved through physical measures that require vehicles to slow down, but may also include other traffic control elements that better reflect conditions and elicit appropriate driving speeds and behaviours.

Speed humps are a proven effective means of maintaining a lower operational speed whilst other speed calming measures and techniques do not have reliable results. Speed humps are appropriate on local roads however the modification of speed humps to create a "speed cushion" are more appropriate on collector and arterial roads such as River Road, particularly to accommodate emergency vehicles such as fire and ambulance. Cushions provide a softer vertical deflection compared to speed humps, and are typically installed with gaps to allow wider wheelbase emergency vehicles more easy passage while still requiring passenger vehicles to ride over the hump. Cyclists are not typically bothered by speed humps or cushions and this is

evident by the existing installation of speed humps on the corridor. With cyclists "taking the lane" by driving single file in the middle of the lane they will have the option of driving over the speed hump or using the gap in the cushion without adversely affecting other traffic.

Speed reader boards can also be effective in reducing speeds and alerting drivers they are going too fast for conditions. However, their effectiveness is more when first installed and gradually reduces over time, suggesting that movable devices be installed and their location be changed from time to time.

5.2 EVALUATION OF FULL COUNTERMEASURE ROSTER

The countermeasures that were proposed by the various groups were evaluated to assess whether they addressed the identified four major collision issues identified in this review. An explanation was also provided as to why a measure may have been proposed or not. Based on this preliminary screening, a list of proposed measures is proposed. See **Appendix A** for the full list of countermeasures and evaluation results.

5.3 PROPOSED COUNTERMEASURES

The proposed measures are summarized in **Table 1** and shown conceptually in **Figure 9** – Proposed Countermeasures. In general, the proposed measures include:

- a package of sign and pavement marking improvements that provide consistent messages to drivers and cyclists;
- improved maintenance, particularly to remove debris;
- improvements to reduce off-road crashes such as increasing the pavement friction (to help motorists maintain control) at the two 90 degree curves;
- measures to guide drivers through the two 90-degree turns.

The summary table includes the general application details of the countermeasure, the justification and benefit of the countermeasure, the applicable implementation timeframe, and cost estimate.

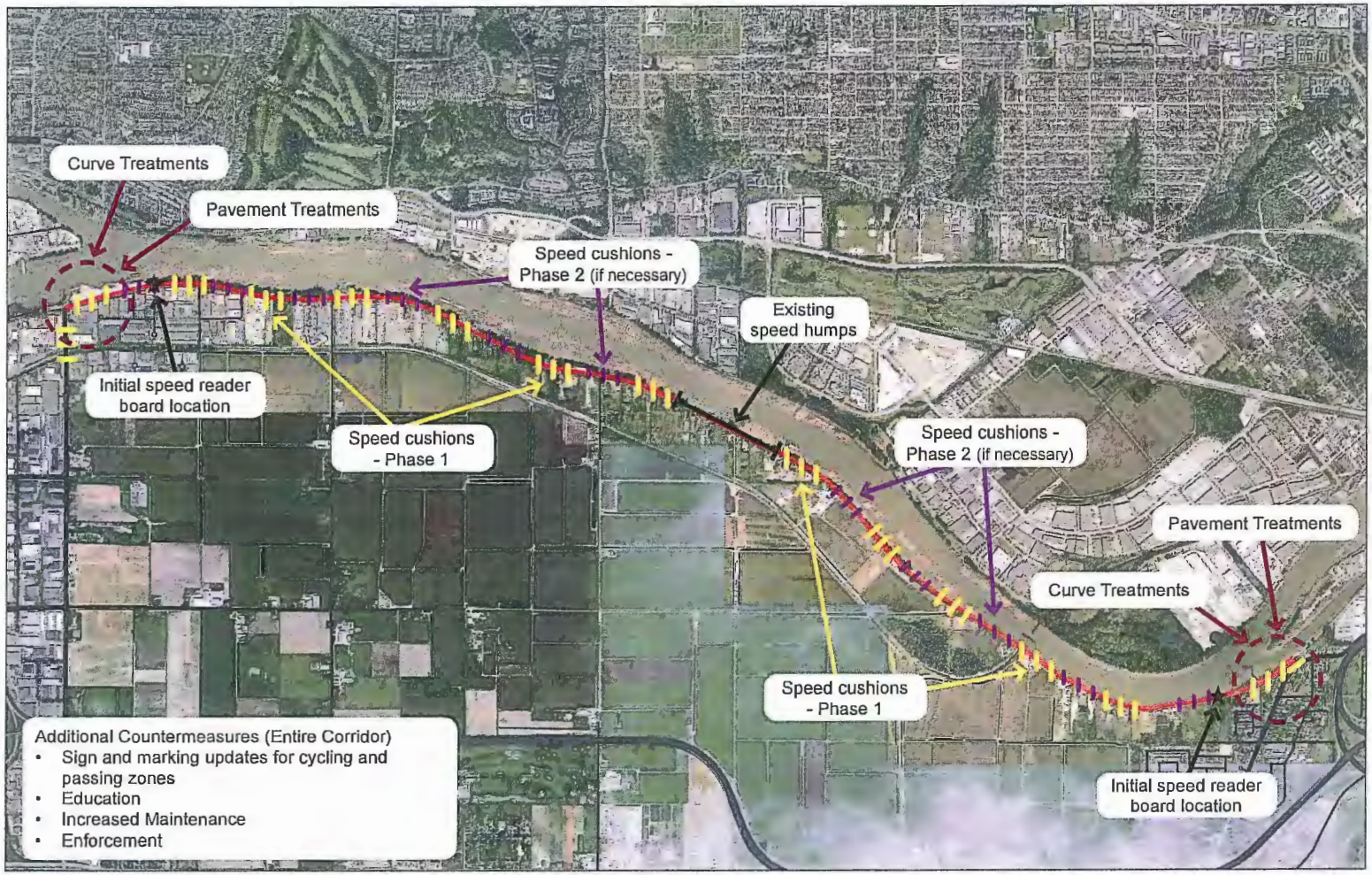
TABLE 1: SUMMARY OF PROPOSED COUNTERMEASURES

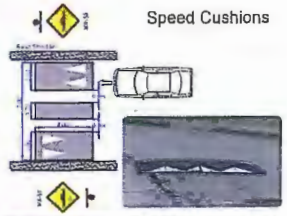
Proposed Countermeasure	Justification and Benefit	Time Frame	Estimated Cost
Sign and Pavement Marking Updates (including conversion to single broken yellow centreline, addition of sharrow stencils, and signage improvements). High end estimate assumed conversion of up to 7000m of double yellow to single broken markings, sharrows spaced at 75m for the entire corridor, and up to 40 new signs.	To clarify shared use motorist-cyclist nature of the road and to create clear and consistent messaging along the corridor. Narrow (shared) road and high motorists speeds create speed differential and safety risk. **Target:** Reduce cyclist collisions.	Short Term	$67,000 to $180,000
Speed Reader Boards (assuming four boards). Recommend that the boards be movable, to reduce driver complacency and allow for flexibility in application at areas of concern.	Speed reader boards provide direct feedback to drivers vis-à-vis posted speed limit and road conditions and can reduce speeds. Observed speeds are currently faster than are safe for road conditions. **Target:** Reduce speed-related collisions.	Short Term	$50,000 to $60,000
Curve Treatments, including chevron warning signs (possible LED enhancements). These would be installed at the 90 degree curves.	Provide enhanced warning and guidance through sharp curves where collision frequency is higher. Sharp curves may be unexpected after long, relatively straight and unimpeded approach. **Target:** Reduce off-road collisions.	Short Term	$15,000 to $50,000
Pavement Treatments – to increase friction (assumed 800 lane-metres of application; assumed 200m length per lane at each curve)	Provide increased driver control through sharp curves where collision frequency is higher. Sharp curves may be unexpected after a long, relatively straight and unimpeded approach. **Target:** Reduce off-road collisions.	Short Term	$425,000 to $500,000

Proposed Countermeasure	Justification and Benefit	Time Frame	Estimated Cost
Education (for both drivers and cyclists, regarding shared roads and single file operations. Could include informational material or presentations to cycling groups.)	May increase driver understanding and behaviour toward cyclists, and cyclists understanding towards driver behaviour, regarding desirable single file and passing behaviour. **Target:** Reduce cyclist collisions	Short Term	Not estimated
Increase Maintenance (more frequent debris clearing / street sweeping, and/or re-striping of pavement markings).	Reduce potential for collisions involving debris, or off-road collisions in areas where markings may be faded or obscured. Debris was a noted factor in some single vehicle collisions. **Target:** Reduce debris-related and off-road collisions.	Short Term	Not estimated
Traffic Calming – Speed Cushions Reduce posted speed limit to 30 km/h for all vehicles with traffic calming comprising 43 speed cushions: • 13 sets of 3 speed cushions spaced at 100 m between the curves with a minimum of 400 m between each set • 1 set of 3 speed cushions on No. 6 Road approaching River Road, and • 1 speed cushion on River Road approaching Westminster Highway. If the above speed cushions do not achieve 40 km/h operating speeds, then 11 additional sets of 3 speed cushions (33) can be installed between the gaps for a combined total of 76 speed cushions.	This design will minimize excessive speeds and keep motorists within an appropriate speed to share the road with cyclists. Speed cushions have lesser response time impacts to emergency vehicles than speed humps. Narrow (shared) road and high motorists speeds create speed differential and safety risk for cyclists. Observed motorist speeds are currently faster than are safe for road conditions. **Target:** Reduce cyclist collisions, reduce off-road collisions, and reduce sideswipe collisions.	Interim	$325,000 to $350,000 for initial installation of 43 speed cushions. $250,000 to $275,000 for Phase 2 installation of 33 speed cushions (if required).

Proposed Countermeasure	Justification and Benefit	Time Frame	Estimated Cost
Re-Build Dyke and Road	Design would match the secondary arterial roadway classification, and accommodate all road users. **Target:** Reduce all collisions.	Long Term	Not estimated
Enforcement	Enforcing vehicle speeds and other rules of the road (e.g. passing behaviour) can improve safety. The benefits, however, lessen over time unless enforcement is frequent or continual (which may be prohibitive). **Target:** Reduce all collisions.	Short and Long Term	Not estimated

River Road Traffic Operations Safety Review - City of Richmond
Proposed Countermeasures





6.0 RECOMMENDATION

It is recommended that the City develop a long-term plan to widen River Road to a 50 km/h per hour design speed and to provide for shoulders, and separate recreational users from general traffic (cyclists, pedestrians, equestrians).

In the interim, it is recommended that the City implement measures to reduce operating speeds and mitigate the occurrence of the four key collision types. Proposed measures include the installation of a series of speed cushions to minimize excessive speeds and keep motorists within an appropriate speed to share the road single file with cyclists (40 km/h or less). Speeds should be reduced further at the No. 6 Road and the Westminster Highway 90-degree curves. The speed cushions should be accompanied with appropriate speed hump warning signs, regulatory 30 km/h hour signs for all (including trucks), 20 km/h advisory speeds should be posted on 90 degree curve ahead signs at the two 90 degree curves. Speed reader boards should be installed, and should be movable so that different areas along the corridor can be benefited. Additional measures listed in the table above should also be implemented as part of the short term and/or interim approach.

ICBC is a project partner, and funding from ICBC is likely available for many of the recommended measures.

APPENDIX A: FULL ROSTER OF SUGGESTED COUNTERMEASURES

LIST OF COUNTERMEASURES FOR EVALUATION

River Road Traffic Operations and Safety Review, No. 6 Road to Westminster Highway

#	Countermeasure	Proposed By	Collision Issue ✓ = if the countermeasure may address				Proposed for further consideration (safety review report short list)	
			Cyclist Involved	Single Vehicle Off-Road	Single Vehicle Debris	Side Impact	Proposed	Explanation
1	Speed Humps and/or Cushions	City Staff, ICBC	✓	✓		✓	Yes	Cost-effective approach to lower speeds, helps all collisions, reduces severity.
2	"Single File" Signs	City Staff	✓			✓	Yes	Low cost.
3	"Sharrow" Pavement Markings	City Staff	✓				Yes	Relatively low cost.
4	Dashed Single Yellow Centreline	City Staff	✓			✓	Yes	Permits passing in designated locations.
5	"Expect Cyclist" Signs"	City Staff	✓				No	Limited impact, redundant, non-standard signage.
6	Remove Raised Pavement Markers (Cat's Eyes)	City Staff	✓				Maybe	Minimal effect.
7	Shoulder Delineator Posts	City Staff, ICBC		✓			Yes	Being installed by City now on curves.
8	Guard Rails on Curves	Resident		✓			No	Expect insufficient space.
9	Solarlite Edge Markers	Resident		✓			Maybe	Further research required, may be limited in winter.
10	Reflective Markers on Roadside Objects	Resident		✓			Yes	Low cost.
11	Increase Speed Limit to 60 kph, with exceptions	Resident					No	No expected safety benefit.
12	Reduce Speed Limit to 30 kph at Shipyard	Resident	✓	✓		✓	Yes	Will require measures to encourage compliance.
13	Flashing Caution Signs at Shipyard	Resident					No	Low cost, but does not address issues.
14	Speed Reader Board(s)	Resident	✓	✓		✓	Yes	Relatively low cost. Lower speeds helps all collision types.
15	Police Enforcement	Resident		✓			Yes	Provides short-term benefit, but ineffective when police not present.
16	"No Shoulder" Signs	Resident	✓				No	Adds to sign clutter. Limited impact.
17	Educate Cyclists and Motorists	Resident	✓				Yes	Assumed by others, but expect limited effect.
18	Encourage Other Cycling Routes	Resident	✓				No	Expect limited effect.
19	"Local Traffic Only" signs	Resident		✓			No	Changes role of road (minor arterial).
20	Encourage Other Driving Routes	Resident		✓			No	Expect limited effect.
21	Visual Narrowing with Pavement Markings	City Staff					No	Already narrow.
22	LED Chevron Curve Warning Signs	City Staff		✓		✓	Yes	Particularly for curve near Westminster Highway.
23	Improve Lighting	ICBC		✓	✓		No	Roadway currently well lit.
24	Non-skid Pavement Treatment	Watt		✓		✓	Yes	Consider on curves when re-paving.
25	Consistent & Standard Signs	Watt	✓			✓	Yes	Low cost.
26	Re-Build Dyke and Road to Guidelines, with cycling facility	All	✓	✓	✓	✓	Yes	Very expensive option, consider when dyke re-built.
27	Reduce posted speed to 30 kph all corridor	Watt	✓	✓		✓	Yes	Include measures to encourage compliance.
28	Increase Maintenance: sweeping to remove debris, trim brush	Watt	✓	✓	✓		Yes	
29	Disconnect east and westerns sections	Resident		✓	✓		No	May consider if other measures ineffective.

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ADDENDUM

To: Fred Lin – City of Richmond

From: Tom Baumgartner, M.Sc., P.Eng.

Our File #: 2331.B01

Project: River Road TOSR

Date: February 19, 2018

RE: Executive Summary Addendum No.1

The following addendum provides a correction for the *River Road Traffic Operations Safety Review Executive Summary* dated February 6, 2018. Collision frequencies were incorrectly calculated for the period from 2012-2016 and have now been updated for the analyzed collision data period of 2011-2016. Changes to the report are as follows:

1. CHANGE FROM:
   Method Used
   Crash records from the Insurance Corporation of British Columbia were reviewed for the five years between 2012 and 2016 (inclusive).

   CHANGE TO:
   Method Used
   Crash records from the Insurance Corporation of British Columbia were reviewed for the six years between 2011 and 2016 (inclusive).

2. CHANGE FROM:
   Findings

   On average, 24 crashes were recorded annually along the corridor.

   CHANGE TO:
   Findings

   On average, 20 crashes were recorded annually along the corridor.