DISTRICT OF NORTH VANCOUVER
INSURANCE CORPORATION OF BRITISH COLUMBIA

DISTRICT OF NORTH VANCOUVER ROAD SAFETY PLAN

FINAL REPORT

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FINAL REPORT

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EXECUTIVE SUMMARY

The District of North Vancouver is preparing a Transportation Plan to guide decision-making related to expanding transportation infrastructure to the year 2031. As a component of the Transportation Plan, the District is interested in conducting a Road Safety Plan to help set priorities related to reducing the risk of crashes in the District.

The Insurance Corporation of British Columbia's Road Improvement Program provides support for municipal initiatives that help to reduce the risk of auto crashes, and therefore, claim costs. The Road Improvement Program has assisted the District in conducting a variety of studies and implementing several safety improvements over the past 15 years.

As part of the District's objective for a Road Safety Plan and ICBC's Road Improvement Program initiatives, Opus International has been commissioned to undertake this Road Safety Plan.

The Comprehensive Road Safety Strategy is based on three approaches to improving traffic safety:

- *Engineering*, including transportation planning, design, operations, and maintenance;
- *Education*, aimed at improving behaviour safety issues among all road users; and,
- *Enforcement* of traffic laws and bylaws by police and bylaw-enforcement staff.

Based on the findings of the site visits, the results of the stakeholder consultation, and the collision trends identified through the network screening, seven key road safety issues were identified. The seven safety issues are:

- excessive traffic speeds;
- congestion and high traffic volumes;
- pedestrian risk;
- cyclist risk;
- signal operations and display;
- sightlines at intersections; and,
- transit safety.

Potential strategies were developed based on the issues identified for this study. The proposed strategies and the types of issues mitigated are summarized in TABLE ES-1.

Based and the findings of this study, the following short-, medium, and long-term improvement strategies are recommended as summarized in TABLES ES-2, ES-3, and ES-4. The short-term strategies are more easily implemented, have lower associated cost, and are generally intersection-specific. The medium-term strategies, unlike the short-term strategies, are generally District-wide and have higher associated costs. The long-term strategies generally represent ongoing efforts the District can continue to implement in the future.

TABLE ES-1 TYPES OF ISSUES MITIGATED BY PROPOSED STRATEGIES

STRATEGIES	ISSUES							
	1) Excessive Traffic Speeds	2) Channelized Right-Turn Operations	3) Congestion and High Traffic Volumes	4) Pedestrian Safety	5) Cyclist Safety	6) Signal Operations and Display	7) Sightlines at Intersections	8) Transit Safety
Engineering Solutions								
Signals								
A. Left Turn Signal Phasing			■	■		■		
B. Upgrade Traffic Signal Displays						■		
Traffic Controls								
A. Review/Upgrade Traffic Control Devices		■	■			■		
B. Traffic Calming	■		■	■	■			■
Geometry								
A. Modified Right-Turn Lanes		■		■	■			
B. Restricted Turning Movements		■		■	■		■	
Zoning and Maintenance								
A. Intersection Sight Triangles		■		■	■	■	■	■
Pavement								
A. Repavement	■				■			
Signing/Guidance								
A. Signing and Pavement Marking Improvements	■	■		■	■			■
Pedestrian/Cyclist								
A. Complete Pedestrian Network			■	■				
B. Complete Cycling Network					■			
Planning/Policy								
A. Review of Bylaws	■			■	■		■	
Education Solutions								
A. Share the Road					■			
B. Be Safe, Be Seen				■	■			
Enforcement Solutions								
A. Traffic Safety Plan	■	■		■	■			

TABLE ES-2 SHORT-TERM STRATEGIES

Solution Strategy	Aligned with Existing Initiatives:			Funding maybe Available From:				Reduces Crash Risk for:				Comments
	District's Capital Improvement Program	ICBC Road Safety Initiatives	Police Enforcement Initiatives	Internal	ICBC	TransLink	Provincial Government Programs	Motor Vehicles	Pedestrians	Cyclists	Transit	
Signals												
Left-turn signal phasing												• Priority should be given to intersections with existing left-turn lanes. Split or advanced phasing can be considered where left-turn lanes are not provided. • Study can be conducted to identify locations where left-turn phasing and left-turn lanes are needed throughout the District.
Upgrade signal displays												• Measures may include: ○ Increasing the number of signal heads for multi-lane roadways ○ Improving the visibility of individual signal heads (larger lenses, LED displays, reflective backplates)
Review clearance intervals												• In the long-term, develop policy and/or review existing policy • On truck routes, clearance intervals should take into consideration the braking ability for trucks • In commercial areas and on school routes, clearance intervals should account for pedestrian walking speeds
Traffic Control												
Review/ upgrade traffic control device												• Signal warrants should be reviewed
restricted turning movements												• Ensure signage of restrictions are clear and conspicuous
Zoning and Maintenance												
Clearance of sight triangle obstruction												• Foliage should be maintained to ensure that sight triangles are not obstructed • Parking should be clear of intersections and crosswalks, and can be implemented by signage, pavement marking, and channelization • Policy should be developed regarding sightline obstructions on private property
Pavement												
Repavement												• Review pavement conditions and repave roads as needed with consideration for anti-skid treatment

TABLE ES-3 MEDIUM-TERM STRATEGIES

Solution Strategy	Aligned with Existing Initiatives:			Funding maybe Available From				Reduces Crash Risk for:				Comments
	District's Capital Improvement Program	ICBC Road Safety Initiatives	Police Enforcement Initiatives	Internal	ICBC	TransLink	Provincial Government Programs	Motor Vehicles	Pedestrians	Cyclists	Transit	
Signing/Guidance												
Signing and pavement marking improvement												• Bus lanes should be signed with lane warning signs • Designated bicycle routes should have bicycle stencil marking and "share the road" signs • Measures may include: ○ Highly-reflective sign sheeting and markings ○ Use of Clearview font on street-name and other guide signs • Program to document maintenance should be in place
Pedestrians												
Complete pedestrian network												• Sidewalks should be provided on both sides of the roadway on arterial and collector roads • Local roads should have sidewalks on at least one-side of the roadway • Follow District's Pedestrian Master Plan
Geometry												
Modified right-turn lanes												• Collisions should be reviewed to identify locations with safety issues

TABLE ES-3 LONG-TERM STRATEGIES

Solution Strategy	Aligned with Existing Initiatives:			Funding maybe Available From:				Reduces Crash Risk for:				Comments
	District's Capital Improvement Program	ICBC Road Safety Initiatives	Police Enforcement Initiatives	Internal	ICBC	TransLink	Provincial Government Programs	Motor Vehicles	Pedestrians	Cyclists	Transit	
Policy/Planning												
Review Bylaws												• Specific needs associated with: o Trucking restrictions; o Cycling on sidewalks; and, o Location and/or restriction of parking.
Cyclists												
Complete Cycling Network												• Areas circled in red on the map indicate zones of caution • Areas highlighted in blue should be considered for cycling infrastructure improvements
Traffic Control												
Traffic Calming												• Traffic study should be conducted on surrounding streets to evaluate impacts of proposed traffic calming devices • Affected property owners and neighbourhood groups and other stakeholders should be contacted for early involvement
Enforcement												
Enforcement												• Continued support for Police enforcement and education initiatives and programs • Consultation with Police regarding equipment needs for enforcement

1.0 INTRODUCTION

1.1 Background

The District of North Vancouver is preparing a Transportation Plan to guide decision-making related to expanding transportation infrastructure to the year 2031. As a component of the Transportation Plan, the District is interested in conducting a Road Safety Plan to help set priorities related to reducing the risk of crashes in the District.

The Insurance Corporation of British Columbia's Road Improvement Program provides support for municipal initiatives that help to reduce the risk of auto crashes, and therefore, claim costs. The Road Improvement Program has assisted the District in conducting a variety of studies and implementing several safety improvements over the past 15 years.

As part of the District's objective for a Road Safety Plan and ICBC's Road Improvement Program initiatives, Opus International has been commissioned to undertake this Road Safety Plan.

1.2 Objectives

The objectives of this Plan are:

1. to identify a short list of high-priority improvements that will improve safety, and to prepare conceptual design drawings, cost estimates, and a benefit/cost analysis for the high-priority improvements;

2. to identify other short-term (approximately five years to 2015), medium-term (to a horizon year 2020), and long-term (to a horizon year 2030) road safety improvements and strategies that the District may consider for implementation, with greater detail on the short-term improvements; and

3. to prepare the Road Safety chapter for the overall District Transportation Plan.

1.3 Method

The detailed objectives of the Road Safety Plan required a systematic approach. The Plan was developed in two phases:

- Phase One: The Issues
- Phase Two: The Strategies

Phase One: The Issues

The purpose of Phase One was to create the foundation for the study. This included identifying and contacting the project stakeholders; receiving and compiling existing information; and assembling and analyzing the available data. The following tasks were conducted for Phase One for the study:

- Start-up meeting with the District;
- Stakeholder consultation;
- Network screening (multi-modal collisions analysis) using ICBC crash claims data, which included pedestrian and bicycle safety-related issues; and,
- Site visits and human factors analysis.

Phase Two: The Strategies

The objective of Phase Two was to identify, develop, and evaluate strategies that would be suitable for the District. The strategies included initiatives in the engineering, education, and enforcement areas. The following tasks were conducted for Phase Two of the study:

- Review of current practices and conditions;
- Generation of multi-disciplinary solution options: engineering, education, and enforcement;
- Preparation of conceptual drawings and preliminary economical analysis; and,
- Development of strategic and comprehensive strategy plan

2.0 STAKEHOLDER CONSULTATION AND INITIATIVES

2.1 Consultation Initiatives

Many programs aimed at improving road safety are already operational in the District. These programs were identified from the stakeholder consultation and help to promote the goal of improved road safety.

Transportation Planning Advisory Committee (TPAC)

The purpose of TPAC is:

> "… to advise Council on regional and municipal transportation policy, planning and mobility issues. The committee will work towards promoting, developing and improving an environmentally friendly, energy efficient, socially equitable, safe, low impact transportation network.

The goal of the District's TPAC is to review and consider transportation and transit policy in a municipal and regional context; to provide options on how to promote, advance, and improve the movement of goods and people to, from and within North Vancouver; and to provide on-going advice of a policy nature to staff and Council.

Initiatives with other Agencies

The District is involved with ICBC on several programs, such as:

- Speed Watch Program (through the Community Policing Centres);
- Speed and Intersection Safety;
- Counter Attack (not necessarily an ICBC program, mostly advertising of enforcement);
- Operation Red Nose;
- the Road Improvement Program; and,
- the Road Sense Speaker Program for schools (in which ICBC offers up to $500.00 to cover the cost the presentation).

As well, BCAA partners with the RCMP and the North Vancouver School District (13 schools), to help implement student based patrol systems. The District is also involved in a cost sharing program with Coast Mountain Bus Company, where there is a 50/50 cost share for such things as wheel chair curb drops, lighting issues, and bus stop access.

Integrated Intersection Safety Camera Unit

Some traffic signals in the District are equipped with intersection safety cameras (also known as red-light cameras) that capture drivers who commit red-light violations. The cameras work with a combination of road sensors coordinated with the traffic signals, and can detect when a vehicle enters the intersection during a red phase. This occurrence would then trigger the camera to take a photograph of the vehicle and the licence plate, after which a violation ticket is sent to the registered insurer of the vehicle.

The locations of the intersection safety cameras are installed where the devices are considered to bring the most safety benefits. Locations are based on collision and population data where the devices are considered most beneficial. Currently, there are three locations within the District with intersection safety cameras:

- Eastbound on Mt. Seymour Parkway at Riverside Drive;
- Westbound on Marine Drive at Capilano Road; and,
- Eastbound on Main Street at Mountain Highway.

The locations and direction of the intersection safety camera are typically determined by ICBC and the Integrated Traffic Camera Unit using collision analysis. However, municipalities can alert ICBC of potential locations if there are documented incidents of red-light running or if there may be potential safety benefits. It is noted that the cameras used to be rotated among the selected locations; however, with the use of digital cameras in 2009, all locations now house a camera full-time.

2.2 Consultation Objectives

The objective of these stakeholder consultations was to obtain input on current road safety issues, concerns, and locations that require improvement, to help set priorities, and to generate ideas for possible improvements.

The consultation was conducted in two parts:

- Web-Based Survey; and
- Stakeholder Group Meetings

A. Web-Based Survey

The survey was administered on-line from June 9th to July 3rd, 2009, and was available through the District's website. A total of 76 responses were collected. The results of the survey are summarized below and in APPENDIX A. Tabulated respondent comments are also included in APPENDIX A.

Road Safety Issues

Respondents were asked to identify what they felt was the most important road safety issue in the District. A total of 55 responses were collected, and individual responses were summarized by category. The most frequently identified categories are summarized in FIGURE 2.1. The most common issue for respondents was excessive speed.

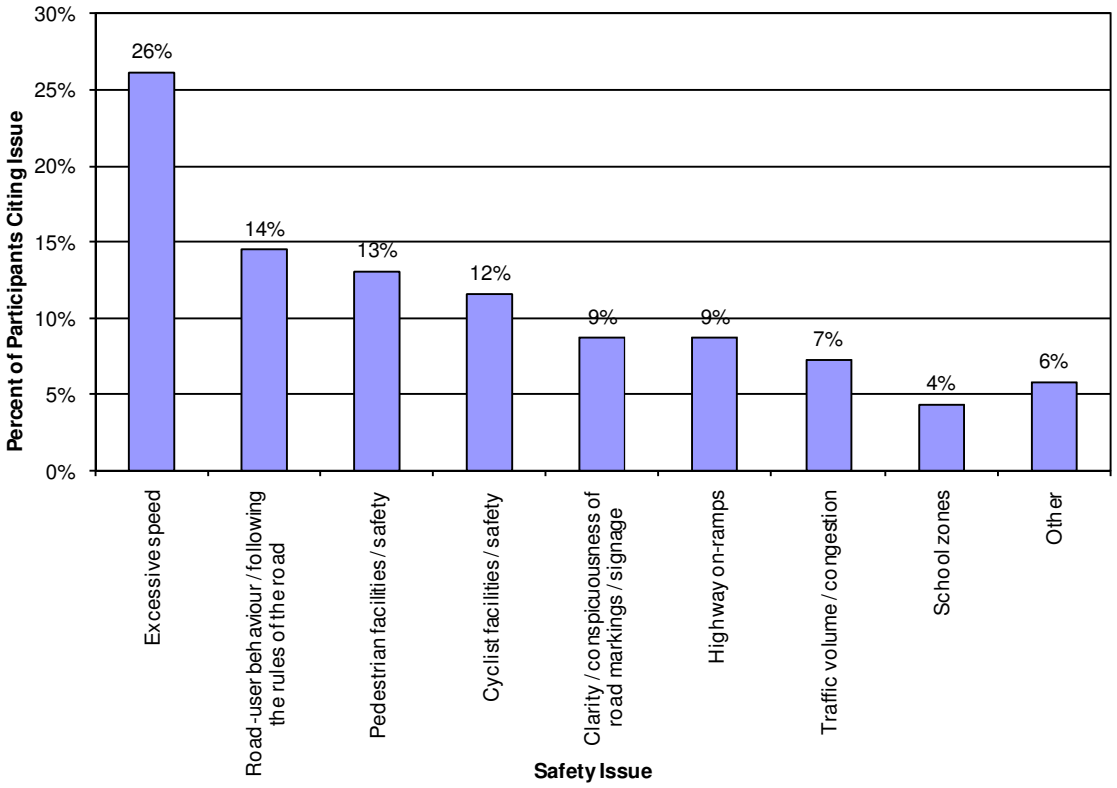

FIGURE 2.1 SUMMARY OF SAFETY ISSUES IDENTIFIED BY SURVEY PARTICIPANTS

Road Safety Resources

Respondents were asked to indicate road safety improvements in the District they would prioritize given available funding. Respondents were required to select their top three priorities for road safety improvements. Overall, respondents indicated that, given available funding, providing more enforcement, improving pedestrian facilities, improving cyclist facilities, and providing more traffic calming facilities would be their top priorities. Providing more enforcement was also the most common first priority of the respondents, followed by more cyclist facilities. A summary of the respondents' improvement priorities is provided in FIGURE 2.2.

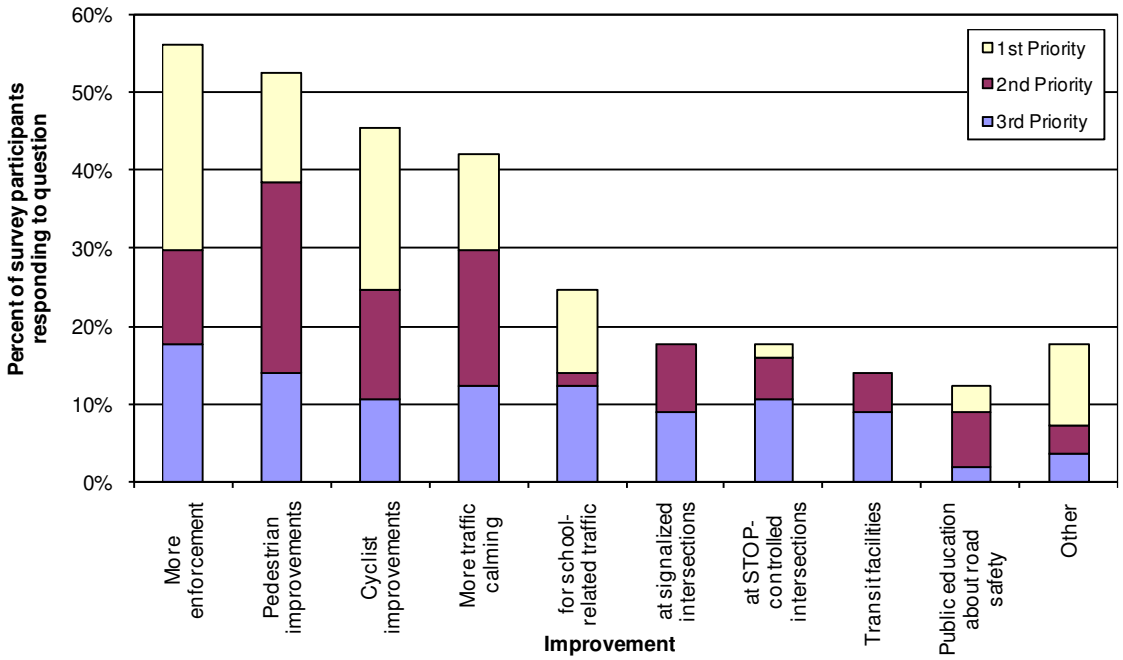

FIGURE 2.2 ROAD SAFETY IMPROVEMENT PRIORITIES

Respondents had an opportunity to identify their concerns in eight specific areas, summarized below and in more detail in APPENDIX A. The number of respondents providing their input is summarized in FIGURE 2.3.

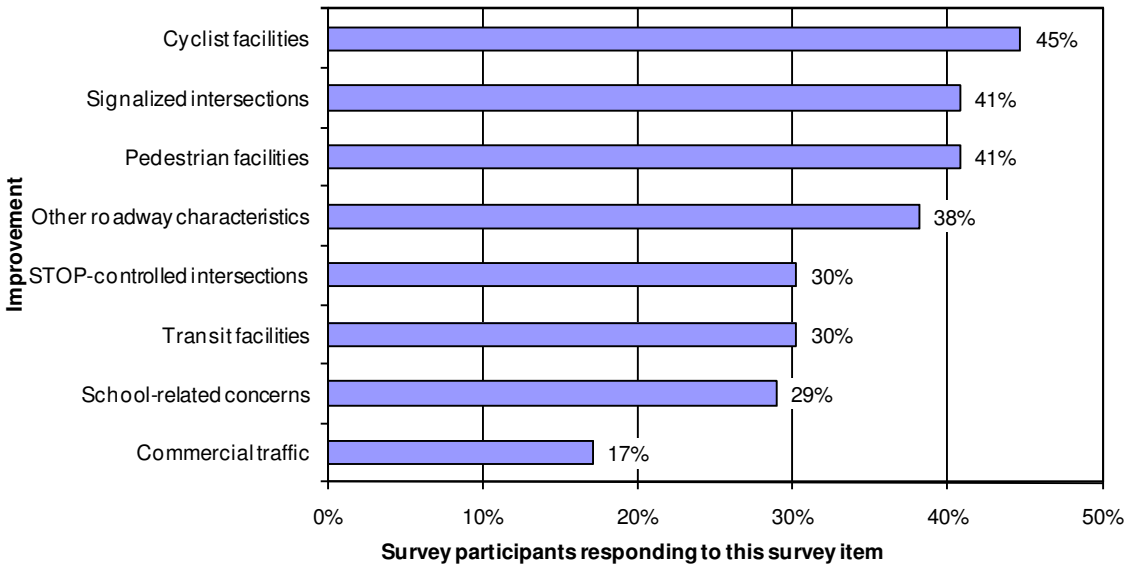

FIGURE 2.3 PROPORTION OF SURVEY PARTICIPANTS PROVIDING INPUT IN SPECIFIC AREAS OF CONCERN

Survey results showed the following common concerns:

- *cyclist facilities:* Respondents felt that the District should improve existing, and provide more bike lanes. A major concern related to bike lanes was adequate separation between vehicle and bicycle traffic on roads.
- *signalized intersections:* The top concerns were lack of adequate pedestrian/cyclist accommodations at intersections, and poor pavement marking or signage.
- *pedestrian facilities:* Respondents felt that the District should improve existing sidewalks and crosswalks, and provide more sidewalks and crosswalks.
- *other roadway characteristics:* Trans-Canada Highway on-ramps were the most commonly mentioned concern, as respondents generally felt that on-ramps were too short, resulting in dangerous merges.
- *stop-controlled intersections:* The top concerns were inconspicuous pavement markings or signage, and obstructed sightlines caused by parked cars or landscaping.
- *transit facilities:* The most common concern was poor pedestrian connections or accessibility to bus stops.
- *school-related activities:* The top concerns were congestion in school zones during drop-off and pick-up times, and drivers constantly ignoring speed limits in school zones.
- *commercial traffic:* The speed of commercial traffic vehicles was the top concern.

B. Stakeholder Group Meetings

Meetings were held with the District's TPAC (May 7th, 2009) and Traffic and Safety Committee ("TSC", May 13th, 2009). Common concerns expressed by members of these committees, District staff, and by other stakeholders are summarized in TABLE 2.1.

TABLE 2.1 COMMON STAKEHOLDER SAFETY CONCERNS

	TPAC	TSC	District staff
transitions/consistency at connections with other jurisdictions (City of North Vancouver, Ministry of Transportation), including Hwy 1 interchanges	✓	✓	✓
need for greater traffic enforcement (speed, signals, Stop signs, jaywalking, etc.)	✓	✓	
school zone safety	✓	✓	
bus stops (including pedestrian access to bus stops)	✓	✓	
other issues (e.g., jaywalking, left-turn conflicts, etc.)	✓	✓	
cyclist safety	✓	✓	
aging road users	✓	✓	✓

In addition:

- *Prioritization of issues (TSC):* TSC members noted that prioritization of safety issues should reflect the severity of crashes, not necessarily just the frequency of crashes, resulting from those issues.
- *Aging road users (TSC):* TSC members noted that non-driving aging road users are generally pedestrians (including pedestrians accessing transit), and seldom cyclists. As a result, prioritization of pedestrian issues/improvements (but not necessarily cycling improvements) can also help many aging residents.

3.0 COLLISION REVIEW

3.1 Network Screening Update

A. 2005 Network Screening Study

The 2005 Network Screening Study conducted an identification of correctable intersections that may benefit from Road Improvement Program funding and achieve the Program's investment targets. As part of the Network Screening Study, District staff had identified 15 intersections, summarized in TABLE 3.1, for detailed correctability analysis based on three years of ICBC claims data (2001 through 2003). The first four intersections were considered to be strong candidates for providing a high return on road safety investments.

TABLE 3.1 RESULTS OF 2005 NETWORK SCREENING ANALYSIS

LOCATION	2005 NETWORK SCREENING RESULTS		CURRENT STATUS	
	Correct-ability Score* (out of 10)	Recommen-dations	Studies Completed	Most Recent Ranking**
E 29th St / Fromme Rd	9	further study	study completed (2007), some measures built (2010)	--
Capilano Rd / Garden Ave	8	further study	--	34
Kirkstone Rd / Mountain Hwy / 20th St	8	further study	study completed (2007) , some measures built (2010)	25
E Keith Rd / Mountain Hwy	7	further study	--	3
Edgemont Blvd / W Queens Rd	6	--	study completed (2007)	--
Delbrook Av / Queens Rd / Westview Dr	6	--	study completed (2007)	16
Main St / Harbour Ave	6	--	--	7
Mt Seymour Pky / Riverside Dr	6	--	--	4
Marine Dr / Garden Ave	6	--	--	11
Marine Dr/ Tatlow Ave	5	--	--	26
Marine Dr / Philip Ave	5	--	--	19
Marine Dr / Lloyd Ave	5	--	--	8
Marine Dr / Pemberton Ave	5	--	--	5
Mt Seymour Pky / Mt Seymour Rd	5	--	high-level study as part of DNV crosswalk policy (2009)	21
Berkley Rd / Mt Seymour Pky	4	--	--	24

Shaded cells indicate intersections in corridors carried forward for study in this update.

* *Correctability Score is a judgement on the potential for investment in road safety improvements and the value of further review at the intersection, and is based on an assessment of issues and correctability.*

** *Ranking is from the District's most recent summary of its "Top 40" crash locations, based on frequency as reported in ICBC claims data from April 2005 through March 2008. The rankings were not consistent with the worst 15 locations identified in the network screening as the collision years used were different.*

B. Update to the 2005 Network Screening Study

The 2005 network screening results were reviewed and updated with reference to collision data supplied by the District. The District's updated crash data reflects ICBC claims data for three years (April 2005 through March 2008). The District-wide collision frequencies are summarized in TABLE 3.2, and were generally consistent with the complete annual frequencies ranging between 10,200 and 11,090 collisions per year.

TABLE 3.2 TOTAL DISTRICT COLLISION FREQUENCY BY YEAR

YEAR	NUMBER OF COLLISIONS
2003	11,089
2004	11,076
2005	10,197
2006	10,652
2007	10,660
2008	2,413*
TOTAL	56,087

* Through March 31. Projected annual frequency is 9,650

As part of network screening studies, the collision characteristics are summarized by location collision frequency and claims cost (accounting for severity), and the top 40 locations are shown in TABLES 3.3 and 3.4.

TABLE 3.3 INTERSECTION RANK BY ANNUAL COLLISION FREQUENCY

INTERSECTION	INTERSECTION TYPE	3-YEAR FREQUENCY (2005 - 2008)				SEVERITY PERCENTAGE		ANNUAL CLAIMS COST TO ICBC	MEV	COLLISION RATE	CCRI
		Injury	PDO	Unknown	Total	Injury	PDO				
Marine Dr. and Capilano Rd.	Signalized	98	202	11	311	33%	67%	$1,177,515	16.50	6.28	2.17
Keith Rd. and Mountain Hwy.	Signalized	38	60	9	107	39%	61%	$462,211	12.23	2.92	0.97
Marine Dr. and Pemberton Ave.	Signalized	36	63	1	100	36%	64%	$410,909	15.55	2.14	0.74
Mt Seymour Pkwy. and Riverside Dr.	Signalized	36	65		101	36%	64%	$408,667	16.10	2.09	0.72
Queens Rd. and Lonsdale Ave.	Signalized	5	24		29	17%	83%	$70,733	4.96	1.95	0.56
Lynn Valley Rd. and Mountain Hwy.	Signalized	20	52	8	80	28%	72%	$268,741	14.02	1.90	0.65
Lonsdale Ave. and 29th St.	Signalized	13	22	3	38	37%	63%	$158,731	7.01	1.81	0.55
Garden Ave. and Welch St.	Unsignalized	7	9		16	44%	56%	$76,067	3.03	1.76	0.93
Mountain Hwy. and Fern St.	Signalized	19	38	1	58	33%	67%	$222,978	12.74	1.52	0.51
Main St. and Harbour Ave.	Signalized	24	44	3	71	35%	65%	$285,114	15.62	1.51	0.52
Dollarton Hwy. and Riverside Dr.	Signalized	22	33	4	59	40%	60%	$261,173	12.99	1.51	0.51
Marine Dr. and Lloyd Ave.	Signalized	28	33	3	64	46%	54%	$316,293	15.07	1.42	0.48
Mountain Hwy. and Hwy. 1 Off-ramp	Unsignalized	15	25	1	41	38%	63%	$172,542	9.75	1.40	1.01
Old Lillooet Rd. and Lillooet Rd.	Signalized	8	18		26	31%	69%	$94,133	6.57	1.32	0.40
Queens Rd. and Delbrook Ave./Westview Dr.	Signalized	12	24	2	38	33%	67%	$146,089	10.37	1.22	0.40
Marine Dr. and Garden Ave.	Signalized	18	30	1	49	38%	63%	$206,208	13.69	1.19	0.40
Capilano Rd. and Ridgewood Dr.	Signalized	17	30		47	36%	64%	$192,333	13.47	1.16	0.39
Highland Blvd. and Edgemont Blvd.	Unsignalized	5	12		17	29%	71%	$59,533	4.93	1.15	0.70
Pemberton Ave. and Welch St.	Unsignalized	5	11		16	31%	69%	$58,600	4.71	1.13	0.68
Keith Rd. and Brooksbank Ave.	Signalized	10	26		36	28%	72%	$120,933	11.24	1.07	0.35
Lynn Valley Rd. and William Ave.	Signalized	17	22	7	46	44%	56%	$218,048	15.04	1.02	0.35
Marine Dr. and Bridgman Ave.	Signalized	14	21	1	36	40%	60%	$159,360	12.01	1.00	0.33
Main St. and Lynn Ave.	Signalized	18	25	2	45	42%	58%	$206,512	15.26	0.98	0.34
Mountain Hwy. and 27th St.	Signalized	4	18	1	23	18%	82%	$57,988	8.29	0.93	0.29
Marine Dr. and Philip Ave.	Signalized	14	18	2	34	44%	56%	$161,642	13.07	0.87	0.29
Mountain Hwy. and Kirkstone Rd./20th St.	Signalized	13	14	1	28	48%	52%	$143,872	11.42	0.82	0.27
Mt. Seymour Pkwy. and Mt. Seymour Rd./Roche Point Dr	Signalized	12	14		26	46%	54%	$129,067	10.62	0.82	0.27
Lynn Valley Rd. and Fromme Rd.	Signalized	13	19	1	33	41%	59%	$147,881	13.51	0.81	0.27
Pemberton Ave. and 1st St.	Signalized	5	10	1	16	33%	67%	$61,511	7.23	0.74	0.23
Marine Dr. and Tatlow Ave.	Signalized	8	17		25	32%	68%	$93,200	11.94	0.70	0.23
Lynn Valley Rd. and Kirkstone Rd.	Signalized	11	18		29	38%	62%	$123,133	14.67	0.66	0.22
Mountain Hwy. and Arborlynn Dr.	Signalized	8	10		18	44%	56%	$86,667	9.13	0.66	0.21
Capilano Rd. and Fullerton Ave.	Signalized	5	20		25	20%	80%	$67,000	12.81	0.65	0.22
Capilano Rd. and Curling Rd.	Unsignalized	4	14		18	22%	78%	$51,733	9.64	0.62	0.45
Mt. Seymour Pkwy. and Dollarton Hwy./Deep Cove Rd.	Signalized	6	10		16	38%	63%	$67,333	9.23	0.58	0.19
Mt Seymour Pkwy. and Berkley Rd.	Signalized	11	15		26	42%	58%	$120,333	16.02	0.54	0.19
Lynn Valley Rd. and 29th St.	Signalized	7	11	1	19	39%	61%	$82,263	13.32	0.48	0.16
Capilano Rd. and Garden Ave.	Unsignalized	3	15		18	17%	83%	$43,000	13.40	0.45	0.34

TABLE 3.4 INTERSECTION RANK BY ANNUAL CLAIMS COST

INTERSECTION	INTERSECTION TYPE	3-YEAR FREQUENCY (2005 - 2008)				SEVERITY PERCENTAGE		ANNUAL CLAIMS COST TO ICBC	MEV	COLLISION RATE	CCRI
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Dollarton Hwy. and Riverside Dr.	Signalized	22	33	4	59	40%	60%	$261,173	12.99	1.51	0.51
Mountain Hwy. and Fern St.	Signalized	19	38	1	58	33%	67%	$222,978	12.74	1.52	0.51
Lynn Valley Rd. and William Ave.	Signalized	17	22	7	46	44%	56%	$218,048	15.04	1.02	0.35
Main St. and Lynn Ave.	Signalized	18	25	2	45	42%	58%	$206,512	15.26	0.98	0.34
Marine Dr. and Garden Ave.	Signalized	18	30	1	49	38%	63%	$206,208	13.69	1.19	0.40
Capilano Rd. and Ridgewood Dr.	Signalized	17	30		47	36%	64%	$192,333	13.47	1.16	0.39
Mountain Hwy. and Hwy. 1 Off-ramp	Unsignalized	15	25	1	41	38%	63%	$172,542	9.75	1.40	1.01
Marine Dr. and Philip Ave.	Signalized	14	18	2	34	44%	56%	$161,642	13.07	0.87	0.29
Marine Dr. and Bridgman Ave.	Signalized	14	21	1	36	40%	60%	$159,360	12.01	1.00	0.33
Lonsdale Ave. and 29th St.	Signalized	13	22	3	38	37%	63%	$158,731	7.01	1.81	0.55
Lynn Valley Rd. and Fromme Rd.	Signalized	13	19	1	33	41%	59%	$147,881	13.51	0.81	0.27
Queens Rd. and Delbrook Ave./Westview Dr.	Signalized	12	24	2	38	33%	67%	$146,089	10.37	1.22	0.40
Mountain Hwy. and Kirkstone Rd./20th St.	Signalized	13	14	1	28	48%	52%	$143,872	11.42	0.82	0.27
Mt. Seymour Pkwy. and Mt. Seymour Rd./Roche Point Dr	Signalized	12	14		26	46%	54%	$129,067	10.62	0.82	0.27
Lynn Valley Rd. and Kirkstone Rd.	Signalized	11	18		29	38%	62%	$123,133	14.67	0.66	0.22
Keith Rd. and Brooksbank Ave.	Signalized	10	26		36	28%	72%	$120,933	11.24	1.07	0.35
Mt Seymour Pkwy. and Berkley Rd.	Signalized	11	15		26	42%	58%	$120,333	16.02	0.54	0.19
Old Lillooet Rd. and Lillooet Rd.	Signalized	8	18		26	31%	69%	$94,133	6.57	1.32	0.40
Marine Dr. and Tatlow Ave.	Signalized	8	17		25	32%	68%	$93,200	11.94	0.70	0.23
Mountain Hwy. and Arborlynn Dr.	Signalized	8	10		18	44%	56%	$86,667	9.13	0.66	0.21
Lynn Valley Rd. and 29th St.	Signalized	7	11	1	19	39%	61%	$82,263	13.32	0.48	0.16
Garden Ave. and Welch St.	Unsignalized	7	9		16	44%	56%	$76,067	3.03	1.76	0.93
Queens Rd. and Lonsdale Ave.	Signalized	5	24		29	17%	83%	$70,733	4.96	1.95	0.56
Mt. Seymour Pkwy. and Dollarton Hwy./Deep Cove Rd.	Signalized	6	10		16	38%	63%	$67,333	9.23	0.58	0.19
Capilano Rd. and Fullerton Ave.	Signalized	5	20		25	20%	80%	$67,000	12.81	0.65	0.22
Pemberton Ave. and 1st St.	Signalized	5	10	1	16	33%	67%	$61,511	7.23	0.74	0.23
Highland Blvd. and Edgemont Blvd.	Unsignalized	5	12		17	29%	71%	$59,533	4.93	1.15	0.70
Pemberton Ave. and Welch St.	Unsignalized	5	11		16	31%	69%	$58,600	4.71	1.13	0.68
Mountain Hwy. and 27th St.	Signalized	4	18	1	23	18%	82%	$57,988	8.29	0.93	0.29
Capilano Rd. and Curling Rd.	Unsignalized	4	14		18	22%	78%	$51,733	9.64	0.62	0.45
Capilano Rd. and Garden Ave.	Unsignalized	3	15		18	17%	83%	$43,000	13.40	0.45	0.34

To further account for changes in traffic volumes, the intersection collision rates were also recalculated. Using estimated entering vehicle volumes, the collision rates (in terms of annual collisions per Million Entering Vehicles) were calculated, and the top 40 locations ranked by collision rate are shown in TABLES 3.5.

Based on an estimate of the average intersection collision rate in the Lower Mainland, the Critical Collision Rate (CCR) and the Critical Collision Rate Index (CCRI) was recalculated for each intersection. The CCR is calculated using the following critical collision rate equation:

$$R_c = R_a + k\sqrt{\frac{R_a}{M}} + \frac{1}{2M}$$

Where:

- R_c is the critical rate
- R_a is the average collision rate (based on all network screening studies, this is about 2.25 collisions per MEV for signalized intersections, 0.85 collisions per MEV for unsignalized intersections)
- M is the Million Entering Vehicles for the intersection
- k is a normal distribution probability constant (1.645 is used to give a 95% confidence interval)

The CCR represents the level where collision rate is statistically high, and is an indication that there are site-specific characteristics that is causing an abnormally high number of collisions. The CCRI is the ratio of the intersection's collision rate and CCR. A CCRI value of 1.0 or more signifies a high intersection collision rate that is statistically significant, and usually indicates site-specific issues that may be resulting in the high rate. The analysis is summarized in TABLE 3.6.

TABLE 3.5 INTERSECTION RANK BY COLLISION RATE

INTERSECTION	INTERSECTION TYPE	3-YEAR FREQUENCY (2005 - 2008)				SEVERITY PERCENTAGE		ANNUAL CLAIMS COST TO ICBC	MEV	COLLISION RATE	CCRI
		Injury	PDO	Unknown	Total	Injury	PDO				
Marine Dr. and Capilano Rd.	Signalized	98	202	11	311	33%	67%	$1,177,515	16.50	6.28	2.17
Keith Rd. and Mountain Hwy.	Signalized	38	60	9	107	39%	61%	$462,211	12.23	2.92	0.97
Marine Dr. and Pemberton Ave.	Signalized	36	63	1	100	36%	64%	$410,909	15.55	2.14	0.74
Mt Seymour Pkwy. and Riverside Dr.	Signalized	36	65		101	36%	64%	$408,667	16.10	2.09	0.72
Queens Rd. and Lonsdale Ave.	Signalized	5	24		29	17%	83%	$70,733	4.96	1.95	0.56
Lynn Valley Rd. and Mountain Hwy.	Signalized	20	52	8	80	28%	72%	$268,741	14.02	1.90	0.65
Lonsdale Ave. and 29th St.	Signalized	13	22	3	38	37%	63%	$158,731	7.01	1.81	0.55
Garden Ave. and Welch St.	Unsignalized	7	9		16	44%	56%	$76,067	3.03	1.76	0.93
Mountain Hwy. and Fern St.	Signalized	19	38	1	58	33%	67%	$222,978	12.74	1.52	0.51
Main St. and Harbour Ave.	Signalized	24	44	3	71	35%	65%	$285,114	15.62	1.51	0.52
Dollarton Hwy. and Riverside Dr.	Signalized	22	33	4	59	40%	60%	$261,173	12.99	1.51	0.51
Marine Dr. and Lloyd Ave.	Signalized	28	33	3	64	46%	54%	$316,293	15.07	1.42	0.48
Mountain Hwy. and Hwy. 1 Off-ramp	Unsignalized	15	25	1	41	38%	63%	$172,542	9.75	1.40	1.01
Old Lillooet Rd. and Lillooet Rd.	Signalized	8	18		26	31%	69%	$94,133	6.57	1.32	0.40
Queens Rd. and Delbrook Ave./Westview Dr.	Signalized	12	24	2	38	33%	67%	$146,089	10.37	1.22	0.40
Marine Dr. and Garden Ave.	Signalized	18	30	1	49	38%	63%	$206,208	13.69	1.19	0.40
Capilano Rd. and Ridgewood Dr.	Signalized	17	30		47	36%	64%	$192,333	13.47	1.16	0.39
Highland Blvd. and Edgemont Blvd.	Unsignalized	5	12		17	29%	71%	$59,533	4.93	1.15	0.70
Pemberton Ave. and Welch St.	Unsignalized	5	11		16	31%	69%	$58,600	4.71	1.13	0.68
Keith Rd. and Brooksbank Ave.	Signalized	10	26		36	28%	72%	$120,933	11.24	1.07	0.35
Lynn Valley Rd. and William Ave.	Signalized	17	22	7	46	44%	56%	$218,048	15.04	1.02	0.35
Marine Dr. and Bridgman Ave.	Signalized	14	21	1	36	40%	60%	$159,360	12.01	1.00	0.33
Main St. and Lynn Ave.	Signalized	18	25	2	45	42%	58%	$206,512	15.26	0.98	0.34
Mountain Hwy. and 27th St.	Signalized	4	18	1	23	18%	82%	$57,988	8.29	0.93	0.29
Marine Dr. and Philip Ave.	Signalized	14	18	2	34	44%	56%	$161,642	13.07	0.87	0.29
Mountain Hwy. and Kirkstone Rd./20th St.	Signalized	13	14	1	28	48%	52%	$143,872	11.42	0.82	0.27
Mt. Seymour Pkwy. and Mt. Seymour Rd./Roche Point Dr	Signalized	12	14		26	46%	54%	$129,067	10.62	0.82	0.27
Lynn Valley Rd. and Fromme Rd.	Signalized	13	19	1	33	41%	59%	$147,881	13.51	0.81	0.27
Pemberton Ave. and 1st St.	Signalized	5	10	1	16	33%	67%	$61,511	7.23	0.74	0.23
Marine Dr. and Tatlow Ave.	Signalized	8	17		25	32%	68%	$93,200	11.94	0.70	0.23
Lynn Valley Rd. and Kirkstone Rd.	Signalized	11	18		29	38%	62%	$123,133	14.67	0.66	0.22
Mountain Hwy. and Arborlynn Dr.	Signalized	8	10		18	44%	56%	$86,667	9.13	0.66	0.21
Capilano Rd. and Fullerton Ave.	Signalized	5	20		25	20%	80%	$67,000	12.81	0.65	0.22
Capilano Rd. and Curling Rd.	Unsignalized	4	14		18	22%	78%	$51,733	9.64	0.62	0.45
Mt. Seymour Pkwy. and Dollarton Hwy./Deep Cove Rd.	Signalized	6	10		16	38%	63%	$67,333	9.23	0.58	0.19
Mt Seymour Pkwy. and Berkley Rd.	Signalized	11	15		26	42%	58%	$120,333	16.02	0.54	0.19
Lynn Valley Rd. and 29th St.	Signalized	7	11	1	19	39%	61%	$82,263	13.32	0.48	0.16
Capilano Rd. and Garden Ave.	Unsignalized	3	15		18	17%	83%	$43,000	13.40	0.45	0.34

TABLE 3.6 INTERSECTION RANK BY CCRI

INTERSECTION	INTERSECTION TYPE	3-YEAR FREQUENCY (2005 - 2008)				SEVERITY PERCENTAGE		ANNUAL CLAIMS COST TO ICBC	MEV	COLLISION RATE	CCRI
		Injury	PDO	Unknown	Total	Injury	PDO				
Marine Dr. and Capilano Rd.	Signalized	98	202	11	311	33%	67%	$1,177,515	16.50	6.28	2.17
Mountain Hwy. and Hwy. 1 Off-ramp	Unsignalized	15	25	1	41	38%	63%	$172,542	9.75	1.40	1.01
Keith Rd. and Mountain Hwy.	Signalized	38	60	9	107	39%	61%	$462,211	12.23	2.92	0.97
Garden Ave. and Welch St.	Unsignalized	7	9		16	44%	56%	$76,067	3.03	1.76	0.93
Marine Dr. and Pemberton Ave.	Signalized	36	63	1	100	36%	64%	$410,909	15.55	2.14	0.74
Mt Seymour Pkwy. and Riverside Dr.	Signalized	36	65		101	36%	64%	$408,667	16.10	2.09	0.72
Highland Blvd. and Edgemont Blvd.	Unsignalized	5	12		17	29%	71%	$59,533	4.93	1.15	0.70
Pemberton Ave. and Welch St.	Unsignalized	5	11		16	31%	69%	$58,600	4.71	1.13	0.68
Lynn Valley Rd. and Mountain Hwy.	Signalized	20	52	8	80	28%	72%	$268,741	14.02	1.90	0.65
Queens Rd. and Lonsdale Ave.	Signalized	5	24		29	17%	83%	$70,733	4.96	1.95	0.56
Lonsdale Ave. and 29th St.	Signalized	13	22	3	38	37%	63%	$158,731	7.01	1.81	0.55
Main St. and Harbour Ave.	Signalized	24	44	3	71	35%	65%	$285,114	15.62	1.51	0.52
Mountain Hwy. and Fern St.	Signalized	19	38	1	58	33%	67%	$222,978	12.74	1.52	0.51
Dollarton Hwy. and Riverside Dr.	Signalized	22	33	4	59	40%	60%	$261,173	12.99	1.51	0.51
Marine Dr. and Lloyd Ave.	Signalized	28	33	3	64	46%	54%	$316,293	15.07	1.42	0.48
Capilano Rd. and Curling Rd.	Unsignalized	4	14		18	22%	78%	$51,733	9.64	0.62	0.45
Marine Dr. and Garden Ave.	Signalized	18	30	1	49	38%	63%	$206,208	13.69	1.19	0.40
Old Lillooet Rd. and Lillooet Rd.	Signalized	8	18		26	31%	69%	$94,133	6.57	1.32	0.40
Queens Rd. and Delbrook Ave./Westview Dr.	Signalized	12	24	2	38	33%	67%	$146,089	10.37	1.22	0.40
Capilano Rd. and Ridgewood Dr.	Signalized	17	30		47	36%	64%	$192,333	13.47	1.16	0.39
Keith Rd. and Brooksbank Ave.	Signalized	10	26		36	28%	72%	$120,933	11.24	1.07	0.35
Lynn Valley Rd. and William Ave.	Signalized	17	22	7	46	44%	56%	$218,048	15.04	1.02	0.35
Capilano Rd. and Garden Ave.	Unsignalized	3	15		18	17%	83%	$43,000	13.40	0.45	0.34
Main St. and Lynn Ave.	Signalized	18	25	2	45	42%	58%	$206,512	15.26	0.98	0.34
Marine Dr. and Bridgman Ave.	Signalized	14	21	1	36	40%	60%	$159,360	12.01	1.00	0.33
Mountain Hwy. and 27th St.	Signalized	4	18	1	23	18%	82%	$57,988	8.29	0.93	0.29
Marine Dr. and Philip Ave.	Signalized	14	18	2	34	44%	56%	$161,642	13.07	0.87	0.29
Lynn Valley Rd. and Fromme Rd.	Signalized	13	19	1	33	41%	59%	$147,881	13.51	0.81	0.27
Mountain Hwy. and Kirkstone Rd./20th St.	Signalized	13	14	1	28	48%	52%	$143,872	11.42	0.82	0.27
Mt. Seymour Pkwy. and Mt. Seymour Rd./Roche Point Dr	Signalized	12	14		26	46%	54%	$129,067	10.62	0.82	0.27
Marine Dr. and Tatlow Ave.	Signalized	8	17		25	32%	68%	$93,200	11.94	0.70	0.23
Pemberton Ave. and 1st St.	Signalized	5	10	1	16	33%	67%	$61,511	7.23	0.74	0.23
Lynn Valley Rd. and Kirkstone Rd.	Signalized	11	18		29	38%	62%	$123,133	14.67	0.66	0.22
Capilano Rd. and Fullerton Ave.	Signalized	5	20		25	20%	80%	$67,000	12.81	0.65	0.22
Mountain Hwy. and Arborlynn Dr.	Signalized	8	10		18	44%	56%	$86,667	9.13	0.66	0.21
Mt Seymour Pkwy. and Berkley Rd.	Signalized	11	15		26	42%	58%	$120,333	16.02	0.54	0.19
Mt. Seymour Pkwy. and Dollarton Hwy./Deep Cove Rd.	Signalized	6	10		16	38%	63%	$67,333	9.23	0.58	0.19
Lynn Valley Rd. and 29th St.	Signalized	7	11	1	19	39%	61%	$82,263	13.32	0.48	0.16

The findings summarized in TABLES 3.2 through 3.6 indicate the following:

- Of the 15 intersections prioritized in the 2005 Network Screening study, 13 remain in the 40-highest frequency list.
- Intersections along Marine Drive were notable on all of the tables, with seven intersections in the 40-highest frequency list. There were five Capilano Road intersections on the list, and four along Mount Seymour Parkway and Lynn Valley Road each.
- The Marine Drive and Capilano Road intersection ranked the highest on all of the tables, and Marine Drive and Pemberton Avenue in the top five.
- There were two intersections (Marine Drive and Capilano Road, and the Ministry's intersection of Mountain Highway and Westbound Highway 1 Off-ramp) had a CCRI of higher than 1.0, with the Keith Road and Mountain Highway intersection approaching 1.0.
- Most of high collision frequency locations were signalized intersections. When considering the intersection CCRI, the unsignalized intersections were more prominent.

3.2 Additional Collision Analysis

To supplement the revised Network Screening analysis for the District, additional collision characteristics were reviewed. Items that were specifically reviewed were:

- Pedestrian collision characteristics (identified by public and stakeholder concerns, vulnerable road user);
- Cyclist collision characteristics (identified by public and stakeholder concerns, vulnerable road user);
- Channelized right-turn collision traits (identified as District staff concern); and,
- High local street collision location trends (identified as District staff concern).

A. Pedestrian Crash Risk Locations

Using ICBC claims data from January 2003 through March 2008, a total of 64 collisions involving pedestrians were identified (out of 56,087 collisions, or less than 1 percent of the total). Intersections having the highest frequency of pedestrian crashes were identified. These intersections are summarized in TABLE 3.7 below. As well, a review of the pedestrian crashes were reviewed by month and time of day, and the results are shown in FIGURES 3.1 and 3.2 respectively.

TABLE 3.7 HIGH PEDESTRIAN CRASH FREQUENCY LOCATIONS

LOCATION	TOTAL PEDESTRIAN CRASHES 1/2003 – 3/2008			
	Fatality	Injury	PDO	Total
Marine Dr / Capilano Rd	--	7	--	7
Marine Dr / Phillip Ave	--	7	--	7
Lynn Valley Rd / Mountain Hwy	--	7	--	7
Marine Dr / Pemberton Ave	--	6	--	6
E 27th St / Lynn Valley Rd	1	3	--	4
E 29th St / Lynn Valley Rd	--	4	--	4
Marine Dr / Bridgeman Ave	1	2	--	3
Marine Dr / Garden Ave	--	3	--	3
Marine Dr / Lloyd Ave	--	3	--	3
Mount Seymour Pkwy / Riverside Dr	--	3	--	3
E Keith Rd / Mountain Hwy	--	3	--	3
Main St / Mountain Hwy	--	3	--	3
Edgemont Blvd / Highland Blvd	--	3	--	3
E 29th St / Lonsdale Ave	--	3	--	3
2600 Whitely Crt	--	3	--	3
Capilano Heights Restaurant / Capilano Road	1	--	--	1
W 15 St / Lloyd Ave	1	--	--	1
Total	**4**	**60**	**0**	**64**

Notes: Shaded cells indicate intersections that are also in the District's most recent "Top 40" crash locations, based on overall crash frequency as reported in ICBC claims data from January 2003 through March 2008.

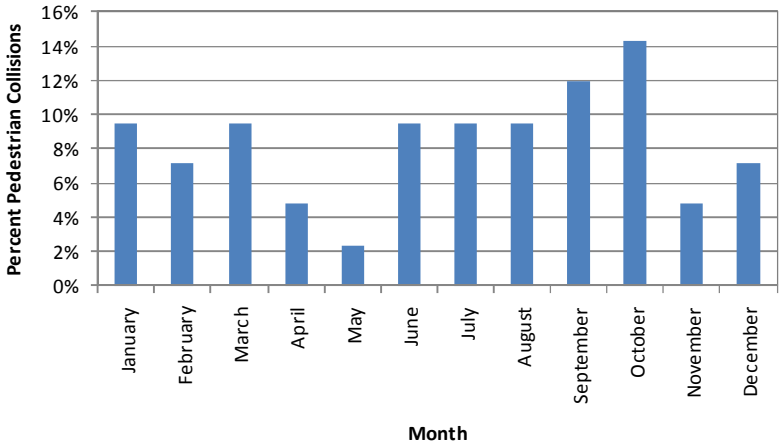


FIGURE 3.1 PEDESTRIAN COLLISIONS BY MONTH

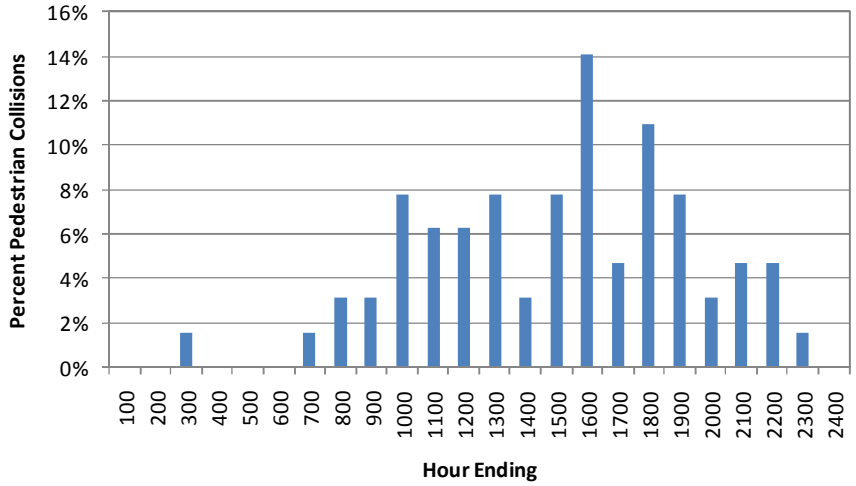


FIGURE 3.2 PEDESTRIAN COLLISIONS BY HOUR ENDING

The results indicate the following findings:

- Intersections along Marine Drive west of Pemberton Avenue occupied six of the top 14 spots. Lynn Valley Road was also a common pedestrian collision location.
- Pedestrian collisions were generally consistent throughout the year and occurred throughout the day from mid-morning to late afternoon and early evening. This corresponds to commercial-related pedestrian activity.

- There were four fatal collisions involving pedestrians. All collisions occurred during daylight hours. Two of the collisions appear to have occurred while the pedestrian was in the crosswalk and a vehicle did not appear to see the pedestrian while turning. There were no other clear trends.

B. Cyclist Crash Risk Locations

Using ICBC claims data from January 2003 through March 2008, a total of 42 collisions involving cyclists were identified (out of 56,087 collisions, or less than 1 percent of the total). Intersections having the highest frequency of cyclist crashes were identified. These intersections are summarized in TABLE 3.8 below. As well, a review of the cyclist crashes were reviewed by month and time of day, and the results are shown in FIGURES 3.3 and 3.4 respectively.

TABLE 3.8 HIGH CYCLIST CRASH FREQUENCY LOCATIONS

LOCATION	TOTAL CYCLIST CRASHES 1/2003 – 3/2008			
	Fatality	Injury	PDO	Total
Marine Dr / Capilano Rd	--	9	--	9
Fullerton Ave / Capilano Rd	--	3	--	3
E Keith Rd / Brooksbank Ave	--	3	--	3
Marine Dr / Lloyd Ave	--	3	--	3
Fern St / Mountain Hwy	--	3	--	3
Mount Seymour Pkwy / Riverside Dr	--	3	--	3
Main St / Mountain Hwy	--	3	--	3
Main St / Lynn Ave	--	3	--	3
W 21 St / Capilano Rd	--	2	--	2
Crown St / Mountain Hwy	--	2	--	2
Windsor Rd / Lonsdale Ave	--	2	--	2
Marine Dr / Philip Ave	--	2	--	2
Edgemont Blvd / Highland Blvd	--	2	--	2
Welch St / Garden Ave	--	2	--	2
Total	**0**	**42**	**0**	**42**

Notes: Shaded cells indicate intersections that are also in the District's most recent "Top 40" crash locations, based on overall crash frequency as reported in ICBC claims data from January 2003 through March 2008.

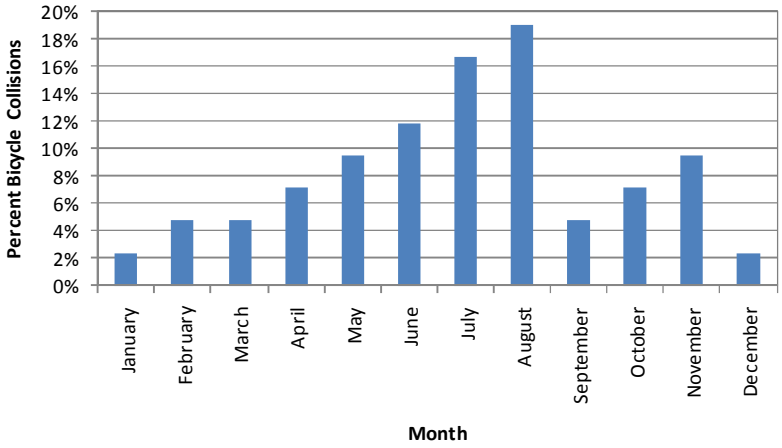


FIGURE 3.3 CYCLIST COLLISIONS BY MONTH

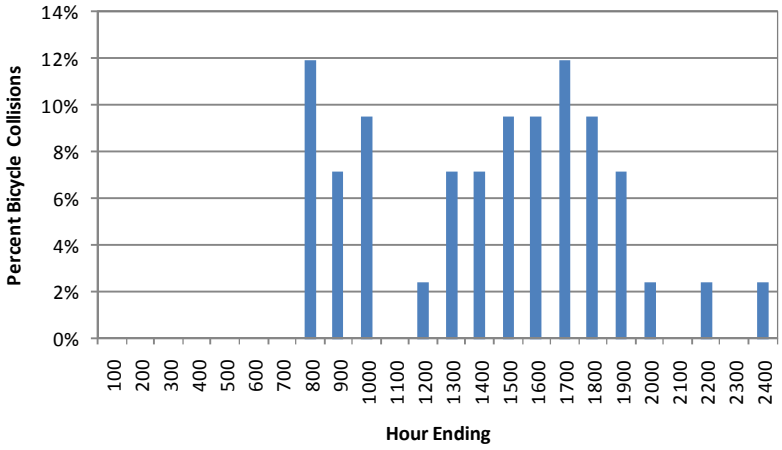


FIGURE 3.4 CYCLIST COLLISIONS BY HOUR ENDING

The results indicate the following findings:

- Street locations that were mentioned more than once in the table above were Capilano Road (three intersections), Mountain Highway (three intersections), Marine Drive (three intersections), Main Street (two intersections). Other locations with at least three collisions over five years were the Mount Seymour Parkway and Riverside Drive intersection and the Keith Road and Brooksbank Avenue intersection.

- Bicycle collisions generally occurred during the morning and afternoon peak periods, indicating that there were cyclists using the road network at all times during the day. Most of the cyclists in the morning were likely commuters. The collisions were also typically occurring during the spring and summer months, indicating that discretionary bicycle trips may be reduced by adverse weather conditions and limited hours of daylight.
- All collisions involving cyclists resulted in injury. No fatal collisions were documented.
- Further review indicates that with the exception of Mount Seymour Parkway, the above streets do not provide exclusive bicycle lanes. On-street parking is also provided along Marine Drive (both sides) and Mountain Highway (northbound side).

C. Channelized Right-Turn Locations

The District has safety-related concerns about channelized right-turn layout, with the locations appear to Intersections with channelized right-turn layouts within the District were identified, and the collision details were summarized in TABLE 3.9.

TABLE 3.9 HIGH COLLISION FREQUENCY LOCATIONS WITH CHANNELIZED RIGHT-TURN LANES

INTERSECTION	DIRECTION WITH CHANNELIZED	3-YEAR FREQUENCY (2005 – 2008)			
Marine Dr. and Capilano Rd.	NB, EB	98	202	11	311
Mt. Seymour Pkwy. And Riverside Dr.	NB, SB, EB, WB	36	65		101
Lynn Valley Rd. and Mountain Hwy.	EB	20	52	8	80
Mountain Hwy. and Hwy. 1 Off-ramp	WB	15	25	1	41
Old Lillooet Rd. and Ridgewood Dr.	SB, EB	8	18		26
Capilano Rd. and Ridgewood Dr.	NB	17	30		47
Lynn Valley Rd. and William Ave.	EB	17	22	7	46
Mountain Hwy. and Arborlynn Dr.	NB	8	10		18
Mt. Seymour Pkwy. And Berkley Rd.	SB, EB, WB	11	15		26

A review of these locations indicates that three locations have at least three collisions on the channelized right-turn lanes. The locations are:

- Marine Drive and Capilano Road;
- Mt. Seymour Parkway and Riverside Drive; and
- Capilano Road and Ridgewood Drive.

Further review indicates that all of the above locations have a YIELD control for the right-turn movement.

D. High Local Street Collision Locations

Local street locations or areas that have relatively high collision frequencies were also reviewed. The purpose was to identify locations that appeared to have more collisions due to neighbourhood “rat-running” or high and/or inappropriate speeds, as well as to provide support for traffic calming priorities and funding decisions.

For the purposes of this study, local road collisions were considered to be those that do not occur at intersections and/or sections classified as arterial or collector. Using ICBC claims data from January 2003 through March 2008, a total of 8,837 collisions not occurring on arterial or collector roads were identified (out of 56,087 collisions, or about 16 percent of the total). These collisions were categorized into areas within the District that are generally similar in physical characteristics and are contained within arterial and/or collector roads. The areas and the ranked collision rate (excluding collisions on the arterials and collectors) are shown in APPENDIX B. The collision rate was determined by summing all collisions within each zone, dividing by the approximate area of the zone, then factoring the rate to reflect one year.

The review indicates the following findings:

- Three of the four zones with the highest collision rates (Norgate, Seymour, and Lynnmour) are located near the approaches to either Lions Gate or Ironworkers Memorial Bridges and may exhibit a potential for “rat-running” to avoid queues onto those bridges.

- Three of the four highest collision rate zones (Norgate, Lynnmour, and Pemberton Heights) have straight, grid-like roads that may have a greater potential for speeding.
- The four zones with the highest collision rates are not purely residential, having some industrial and commercial land use.
- The zones with the lowest collision rates (Kirkstone and Arborlynn) have more curved, winding roads and are generally located on the outer edges of the District.
- The zones with the highest collision frequencies typically have over 100 collisions per year.

The total number of collisions within these zones are comparable to the higher collision frequencies at intersections. Although the number of collisions attributable to the lack of traffic calming cannot be quantified, the potential safety benefits due to traffic calming should nevertheless be reviewed for the high collision rate areas.

3.3 Locations for Further Analysis

Based on all conducted collision analysis, the public survey, and stakeholder consultation, the following locations were reviewed in greater detail in the following chapters (with specific analysis review in parentheses):

- Marine Drive Corridor from Capilano Road to Lloyd Avenue (all collisions, including channelized right-turn collisions at the Capilano Road intersection and cyclist – pedestrian collisions west of Pemberton Avenue);
- Capilano Road Corridor from north of Marine Drive to Fullerton Avenue (all collisions);
- Mount Seymour Parkway between Lillooet Road and Mt. Seymour Road (bicycle collisions);
- Capilano Road and Ridgewood Drive (channelized right-turn collisions); and,
- Mt. Seymour Parkway and Riverside Drive (channelized right-turn collisions).

A summary of the findings are shown in APPENDIX C. The general results of the type of issues are used to assist in determining the key road issues.

4.0 KEY ROAD SAFETY ISSUES

Based on the findings of the site visits, the results of the stakeholder consultation, and the collision trends identified through the network screening, seven key road safety issues were identified. The seven safety issues are:

- excessive traffic speeds;
- congestion and high traffic volumes;
- pedestrian risk;
- cyclist risk;
- signal operations and display;
- sightlines at intersections; and,
- transit safety.

4.1 Excessive Traffic Speeds

Excessive speed on all roads, including local roads, contributes to a higher potential crash severity, as well as higher risk of collisions by:

- giving speeding drivers less time to react to road and traffic conditions;
- conflicting with other road users who expect surrounding or approaching vehicles to be travelling close to the posted speed; and,
- operating outside the speed range for which roadway features and signal operations were designed.

According to the stakeholders, speeding is a safety issue in the District, and is cited as an issue along major corridors, such as Mount Seymour Parkway and Capilano Road.

4.2 Channelized Right-Turn Operations

There are several intersections where channelized right-turn lanes are provided, typically with YIELD control. These channelized lanes allow right-turning traffic to complete their turn at higher turning speeds, and generally increase the capacity and reduce the movement delays. However, the design of the right-turn channelized lanes with YIELD control results in drivers looking for gaps in the through traffic to the left while needing to be wary of stopped vehicles on the right-turn lane in front. This higher driver workload in opposing directions, combined with observed high volumes and limited sight distance can result in rear-end conflicts on the right-turn lane, and right-turn or merging conflicts where the right-turning traffic intersects the main road. Three intersections (Marine Drive and Capilano Road, Mt. Seymour Parkway and Riverside Drive, and Capilano Road and Ridgewood Drive) were found to have at least three collisions on the channelized right-turn lanes. Other locations (such as Mt. Seymour Parkway and Berkley Road) have similar safety issues but had fewer or no collisions.

4.3 Congestion and High Traffic Volumes

Due to the layout of the District's roads and its location opposite Vancouver across two major road bridges, the District's roads accommodate a large number of regional and commuter traffic in addition to local traffic. Many vehicles arriving from/departing to Whistler and Squamish will likely pass through the District, as will vehicles destined for Vancouver Island via Horseshoe Bay in West Vancouver. Other major attractions within the district are Mount Seymour and Grouse Mountain ski areas, and the Capilano Suspension Bridge. The overall congestion during peak periods across both the Lions Gate Bridge and the Ironworkers Memorial Bridge have a major impact on the District's roads nearby.

Consequently, congestion was identified as a safety concern by most of the stakeholders. As well, during the site visits, it was also observed that some municipal roads have volumes that appear to exceed threshold values for their classifications, especially near the Lions Gate Bridge and Ironworkers Memorial Bridge.

As the District's roads need to accommodate a large proportion of regional and commuter traffic in addition to local traffic, drivers frequently encounter congestion and delays on a wide range of municipal roads, leading to:

- Driver frustration and consequent risk-taking behaviour, such as speeding, red-light running, unsafe passing, and tailgating;
- Use of local roads by through drivers attempting to bypass high-volume roads, which increases risks for local road users;
- Increased risk of rear-end and sideswipe collisions resulting from drivers changing lanes to bypass queued traffic.

4.4 Pedestrian Safety

Pedestrian safety is an important component of any road safety plan, as walking is not only a significant mode choice, but is also an important connector between different travel modes. To accommodate pedestrians in the transportation network, their range of characteristics and needs, such as walking speeds, spatial needs, mobility issues, and cognitive abilities, must be considered.

A total of 64 pedestrian collisions occurred over the five-year study period. 29 of the collision locations were along the Marine Drive corridor. The findings along Marine Drive (shown in APPENDIX C) indicate the following:

- Pedestrian collisions occurred throughout the day but were prevalent during the afternoon peak periods when pedestrian and vehicle volumes were generally high. The high pedestrian collision frequency may be due to the high pedestrian activity to access transit and commercial uses along the corridor.
- Site visits indicated that sidewalks and crosswalks along the corridor could be wider, given the relatively high pedestrian volumes along the corridor.
- Some pedestrian jaywalking midblock was also observed, as shown in FIGURE 4.1. These occurred along the corridor near commercial accesses and transit stops to avoid delays at the traffic signals. Although pedestrians may feel that the platooning of vehicles by frequent traffic signals creates adequate gaps, they may be unaware that driver workload and distraction along Marine Drive may increase their risk of being involved in a collision.

- Drivers were sometimes observed to also neglect to look out for pedestrians crossing the intersection when turning on a permissive phase.

FIGURE 4.1 PEDESTRIAN JAYWALKING ACROSS MARINE DRIVE

The analysis along Marine Drive forms the basis of this District-wide issue. It is expected that other corridors with commercial uses and transit facilities (such as Edgemont Village or portions of Lynn Valley Road, for example) will have similar pedestrian safety issues.

Stakeholders had noted that pedestrian infrastructure is insufficient in some areas of the District. During the site visit along Marine Drive locations, issues at crossings such as relatively narrow sidewalks and crosswalks, or faded crosswalk markings were observed. Intersection letdowns were located relative to the marked crosswalks such that users requiring them (such as wheelchairs or strollers) need to travel outside the marked crosswalk to access them, making them more vulnerable to being struck by vehicular traffic. At times, visual clutter around the areas may distract drivers, making pedestrians on the sidewalks or crossing the street less noticeable.

The overall analysis indicates that there is not a single contributing cause for the pedestrian collisions, but that they may be a result of various small issues, such as narrow facilities and pedestrian inconspicuity. High pedestrian demand, as well as unsafe pedestrian and driver behaviour exacerbates the collision risk.

4.5 Cyclist Safety

Cyclist collisions are occurring along high volume streets where cyclists and vehicles share a lane, such as Marine Drive, Capilano Road, or Mountain Highway. The lack of cycling facilities increases the exposure of cyclists to vehicles on a relatively busy corridor. From the responses of some stakeholders, it is felt that designated routes that must share the road with motor vehicles in a curb lane, such as Marine Drive, may be a safety issue for cyclists. The relative narrowness of the curb lane (such as along Capilano Road or Marine Drive) or the presence of on-street parked vehicles (such as along Marine Drive or Mountain Highway) may also be contributing to the collision risk along these corridors.

The occurrence of cyclist-related collisions on Mount Seymour Parkway, which provides exclusive bicycle lanes, may be due to the many cyclists using the bicycle route and thus the increased exposure. It may also be an indicator that the sub-standard 1.3 metre width of the existing bicycle lane on the route may be resulting in a higher collision risk. The bicycle lane is less than the 1.8 metre standard for the GVRD and results in cyclists being situated closer to adjacent vehicular traffic.

In recent years, the District has been progressively focusing efforts to improve facilities to support other road users, such as cyclists. However, as the road network has been focused on vehicular modes in the past, there are many issues that would need to be addressed should cycling initiatives be implemented on the District's roads. On TransLink's Regional Cycling Map, which is shown in FIGURE 4.2, zones of caution for cyclists have been identified and are circled in red, and generally correspond to the locations identified as having a higher collision risk. Other bicycle routes, which are shown in light green or blue, could be considered for upgrades as the routes are regularly used by cyclists.

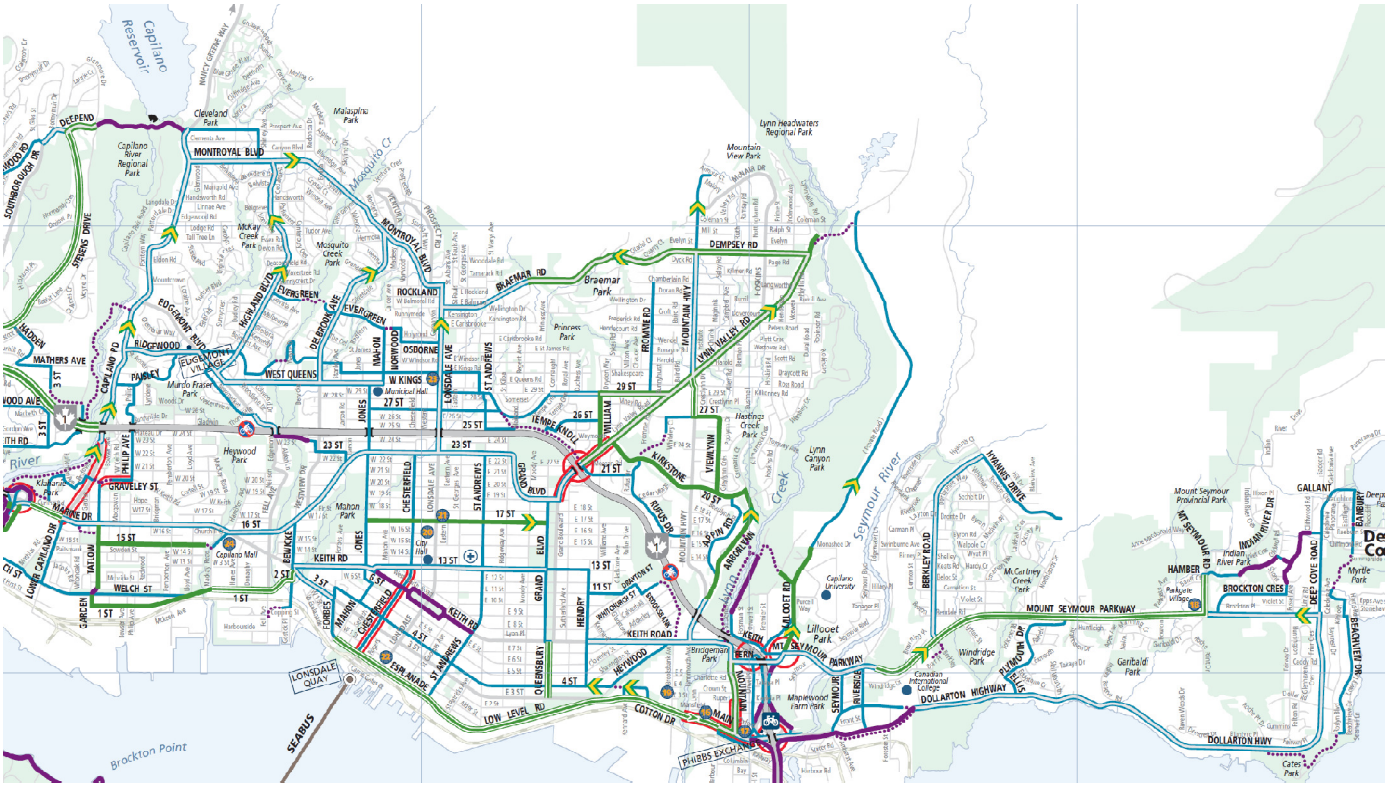


FIGURE 4.2 CYCLIST MAP (TRANSLINK)

4.6 Signal Operations and Display

Traffic signals should provide a clear indication to road users, and should be phased and timed to meet their needs.

From the collision analysis, it was found that collisions may be occurring due to left-turn delays. The delays typically occur at locations without left-turn phasing, and drivers of left-turning vehicles would need to wait until a gap in the opposing through movement complete their turn. Should either the left-turn movement and/or the opposing through movement have high volumes, there may be long delays, resulting in driver frustration and risk-taking driving manoeuvres with inadequate gaps. This results in left-turn opposing collisions or secondary rear-end collisions.

During the site visit, it was found that many of the study intersections have secondary (left-side) signal heads equipped with yellow backplates, with some equipped with smaller 200 millimetre lenses (instead of the larger 300 millimetre lenses). The smaller signal displays and lack of backplates may make the secondary signal heads less conspicuous and visible, and may reduce the signal phase visibility of left-turning drivers who are generally focussed towards the lower left portion of the opposing leg of the intersection. As well, the less conspicuous secondary signal head will make it more difficult for drivers to see the phase should the primary signal head(s) be obstructed, such as by a large heavy vehicle in front.

4.7 Sightlines at Intersections

In the urbanized road environment, constrained sightlines can occur as a result of landscaping, parking, buildings, or other objects in the vicinity. At unsignalized intersections, limited sightlines have the following safety implications:

- increased risk of crossing collisions when drivers fail to observe conflicting traffic because of obstruction; and
- increased risk of pedestrian collisions when drivers enter a crosswalk or sidewalk to observe traffic beyond the obstruction.

At all locations, sightline obstruction may prevent drivers from observing approaching vehicles violating a STOP sign or a red signal, or a pedestrian approaching the crosswalk.

4.8 Transit Safety

The District encourages transit as a viable mode of transportation. Transit services in the District are provided by TransLink through Coast Mountain Bus Company. Currently, there are a number of local and regional routes that provide a connection between the District. Two of the main concerns along transit corridors are:

- pedestrians jaywalking near bus stops; and,
- increased frequency of sideswipe and rear-end collisions involving buses.

As discussed in APPENDIX C, intersections along Marine Drive, which is a major transit corridor, have been identified as high risk locations for pedestrians. During site visits conducted along the corridor, many pedestrians were observed to cross illegally near transit stops. Based on observations, it can be concluded that many pedestrians cross illegally near transit stops to avoid delays, without realizing that they may be outside of drivers' (including possibly bus operators') sight lines.

Site visits along transit corridors also indicated that buses pull over off the travel lane to stop at a bus stop (typically along a street with on-street parking). When the buses pull out of the bus stop, drivers may not yield to the buses attempting to merge, increasing the risk of sideswipe and rear-end collisions. It is also possible that the bus stops increased the safety risk between buses and right-turning traffic. Upon completing a right-turn movement from a minor approach, drivers may unexpectedly encounter a bus merging out of the bus stop to the adjacent travel lane.

5.0 SOLUTION STRATEGIES

Potential strategies were developed based on the issues identified in Section 4.0 of this report. The strategies that the District can consider are classified under the following:

- *Engineering* – This includes transportation planning, design, operations, and maintenance. Although some aspects of driver behaviour or error cannot be entirely addressed or corrected with engineering measures, it is important that the roads be designed to reduce the probability and/or severity of collisions due to an error in judgement.
- *Education*, aimed at improving behaviour safety issues among all road users.
- *Enforcement* of traffic laws and bylaws by police and bylaw-enforcement staff.

are presented in TABLE 5.1. The issues these strategies can be applied towards are summarized in TABLE 5.2.

TABLE 5.1 SUMMARY OF SOLUTION STRATEGIES

ENGINEERING SOLUTIONS	EDUCATION SOLUTIONS	ENFORCEMENT SOLUTIONS
<u>Signals</u> • left-turn signal phasing • upgrade traffic signal display <u>Traffic Controls</u> • review/upgrade traffic control device • traffic calming <u>Geometry</u> • modified right-turn lanes • restricted turning movements <u>Zoning and Maintenance</u> • intersection sight triangles <u>Pavement</u> • repavement <u>Signing/Guidance</u> • signing and pavement marking improvements <u>Pedestrian/Cyclists</u> • complete pedestrian network • complete cyclist network <u>Planning/Policy</u> • review of bylaws	• Share the Road campaign • Be Safe, Be Seen campaign	• Traffic Safety Plan

TABLE 5.2 TYPES OF ISSUES MITIGATED BY PROPOSED STRATEGIES

STRATEGIES	ISSUES							
	9) Excessive Traffic Speeds	10) Channelized Right-Turn Operations	11) Congestion and High Traffic Volumes	12) Pedestrian Safety	13) Cyclist Safety	14) Signal Operations and Display	15) Sightlines at Intersections	16) Transit Safety
Engineering Solutions								
Signals								
C. Left Turn Signal Phasing			■	■		■		
D. Upgrade Traffic Signal Displays						■		
Traffic Controls								
C. Review/Upgrade Traffic Control Devices		■	■			■		
D. Traffic Calming	■		■	■	■			■
Geometry								
C. Modified Right-Turn Lanes		■		■	■			
D. Restricted Turning Movements		■		■	■		■	
Zoning and Maintenance								
B. Intersection Sight Triangles		■		■	■	■	■	■
Pavement								
C. Repavement	■				■			
Signing/Guidance								
B. Signing and Pavement Marking Improvements	■	■		■	■			■
Pedestrian/Cyclist								
B. Complete Pedestrian Network			■	■				
D. Complete Cycling Network					■			
Planning/Policy								
B. Review of Bylaws	■			■	■		■	
Education Solutions								
C. Share the Road					■			
D. Be Safe, Be Seen				■	■			
Enforcement Solutions								
B. Traffic Safety Plan	■	■		■	■			

5.1 Description of Solution Strategies: Signals

A. Left-turn Signal Phasing

Left-turn signal phasing is recommended at intersections where left-turn demands are high to minimize the exposure of left-turn vehicles to through traffic. In addition, left-turn phasing can also reduce pedestrian conflicts with left-turning vehicles.

Left-turn signal phasing can be either protected-only or protected-permissive. With protected-only phasing, drivers are only allowed to turn left during the flashing green arrow display. This phasing may increase delays at the intersections, but provides maximum protection for the turning drivers. Protected-permissive phasing provides a dedicated left-turn phase with the flashing green arrow, but drivers are also permitted to complete left-turn during the green phase, when there is sufficient gap. This phasing increases the left-turn capacity on an approach, but entails a higher risk of left-turn opposing and rear-end collision than the protected-only phasing. With protected-permissive phasing, the required length of the protected phase may be reduced relative to protected-only phasing, which increases the available time for other movements. It should be noted that left-turn signal phasing is usually only implemented where dedicated left-turn lanes are provided. The left-turn lane should be sufficiently long for drivers to decelerate and queue without blocking the adjacent through lane.

B. Upgrade of Traffic Signal Displays

Limited signal visibility and/or conspicuousness were identified as contributing factors to many of the collisions occurring at signalized intersections. To improve signal visibility and to raise driver awareness of traffic signals, it is recommended that the District ensure that all secondary signal heads are equipped with yellow backplates and that all lenses are the larger 300 millimetres signal lenses. Based on discussions with District staff, a program to systematically replace all secondary signals to provide the larger signal heads is currently in place.

It should be noted that while the costs of upgrading signal displays are generally minor, these costs, at some intersections, may be significant due to the potential need for new poles or master arms.

5.2 Description of Solution Strategies: Traffic Control

A. Review/Upgrade Traffic Control Device

Signalization can be considered at existing unsignalized intersections where traffic volumes are significant to increase capacity and to allow vehicles of a minor approach to cross more safely. It is expected that signalization of some intersections will help to reduce left-turn collisions, especially from the minor street. It is therefore recommended that the District identifies locations that may benefit from an installation of a new traffic signal. Based on the site visits, the signalization can be considered at the following intersections:

- Capilano Road and Curling Road; and
- Capilano Road and Garden Avenue.

It is important to note that traffic signals may increase the overall delays at the intersection and may increase the frequency of rear-end collisions. It is also important to ensure that the intersections warrant signalization based on ITE or TAC methodologies, or if not, it can be justified due to identified safety issues.

A roundabout is another traffic control option that can be considered. From a safety perspective, roundabouts offer many significant safety benefits over unsignalized and signalized intersections, as roundabouts have fewer conflict points and tend to have collisions of a less severe nature because there are no opposing, left-turning, or crossing movements. Rear-end crashes are generally less frequent because roundabouts require vehicles to yield on entry rather than stopping for a stop sign or a red phase during every cycle. As well, a roundabout operates without any electrical components, so there are no safety risks associated with electrical malfunction. Additionally, roundabouts offer increased pedestrian safety over signalized intersections, as pedestrians only cross one direction of traffic at a time.

From an operations perspective, roundabout controlled intersections can efficiently service traffic with decreased delay and greater efficiency than traffic signals. This is particularly true where traffic volumes entering the roundabout are nearly balanced on all legs and where there are a high number of left-turning vehicles. As well, there is no sequential assignment of right-of-way and therefore little wasted time.

Several site-specific features need to be considered in determining the suitability of a roundabout:

- Traffic volumes – Analysis as to whether there will be any undue delay should be reviewed, as well as whether additional control devices (such as approach metering) could address the delays.
- Land acquisition – land may need to be acquired to accommodate the roundabout.
- Vehicle speeds on approach - roundabouts are typically designed for speeds from 30 to 50 kilometres per hour. Approaches should be designed and/or signed to ensure that vehicles approach and enter the roundabout with a safe speed.
- Adjacent roads and accesses - In general, there should not be any nearby intersections or driveways that could interfere with the roundabout operations.

B. Traffic Calming

The District has already implemented traffic calming strategies on some neighbourhood streets to reduce vehicles speeds. Speed humps, traffic circles, curb extensions, or road narrowings are examples of traffic calming devices that are designed to reduce vehicle speeds, of which some are used in the District.

It is recommended that the District continue its traffic calming efforts. Based on the collision analysis, traffic calming can be explored or if existing, be further reviewed, in areas where the local roads have a higher collision rate (such as the Norgate, Pemberton Heights, Lionsview, and Canyon Heights areas). However, it is important to note that traffic calming devices are generally designated for certain levels of roadways within the road classification hierarchy. As the implementation of traffic calming devices is expected to impact the surrounding road network, it is suggested that any review should include the entire neighbourhood. In addition, affected property owners and neighbourhood groups should be contacted for involvement early in the planning process.

5.3 Description of Solution Strategies: Geometry

A. Modified Right-Turn Lanes

The elimination of channelized right-turn lanes with YIELD control separates two driver tasks (searching for gaps and watching for stopped vehicles ahead), reducing potential right-turn and rear-end collisions and conflicts.

In general, there are three options available to reduce the safety risks of the right-turn lanes:

- Provide an exclusive right-turn lane adjacent to the other travel lanes;
- Provide a channelized right-turn lane with a less acute angle and STOP control; and,
- Provide a channelized right-turn lane with adequate merge distance and control.

A right-turn lane adjacent to the other travel lanes, while safe, will also require approach widening at the intersection, and would typically need to have traffic signal poles relocated if a new exclusive lane is provided. A merge traffic control would require additional land acquisition to accommodate the longer merge distance. It is therefore suggested that a modified right-turn lane with STOP control be considered.

For this study, conceptual layouts for two of the three identified locations with at least three related collisions were prepared: at the Capilano Road and Ridgewood Drive intersection and at the Mount Seymour Parkway and Riverside Drive intersection. The layouts are shown in APPENDIX D. The right-turn lane design for the third location at Marine Drive and Capilano Road intersection was part of a detailed overall intersection layout that incorporates various safety measures, and is also shown in APPENDIX D.

B. Restricted Turning Movements

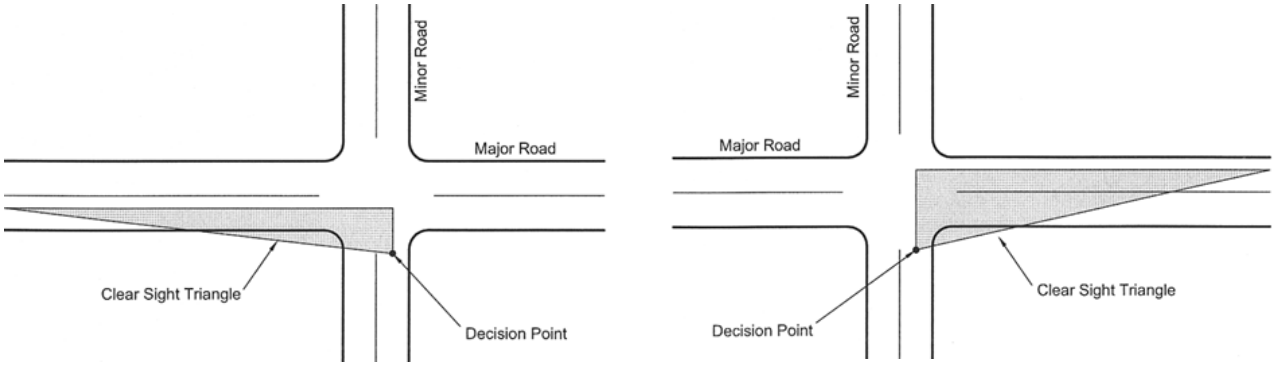
The elimination of turning movements found to be unsafe can also be considered by the District. Locations include the intersections of Garden Avenue and Hope Road with Capilano Road. These can be carried out by either physically restricting the movements (such as with channelizing islands or barriers) or with traffic control devices (such as No Left Turn signs). Before such measures are considered, the District would need to review whether the restricted volumes would migrate to another location and result in capacity or safety issues.

5.4 Description of Solution Strategies: Zoning and Maintenance

A. Intersection Sight Triangles

Adequate sight distance for drivers and cyclists approaching intersections (particularly unsignalized intersections) has been recognized as a contributing factor to the overall intersection safety. Sight distance triangles can be used to determine the area that needs to be clear of obstructions to ensure adequate sight distance. The necessary sight triangles for a driver looking left or right form a minor road are shown in FIGURE 5.1.

Within an urbanized area, sight triangles can be obstructed by buildings, landscaping, retaining walls, commercial signs, transit shelters, street furniture, or cars parked either on the street or in- off-street parking areas immediately adjacent to the sidewalk. Parked vehicles close to intersections and crosswalks may block sightlines between approaching drivers, cyclists, and pedestrians, and obstruct approaching drivers' view of a STOP sign.



Sight Triangle for Driver Looking Left

Sight Triangle for Driver Looking Right

Source: http://www.tfhrc.gov/safety/pubs/04091/11.htm#114

FIGURE 5.1 SIGHT TRIANGLES

Adequate sightlines are also essential for pedestrians approaching a crosswalk, including at signalized intersections where drivers turning may conflict with pedestrians. As pedestrians are more likely to cross illegally near transit stops, it is necessary to ensure that sight lines are not obstructed so that bus operators are able to see pedestrians.

To reduce the risks associated with poor sightlines, the District can do the following:

- Ensure that parking is restricted on approaches to intersection and crosswalk by signing, pavement markings, or restrictive channelization. Intersections at which parking restrictions will be most beneficial may be identified as candidate intersections for this treatment. Candidate intersections are likely to include those at which a high proportion of angle collisions, or where high crossing volumes are recorded. It is noted that the District currently possesses a bylaw that restricts parking to 11 metres from an intersection.
- To reduce collisions attributable to limited sight distance, it is also suggested that the District regularly maintain its landscaping, such as trees, shrubs, hedges, and buses, such that they do not obstruct driver sightlines. Foliage maintenance could be conducted as a District-wide program that is implemented on a regular basis.

- To ensure that sight triangles are not obstructed by developments on private lands, planning-level interventions to establish and enforce building setbacks is considered most effective. Without an established policy, it may be difficult to enforce the removal of sight line obstructions on private property.

5.5 Description of Solution Strategies: Pavement

A. Repavement

Many collisions that occur on poor pavement are the result of reduced pavement friction, particularly on approaches where braking efficiency may be limited. These collisions may be preventable with better pavement conditions, especially on the intersection approaches. As such, it is recommended that pavement condition along major arterial and collector roads be reviewed, and the repaving of the road be planned.

In addition to repaving, anti-skid pavement can be considered where there is significant downgrade. The length of treatment must include the distance within which drivers usually brake on the approach to an intersection. Depending on the treatment method used and site characteristics such as traffic volumes, the areas treated with anti-skid pavement may need to be re-treated within five to ten years.

5.6 Description of Solution Strategies: Signing/Guidance

A. Signing and Pavement Marking Improvements

Signs and pavement markings can provide crucial guidance and information to all road users. Based on the responses received from stakeholders, it is felt that additional signage and pavement markings on designated bicycle routes would improve the safety for cyclists. As such, it is recommended that the District ensure that designated bicycle routes are marked with the appropriate pavement markings. As well, signs similar to common “Share the Road” signs could be provided along all designated bicycle routes. The appropriate lane markings and signage are shown in FIGURE 5.2.

FIGURE 5.2 SIGNAGE AND PAVEMENT MARKINGS FOR BICYCLE FACILITIES

Potential conflicts between right-turning vehicles and transit vehicles exiting a bus stop can be reduced by providing signage warning right-turning drivers of buses after the turn. In the future, as a long-term improvement, the District can also consider providing bus bulges or exclusive bus lanes. With the provision of a bus lane, warning signs such as that shown in FIGURE 5.3 should be provided for the minor street right-turn movement.

FIGURE 5.3 RESTRICTED LANE USE WARNING SIGN FOR RIGHT TURN

To be effective, all pavement markings and signage must be consistently visible and conspicuous under all weather and lighting conditions, and for all road users. However, even with regular maintenance, signing and pavement markings become faded, worn, or damaged. As a result, their visibility and conspicuousness, and therefore their effectiveness, may be reduced. Where signs and pavement markings are ineffective, driver guidance is limited, increasing the risk of all types of collisions. To improve visibility and conspicuousness, durable and/or highly reflective signs and pavement markings may be considered. Highly reflective materials have a higher initial brightness, and typically retain that higher level of brightness over the maintenance cycle. As well, a maintenance program that effectively documents sign/pavement marking installation type and date should be implemented to ensure that the control devices are replaced/repainted as they approach the end of their effective life cycle and before visibility issues arise. The maintenance could possibly be integrated into the District's GIS system.

5.7 Description of Solution Strategies: Pedestrian/Cyclist

A. Complete Pedestrian Network

The pedestrian network should be continuous and convenient to encourage its use by pedestrians, and to remove pedestrians from roadways intended for other modes of travel. A continuous network is one that is free of gaps, and a convenient network is one that is comfortable and easy to use. Some characteristics of a pedestrian network that contribute to convenience include its geometry, its adequacy to accommodate pedestrians under all weather conditions, and how directly it follows pedestrian desire lines. Inconvenient or poorly connected pedestrian facilities can cause pedestrians to walk in the roadway or choose alternative routes that may put them into conflict with vehicles and cyclists.

It is recognized that the District has a Pedestrian Master Plan that addresses various pedestrian, crosswalk, and sidewalk issues. It is suggested that the District continue its effort in completing its pedestrian network, focusing on areas where adequate pedestrian facilities are most needed, such as near schools, parks, transit routes, roads with high volumes/speeds, and sites with a substantial pedestrian collision history. These include the adequate crosswalk widths, letdown locations, and sidewalk widths identified during the site visits.

B. Implement Safe Routes to School Program

The Safe Routes to School initiative covers programs, education, infrastructure and engineering improvements to reduce traffic around schools and increase safety, and encourage pupils and parents to walk to school. Several organizations operate programs and schemes based around the concept of Safe Routes to Schools. Programs can include identifying Best Routes to Schools, special days and incentives to encourage children to walk, and establishing programs such as walking school buses.

Once a Safe Routes to School program have been established, the District can work with schools to identify any engineering or maintenance measures to further enhance the students' walking experience. Examples of engineering measures that can be implemented include crosswalks, curb extensions or extending school speed zones. Maintenance improvements can include trimming trees to improve or to improve the visibility of school speed zone signs, or ensuring that sidewalks on designated Best Routes to School are well-maintained.

In the meantime, it is suggested that the District continue its effort in completing its pedestrian network, focusing on areas where pedestrian facilities are most needed, such as near schools, parks, transit routes, roads with high volumes/speeds, and sites with a substantial pedestrian collision history.

C. Complete Cycling Network

The cycling network should be continuous and convenient to encourage its use by cyclists, and to limit potential conflicts between cyclists and motor vehicles or pedestrians. A continuous cycling network is one that is free of gaps or obstacles, and a convenient network is one that is comfortable and easy to use. Some characteristics of a cycling network that contribute to its continuity and convenience include its geometry, its adequacy to accommodate cyclists under all weather conditions, how directly it follows desire lines, and an absence of extensive gap.

In recent years, the District has been focusing its efforts to improving facilities which support cycling, and is currently conducting a prioritization study for cycling infrastructure. However, funding and staffing constraints can be expected to limit the implementation of cycling initiatives. To obtain the greatest benefit, cycling facilities should be first implemented close to schools, parks, roads with high volumes, and sites having a substantial cyclist collision frequency. The collision characteristics indicated that the following roadways have a high bicycle collision propensity and could benefit from cycling facilities:

- Capilano Road;
- Marine Drive; and
- Mountain Highway.

In addition, the adequacy of existing bicycle facilities should be reviewed. As noted in site observations along Mount Seymour Parkway, the bicycle lane is slightly substandard in width. Although no collisions were associated with the lane widths, the District should monitor this and other bicycle facilities for occurring collisions, and modify the existing design if necessary.

The comprehensive nature of a cyclist network and the need to accommodate pedestrians of all ages and capabilities makes completion of the network a long-term strategy.

5.8 Description of Solution Strategies: Planning/Policy

As traffic volumes and traffic mixes change, municipal bylaws need to keep pace to identify unsafe practices. Examples of possible bylaws that may need to be review are:

- Trucking restrictions;
- Scooters on sidewalks;
- Cycling on sidewalks; and,
- Location and/or restriction of parking.

5.9 Description of Solution Strategies: Enforcement

The RCMP currently collaborates closely with the District on various programs. It is suggested that the District continue working with the RCMP to enforce various safety-related programs. Several key areas of action that can be considered are:

1. *Improved Traffic Safety through Enforcement* includes intelligence-led enforcement in high-collision areas, focused enforcement against impaired driving, and commercial vehicle inspections.

2. *Improved Traffic Safety through Education* includes participation with ICBC and volunteers, and traffic education classes in District high schools.

3. *Partnerships in Traffic Safety* include partnerships with ICBC, the provincial Commercial Vehicle Safety and Enforcement branch, community policing volunteers, and the Integrated Road Safety Unit.

In addition the these three action areas, the RCMP could liaise with the District staff regarding recommended road changes, upgrades, and signage, particularly as outcomes of their fatal crash investigations. The RCMP and the District can also share and assist in reviewing relevant data, such as ICBC collision information and findings (with permission from ICBC), RCMP ticketing statistics, or intersection safety camera data. The District can also consider providing funding for additional traffic officers and traffic enforcement equipment, as there is limited time available for the RCMP allocated to collision-related analysis.

The District can also consider implementing a Speed Reader Board Program that does not require volunteers. A speed reader board that provides instant feedback on driving speeds can be set-up near the study intersection to raise awareness of driving speeds. The Speed Reader Boards will also further reinforce the posted speed limits at non-school crossing times when volunteers are not present.

5.10 Description of Solution Strategies: Education

A. Share the Road

To promote the safe use of the shared roadway by cyclists and motorists including trucks, a “Share the Road” campaign may be considered. Similar campaigns have been conducted throughout Canada and the United States, offering many examples of “best practices”. “Share the Road” programs are usually based on the recognition that cyclists and motorists are equally responsible for bicycle safety. The campaign can be implemented through “Share the Road” media exposure, “Share the Road” signing, brochures and bumper stickers.

B. Be Safe, Be Seen

The Be Safe Be Seen Campaign promotes the importance for pedestrians to be visible to drivers, especially during dark and wet conditions. The campaign advises pedestrians and cyclists to wear bright colours and reflective materials when lighting conditions are poor. In addition, the campaign also reinforces good pedestrian and cyclist practices. This campaign should be implemented at schools and can be incorporated through:

- organizing theme days to encourage certain colours, such as Wear Orange Day;
- supplying reflective materials; and,
- providing brochures to parents and students.

6.0 IMPLEMENTATION OF THE COMPREHENSIVE ROAD SAFETY STRATEGY

The Comprehensive Road Safety Strategy is based on three approaches to improving traffic safety:

- *Engineering*, including transportation planning, design, operations, and maintenance;
- *Education*, aimed at improving behaviour safety issues among all road users; and,
- *Enforcement* of traffic laws and bylaws by police and bylaw-enforcement staff.

6.1 Short-Term Improvements

The short-term improvements that can be considered for implementation are summarized in TABLE 6.1. These strategies are more easily implemented, have lower associated cost, and are generally intersection-specific.

6.2 Medium-Term Improvements

The medium-term improvements that can be considered for implementation are summarized in TABLE 6.2. Unlike the short-term strategies, these strategies are generally District-wide and have higher associated costs.

6.3 Long-Term Improvements

The long-term improvements that can be considered for implementation are summarized in TABLE 6.3. These strategies generally represent ongoing efforts the District can continue to implement in the future.

TABLE 6.1 SHORT-TERM STRATEGIES

Solution Strategy	Aligned with Existing Initiatives:			Funding maybe Available From:				Reduces Crash Risk for:				Comments
	District's Capital Improvement Program	ICBC Road Safety Initiatives	Police Enforcement Initiatives	Internal	ICBC	TransLink	Provincial Government Programs	Motor Vehicles	Pedestrians	Cyclists	Transit	
Signals												
Left-turn signal phasing												• Priority should be given to intersections with existing left-turn lanes. Split or advanced phasing can be considered where left-turn lanes are not provided. • Study can be conducted to identify locations where left-turn phasing and left-turn lanes are needed throughout the District.
Upgrade signal displays												• Measures may include: ○ Increasing the number of signal heads for multi-lane roadways ○ Improving the visibility of individual signal heads (larger lenses, LED displays, reflective backplates)
Review clearance intervals												• In the long-term, develop policy and/or review existing policy • On truck routes, clearance intervals should take into consideration the braking ability for trucks • In commercial areas and on school routes, clearance intervals should account for pedestrian walking speeds
Traffic Control												
Review/ upgrade traffic control device												• Signal warrants should be reviewed
restricted turning movements												• Ensure signage of restrictions are clear and conspicuous
Zoning and Maintenance												
Clearance of sight triangle obstruction												• Foliage should be maintained to ensure that sight triangles are not obstructed • Parking should be clear of intersections and crosswalks, and can be implemented by signage, pavement marking, and channelization • Policy should be developed regarding sightline obstructions on private property
Pavement												
Repavement												• Review pavement conditions and repave roads as needed with consideration for anti-skid treatment

TABLE 6.2 MEDIUM-TERM IMPROVEMENT STRATEGIES

Solution Strategy	Aligned with Existing Initiatives:			Funding maybe Available From				Reduces Crash Risk for:				Comments
	District's Capital Improvement Program	ICBC Road Safety Initiatives	Police Enforcement Initiatives	Internal	ICBC	TransLink	Provincial Government Programs	Motor Vehicles	Pedestrians	Cyclists	Transit	
Signing/Guidance												
Signing and pavement marking improvement												• Bus lanes should be signed with lane warning signs • Designated bicycle routes should have bicycle stencil marking and "share the road" signs • Measures may include: ○ Highly-reflective sign sheeting and markings ○ Use of Clearview font on street-name and other guide signs • Program to document maintenance should be in place
Pedestrians												
Complete pedestrian network												• Sidewalks should be provided on both sides of the roadway on arterial and collector roads • Local roads should have sidewalks on at least one-side of the roadway • Follow District's Pedestrian Master Plan
Geometry												
Modified right-turn lanes												• Collisions should be reviewed to identify locations with safety issues

TABLE 6.3 LONG-TERM IMPROVEMENT STRATEGIES

Solution Strategy	Aligned with Existing Initiatives:			Funding maybe Available From:				Reduces Crash Risk for:				Comments
	District's Capital Improvement Program	ICBC Road Safety Initiatives	Police Enforcement Initiatives	Internal	ICBC	TransLink	Provincial Government Programs	Motor Vehicles	Pedestrians	Cyclists	Transit	
Policy/Planning												
Review Bylaws												• Specific needs associated with: o Trucking restrictions; o Cycling on sidewalks; and, o Location and/or restriction of parking.
Cyclists												
Complete Cycling Network												• Areas circled in red on the map indicate zones of caution • Areas highlighted in blue should be considered for cycling infrastructure improvements
Traffic Control												
Traffic Calming												• Traffic study should be conducted on surrounding streets to evaluate impacts of proposed traffic calming devices • Affected property owners and neighbourhood groups and other stakeholders should be contacted for early involvement
Enforcement												
Enforcement												• Continued support for Police enforcement and education initiatives and programs • Consultation with Police regarding equipment needs for enforcement

6.4 Ongoing Data Needs

For the long-term sustainability of the District's safety program, a structured data management program is necessary. A data management program enables the collection, processing, and dissemination of the information that is necessary to monitor the effectiveness of the District's safety program and establish eligibility for safety-related funding.

The essential requirements are collision data and traffic volumes.

- *Collision Data:* In British Columbia, raw collision data (based on insurance claims) is available to municipalities through the Business Information Warehouse branch at ICBC. The claims data is restricted to collisions involving motor vehicles, and does not reflect crashes that do not involve and insured vehicle, including those involving only pedestrians and/or cyclists. The claims database is unfiltered and must typically be reviewed to remove duplicate reports and non-relevant reports, such as those resulting from vandalism or collision occurring in off-street parking lots. The claims data enables the user to identify the date time, type, and severity of collision.

- *Traffic Volumes:* Traffic volume data is typically available to the District from various sources, including traffic impact assessments Ministry counts, and municipal counts. The data management system may include a repository of volume counts or forecast, including source, date, and type (such as intersection turning movement counts, link counts, forecast volumes or pedestrian counts).

In addition to these essential data requirements, the data management system can also include the following data that can assist in the evaluation of safety initiatives:

- traffic volumes
- speed surveys
- summaries of police citations (especially for speeding, red-light, and signing violations)
- travel time surveys
- pedestrian and bicycle counts
- infrastructure inventories (such as pedestrian and bicycle facility inventories or sign inventories).

The application of the above information can be integrated into the District's GIS system.

APPENDIX A

RESULTS OF PUBLIC SURVEY AND STAKEHOLDER CONSULTATION

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APPENDIX A
RESULTS OF PUBLIC SURVEY AND STAKEHOLDER CONSULTATION

Affiliation with the District of North Vancouver

Respondents were asked to indicate their affiliation(s) with the District of North Vancouver. Multiple answers were permitted for this question. As shown in FIGURE A-1, almost all respondents were residents of the District of North Vancouver.

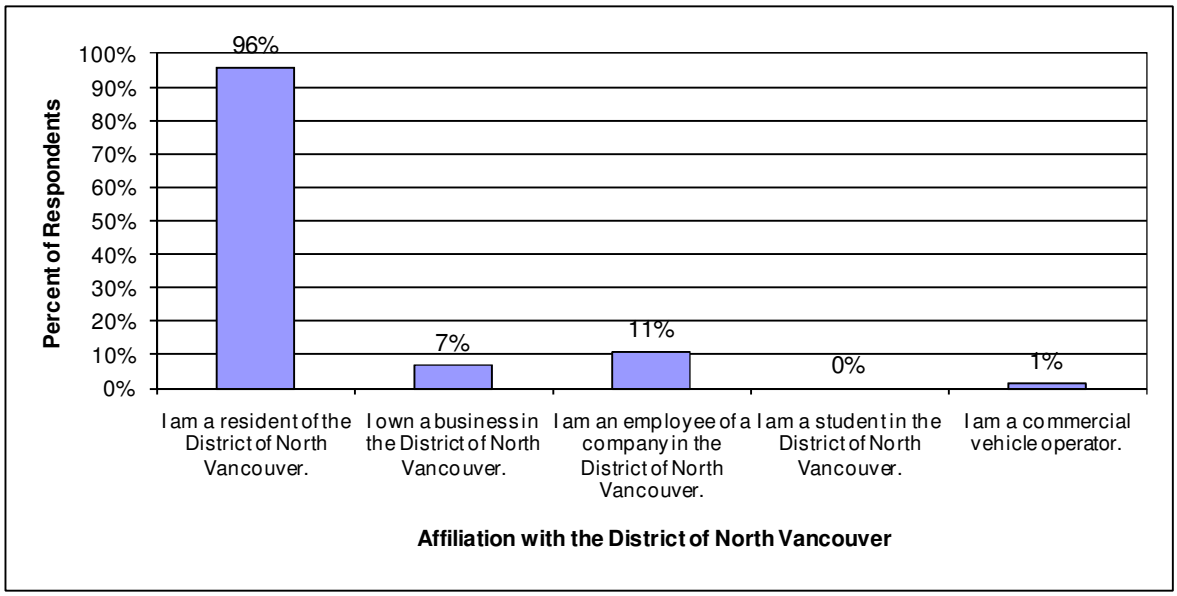

FIGURE A-1 RESPONDENT'S AFFILIATION WITH THE DISTRICT OF NORTH VANCOUVER

Mode

Respondents were also asked to indicate the mode(s) they identified with. Multiple answers were permitted for this question. Of the respondents, 97 percent are drivers, 91 percent are pedestrians, and 46 percent are cyclists. 33 percent of respondents use transit. Complete results are shown in FIGURE A-2.

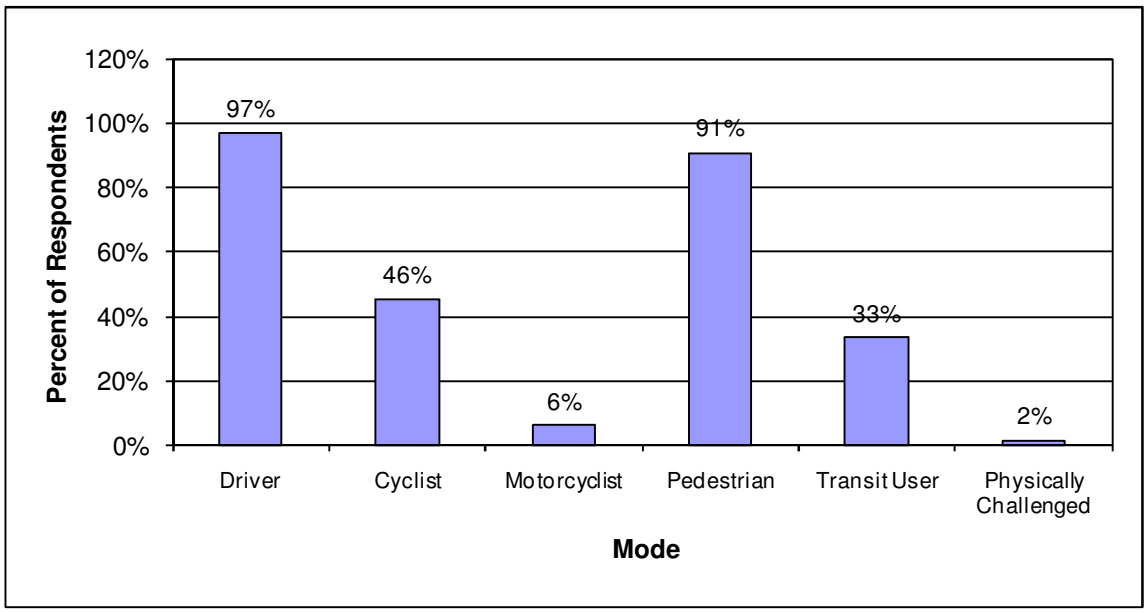

FIGURE A-2 RESPONDENTS BY MODE

Respondents were asked to indicate any specific concerns they had related to the following in the District of North Vancouver:

- pedestrian facilities;
- cyclist facilities;
- transit facilities;
- signalized intersections;
- stop-controlled intersections;
- other roadway characteristics;
- school-related activities; and
- commercial traffic.

Individual responses were read and patterns were identified. Findings for each category are discussed below.

Pedestrian Facilities

A total of 31 respondents provided pedestrian facility related concerns. As shown in FIGURE A-3, the majority of respondents felt that the District should improve existing sidewalks and crosswalks, and provide more sidewalks and crosswalks. Recurring specific comments regarding sidewalks included a lack of sidewalks on side streets, and sidewalks being too narrow. Crosswalk conspicuousness was a recurring specific concern regarding crosswalks.

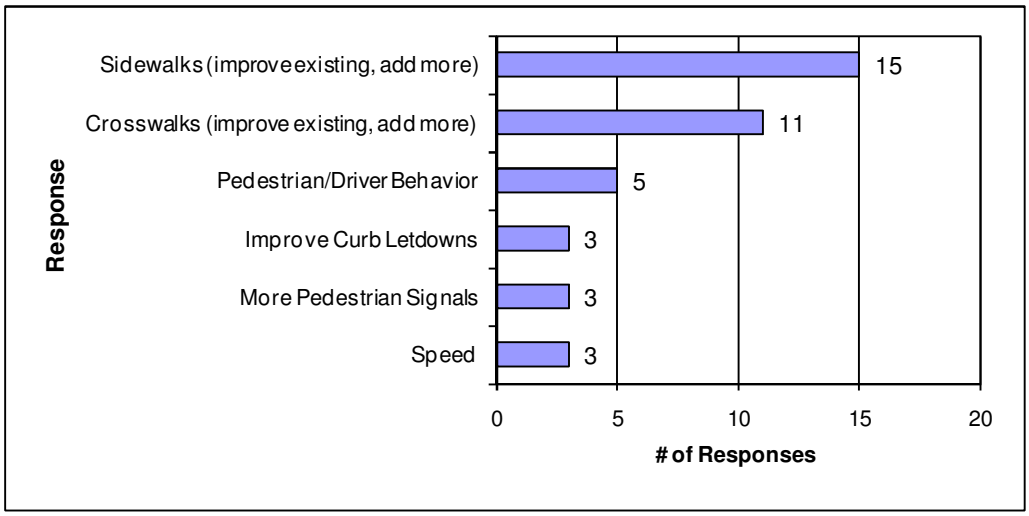

FIGURE A-3 PEDESTRIAN FACILITY CONCERNS

Cyclist Facilities

34 respondents provided comments on safety concerns for cyclist facilities in the District. The majority of respondents felt that the District should improve existing, and provide more bike lanes. A major concern related to bike lanes was adequate separation between vehicle and bicycle traffic on roads. Respondents also noted that potential hazards existed because cyclists do not follow the rules of the road and drivers do not respect, or are often impatient with cyclist on the road. FIGURE A-4 displays major cyclist road safety concerns identified.

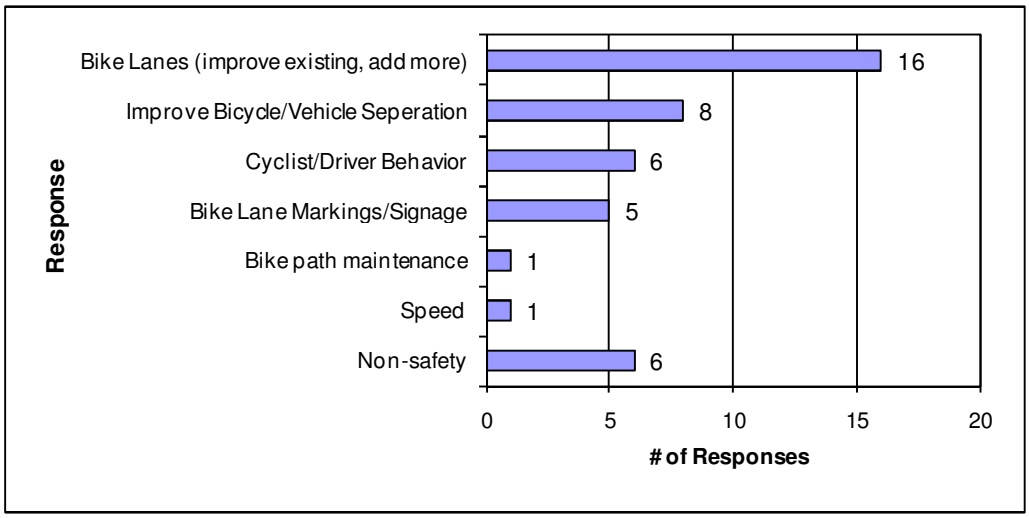

FIGURE A-4 CYCLIST FACILITY CONCERNS

Transit Facilities

23 respondents had comments related to transit facilities. The most common concern was poor pedestrian connections or accessibility to transit facilities (i.e. bus stops). A large portion of the responses were not safety related and had to do with operational suggestions. Four respondents indicated that they felt transit service/facilities to be adequate; those four responses were omitted from this analysis. Specific transit facility related concerns are shown in FIGURE A-5.

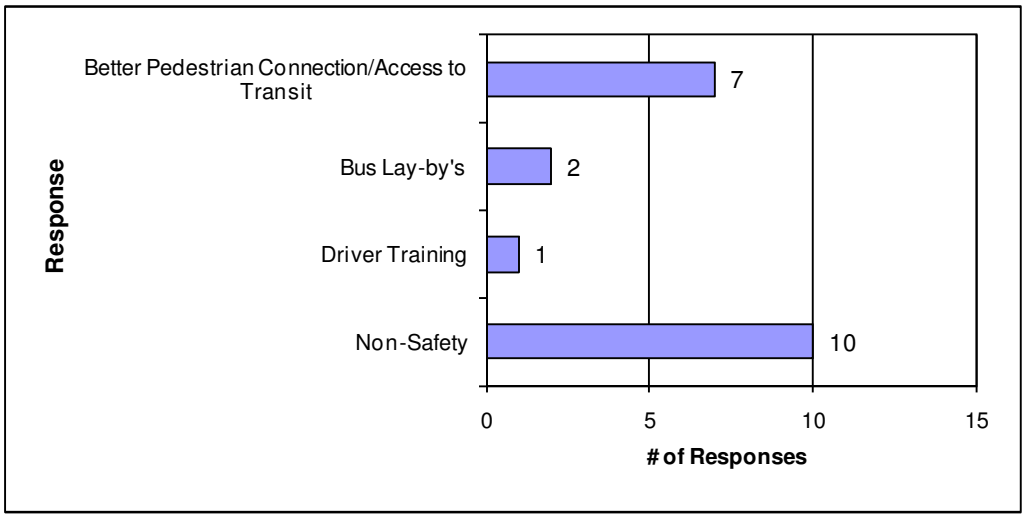

FIGURE A-5 TRANSIT FACILITY CONCERNS

Signalized Intersections

31 respondents indicated concerns they had regarding signalized intersections. The top concerns indicated were a lack of adequate pedestrian/cyclist accommodations (i.e. crosswalks, traffic light controls) at intersections, and poor pavement markings or signage at intersections. Complete results are shown in FIGURE A-6.

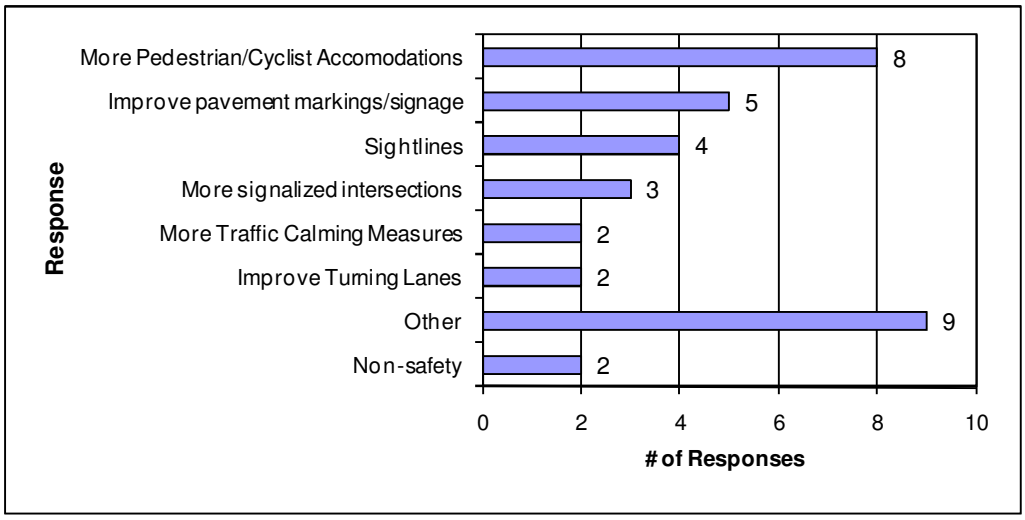

FIGURE A-6 SIGNALIZED INTERSECTION CONCERNS

Stop-controlled Intersections

23 respondents provided concerns they had regarding stop-controlled intersections. The top concerns were inconspicuous pavement markings or signage at intersections and obstructed sightlines caused by parked cars or vegetation. Some respondents indicated that they preferred traffic circles (a traffic calming measure) to traditional four-way stops. Complete results are shown in FIGURE A-7.

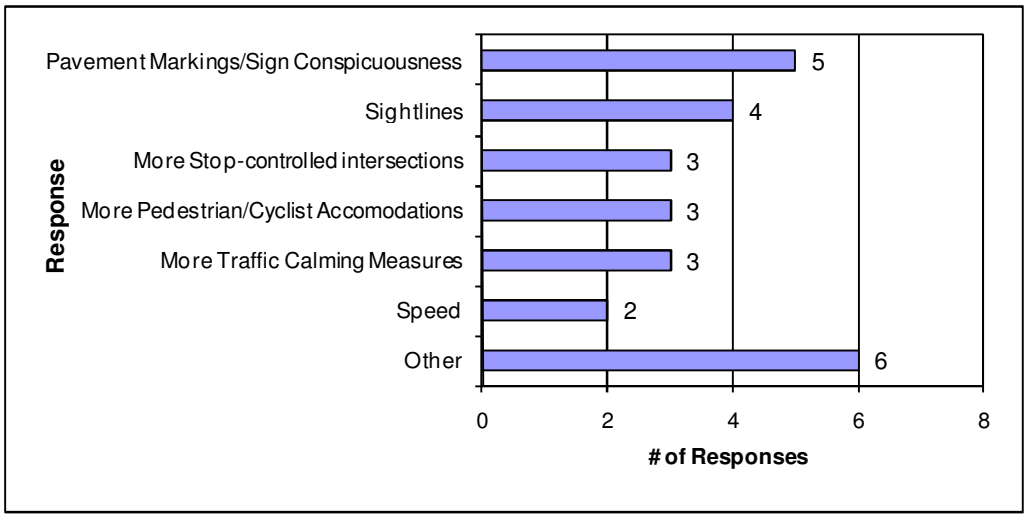

FIGURE A-7 STOP-CONTROLLED INTERSECTION CONCERNS

Other Roadway Characteristics

29 respondents identified concerns they had regarding other roadway characteristics in the District. Highway (Trans-Canada Highway) on-ramps were the most commonly mentioned concern, as respondents generally felt that on-ramps were too short and made for dangerous merges. Speed on District roads was a common concern, as well as on-street parking that respondents generally felt was excessive. Roadway characteristic concerns are displayed in FIGURE A-8.

FIGURE A-8 OTHER ROADWAY CHARACTERISTIC CONCERNS

School-related Activities

22 respondents provided concerns related to school drop-off and pick-up and school zones. The top concerns were congestion in school zones during drop-off and pick-up times, and drivers constantly ignoring speed limits in school zones. Other major concerns identified were aggressive or inattentive drivers, inattentive pedestrians, and poor access in and out of school drop-off areas; these concerns may also be contributing factors to school zone congestion. One notable response indicating speeding through school zones as the major concern mentioned that school zone speed limits on major streets (e.g. Mountain Highway) have excessive in-effect hours and are impractical, leading them to be widely ignored. Complete results are shown in FIGURE A-9.

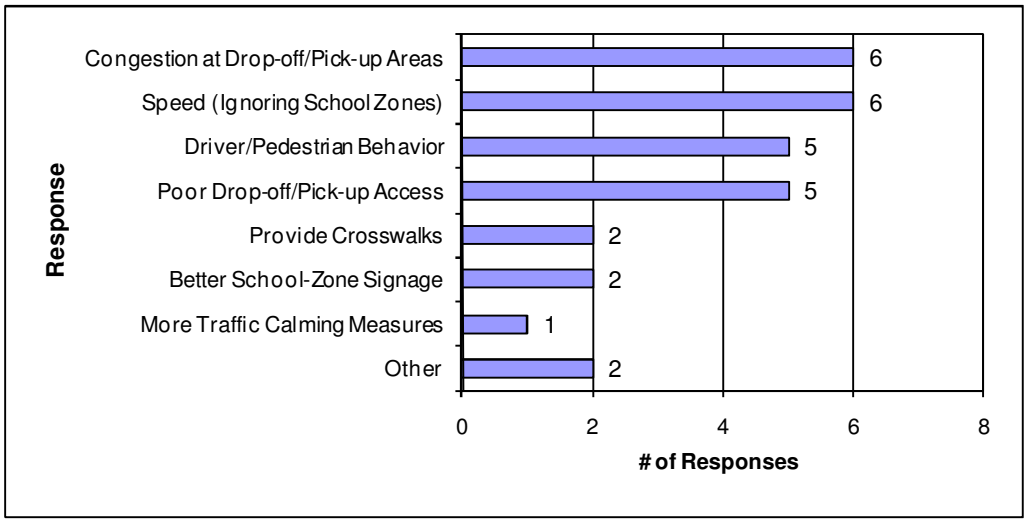

FIGURE A-9 SCHOOL-RELATED CONCERNS

Commercial Traffic

13 respondents provided concerns related to commercial traffic in the District. The speed of commercial traffic vehicles was the top concern. Following speed, respondents felt that commercial traffic volume on District roads was too high. Complete results are shown in FIGURE A-10.

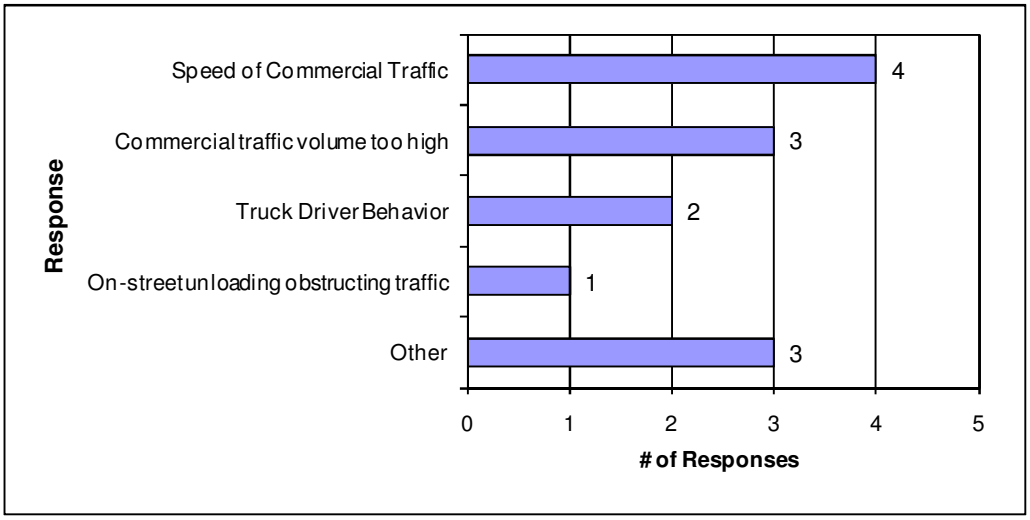

FIGURE A-10 COMMERCIAL TRAFFIC CONCERNS

APPENDIX B

AREAS USED FOR LOCAL ROADS REVIEW

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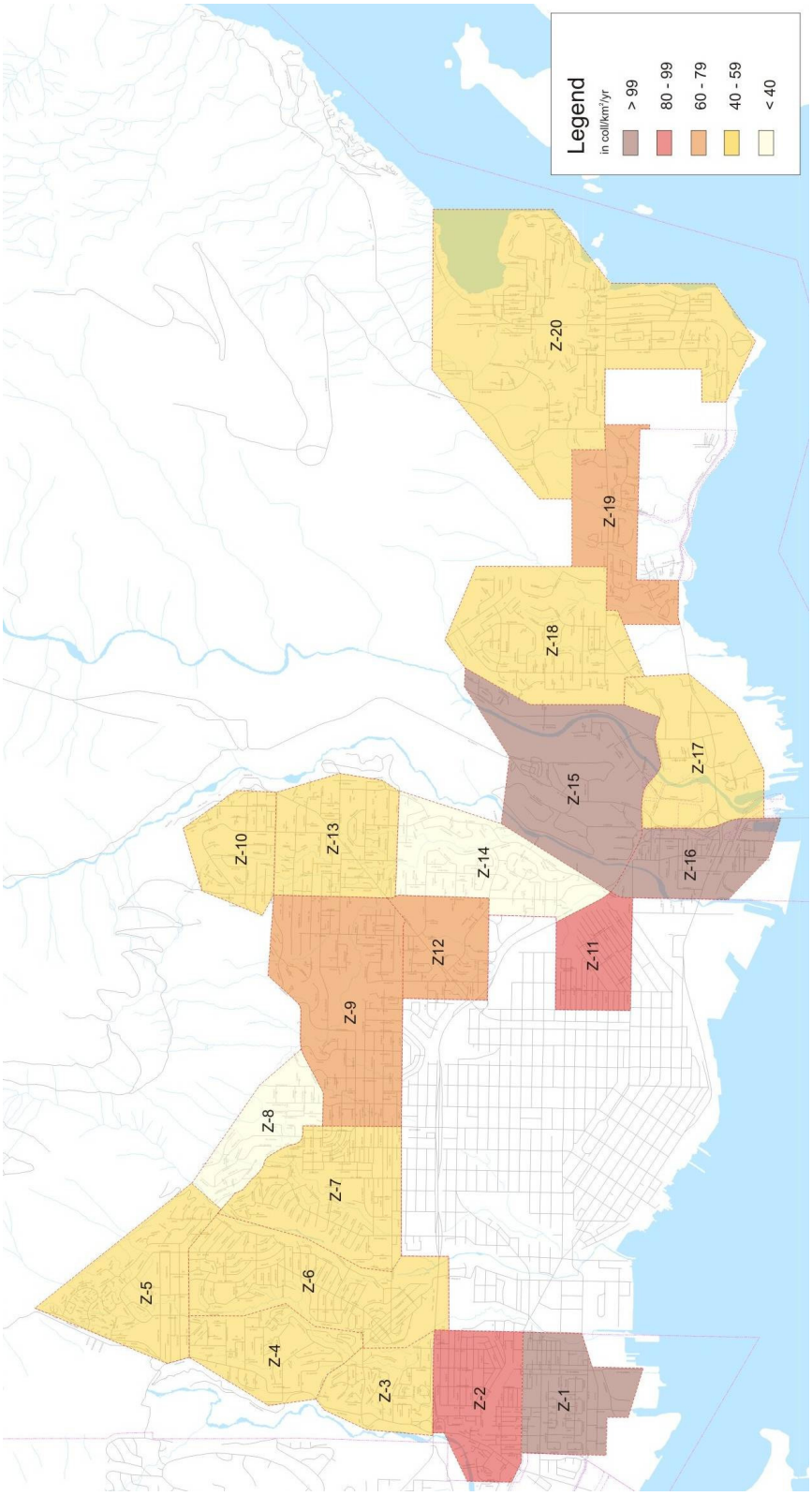

FIGURE B-1 AREAS USED FOR LOCAL ROADS REVIEW

TABLE B-1 LOCAL ROAD COLLISION FREQUENCY LOCATIONS BY ZONE

ZONE	APPROXIMATE NEIGHBOURHOOD*	COLLISIONS PER YEAR	ANNUAL COLLISION RATE (coll/km^2/yr)
1	Norgate	106.9	117.4
15	Seymour	152.4	104.4
16	Lynnmour	87.6	104.3
2	Pemberton Heights	117.3	92.4
11	Keith Lynn	63.8	84.0
12	Lynn Valley	70.1	72.1
9	North Lonsdale	188.0	67.7
19	Windsor Park	57.5	62.6
17	Maplewood	62.1	53.1
6	Forest Hills/Edgemont Village	85.9	47.4
13	Lynn Creek	74.1	46.7
7	Delbrook	81.9	46.5
18	Seymour Heights	78.5	46.5
10	Upper Lynn	41.1	45.2
4	Canyon Heights	47.4	44.1
20	Deep Cove	168.2	44.0
5	Cleveland Park	69.1	40.5
3	Lionsview (Lions Gate)	33.7	40.1
14	Arborlynn	59.4	22.0
8	Kirkstone	38.1	20.7
TOTAL		1683.2	54.6 (average)

* Neighbourhood name given indicates the approximate location of the zone and is not necessarily the neighbourhood boundary as defined by the District

APPENDIX C

SITE OBSERVATION DETAILS

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APPENDIX C
SITE OBSERVATIONS AND COLLISION DETAILS

C-1 Marine Drive Corridor

General Corridor Characteristics

Marine Drive from Capilano Road to Lloyd Avenue is an important east-west corridor for not only the District, but also as access for the District of West Vancouver and the City of North Vancouver. It is a vital thoroughfare for passenger vehicles, buses, cyclists, and with the exception of the Trans-Canada Highway to the north, has the highest east-west traffic volumes in the North Shore communities.

The corridor also provides access to Downtown via the Lions Gate Bridge to the west and the Trans Canada Highway via Capilano Road to the north. As such, the corridor periodically experiences delays due to higher volumes during the morning and afternoon peak periods. Recent traffic volumes along the signalized intersections are shown in TABLE C-1, and indicate that the peak direction of traffic is typically westbound during the morning and eastbound during the afternoon.

TABLE C-1 MARINE DRIVE INTERSECTION TURNING MOVEMENT COUNTS

INTERSECTION	WEEKDAY PEAK PERIOD	TURNING MOVEMENT											
		Eastbound			Westbound			Northbound			Southbound		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Marine Dr. and Capilano Rd.	Morning	265	625	145	20	840	60	35	130	15	80	90	880
	Afternoon	1,250	1,050	175	55	810	230	170	310	65	110	95	655
Marine Dr. and Garden Ave.	Morning	30	945	20	15	840	85	50	35	20	165	35	45
	Afternoon	80	1,235	35	35	1,165	315	50	35	25	185	40	40
Marine Dr. and Tatlow Ave.	Morning	15	930	40	30	900	15	35	10	45	5	5	10
	Afternoon	5	1,250	65	35	1,315	10	40	5	35	5	5	15
Marine Dr. and Philip Ave.	Morning	10	985	45	5	860	30	60	5	105	35	10	20
	Afternoon	20	1,210	65	180	1,265	45	95	15	140	40	15	20
Marine Dr. and Bridgman Ave.	Morning	65	810	15	25	805	35	10	5	25	30	5	40
	Afternoon	180	1,105	40	75	985	25	70	10	80	85	10	155
Marine Dr. and Pemberton Ave.	Morning	25	810	105	285	965	60	100	40	130	90	35	15
	Afternoon	55	1,110	105	215	1,340	145	185	80	110	175	35	35
Marine Dr. and Lloyd Ave.	Morning	25	900	50	135	1,225	15	25	15	65	110	30	40
	Afternoon	85	1,560	45	75	1,255	10	85	35	195	70	40	40

In general, land use through the section is commercial, with residential areas immediately to the north and south. Due to the commercial activity, in addition to its role as a major transit route, there are a relatively high number of pedestrians along this portion of Marine Drive.

As summarized in the overall District collision analysis, the major findings indicated relatively high collision frequencies at several intersections along Marine Drive Corridor from Capilano Road to Lloyd Avenue. There were also relatively high pedestrian and cyclist collision frequencies, especially west of Pemberton Avenue. Individual intersection collision diagrams were also prepared and are shown in FIGURES C-1 through C-7. Further analysis also indicates that there are site-specific issues at the Pemberton Avenue and the Capilano Road intersections. These are described in the following sections.

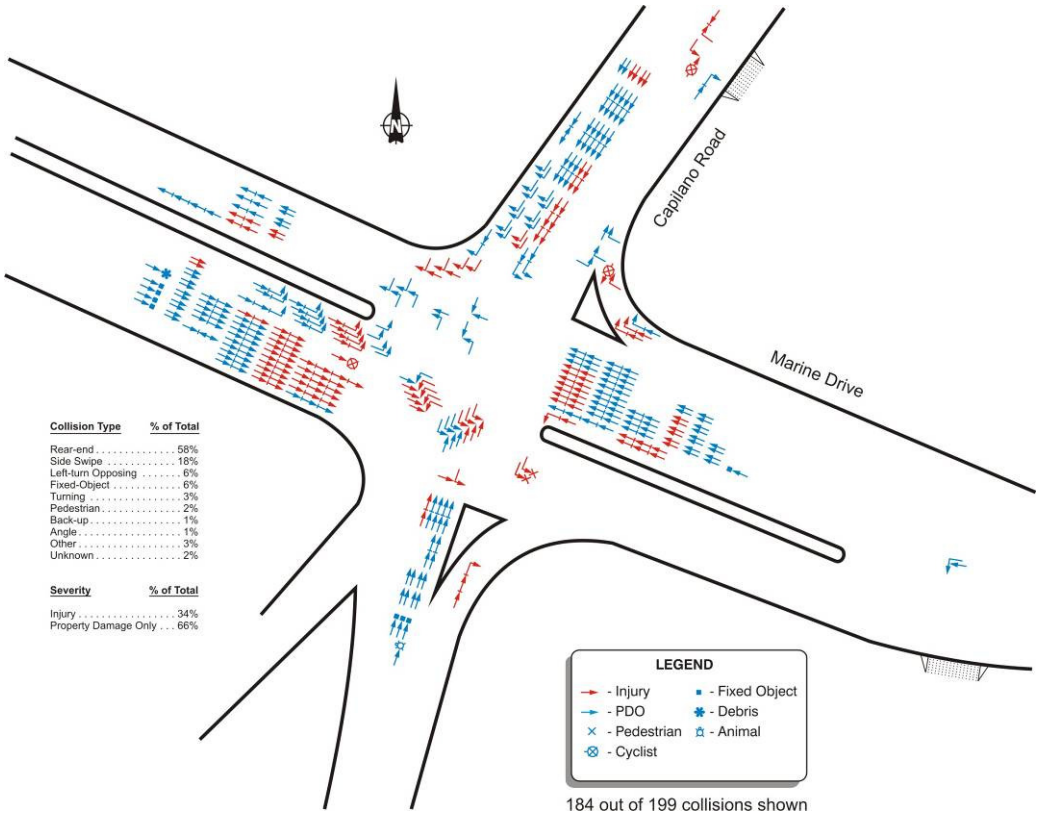


FIGURE C-1 CAPILANO ROAD INTERSECTION COLLISION DIAGRAM

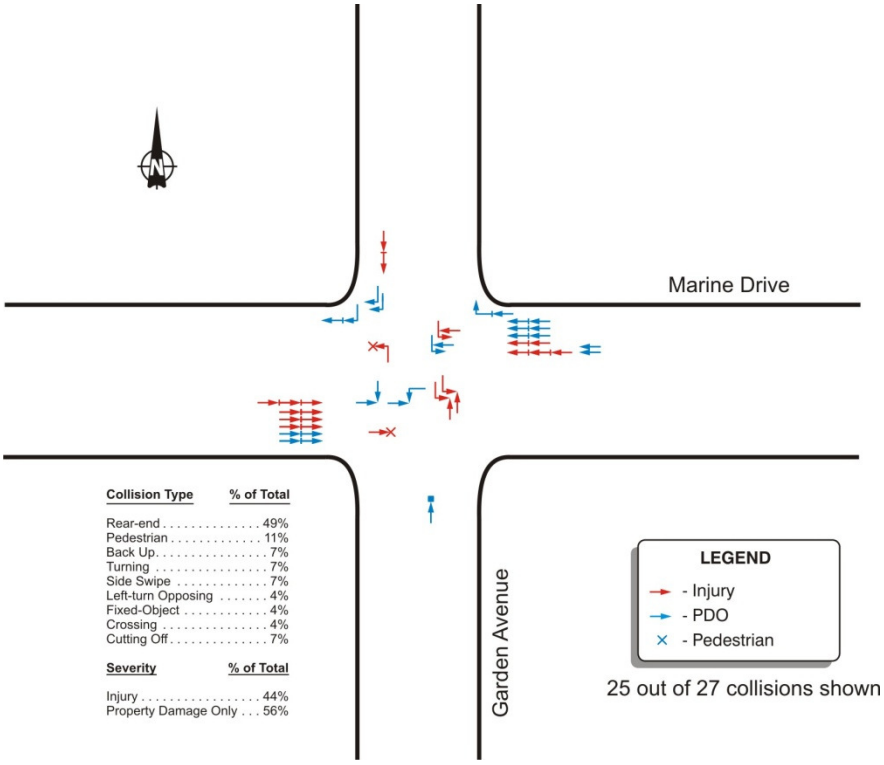


FIGURE C-2 GARDEN AVENUE INTERSECTION COLLISION DIAGRAM

FIGURE C-3 TATLOW AVENUE INTERSECTION COLLISION DIAGRAM

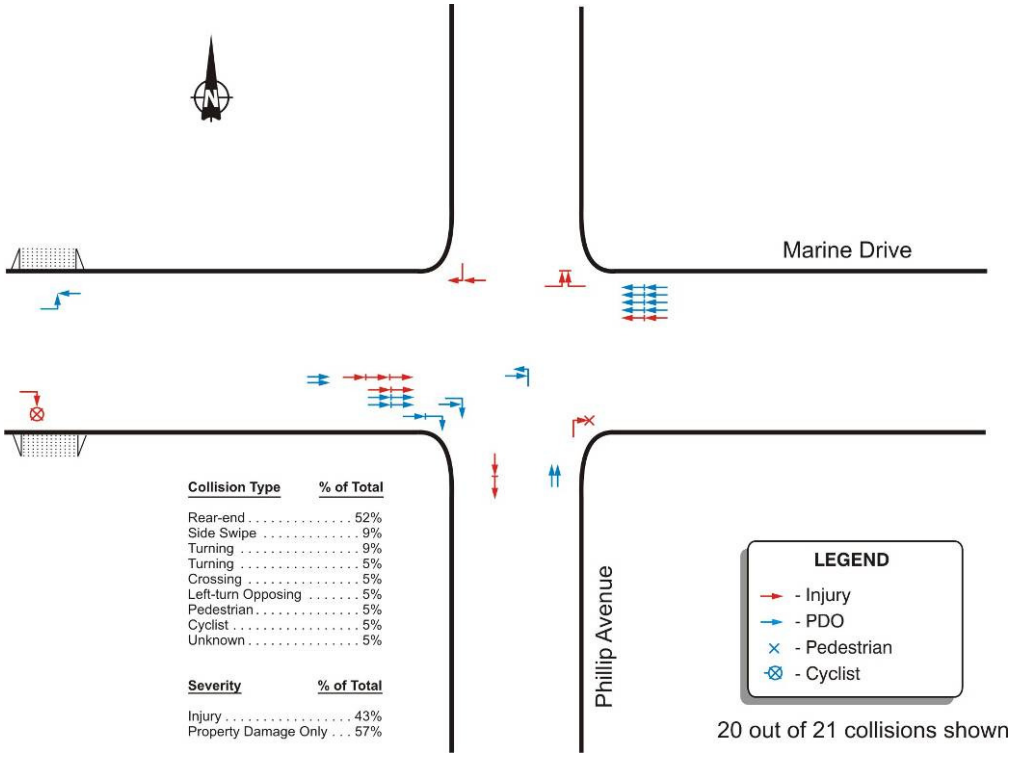


FIGURE C-4 PHILIP AVENUE INTERSECTION COLLISION DIAGRAM

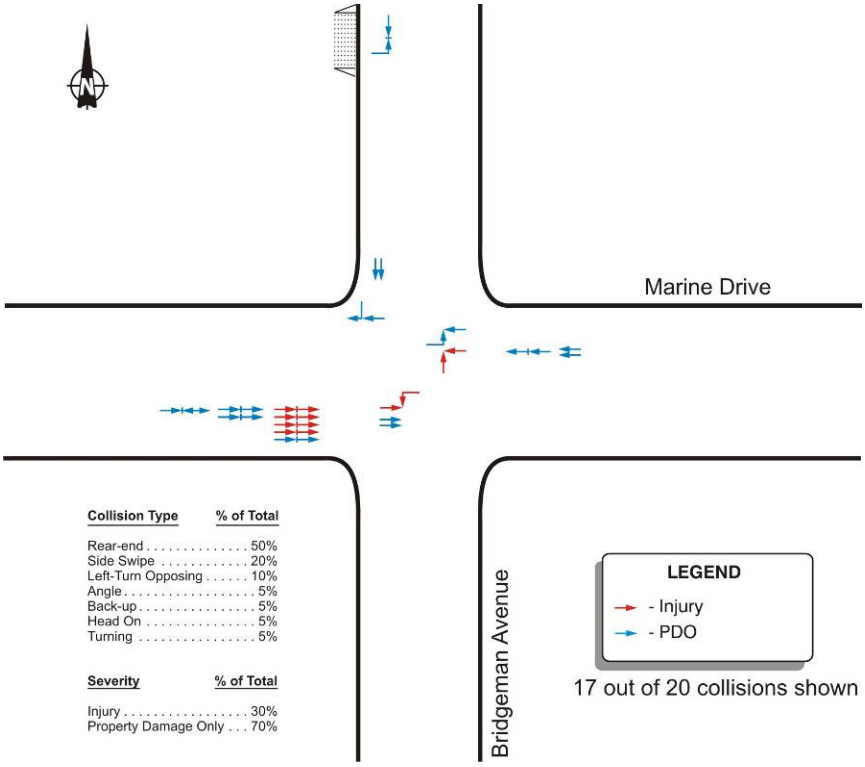


FIGURE C-5 BRIDGMAN AVENUE INTERSECTION COLLISION DIAGRAM

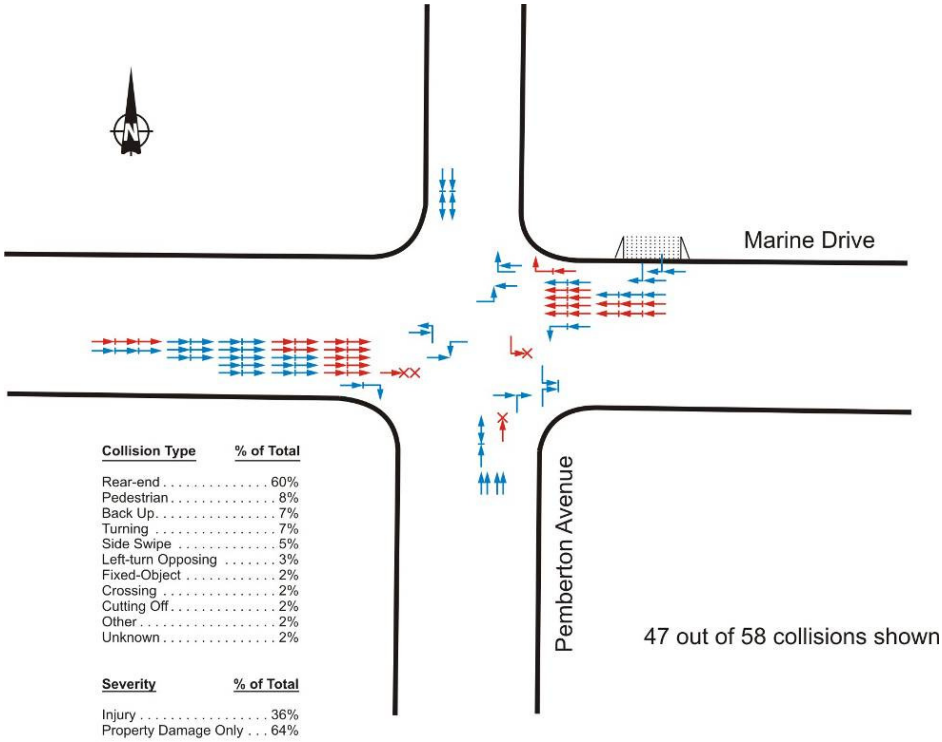


FIGURE C-6 PEMBERTON AVE INTERSECTION COLLISION DIAGRAM

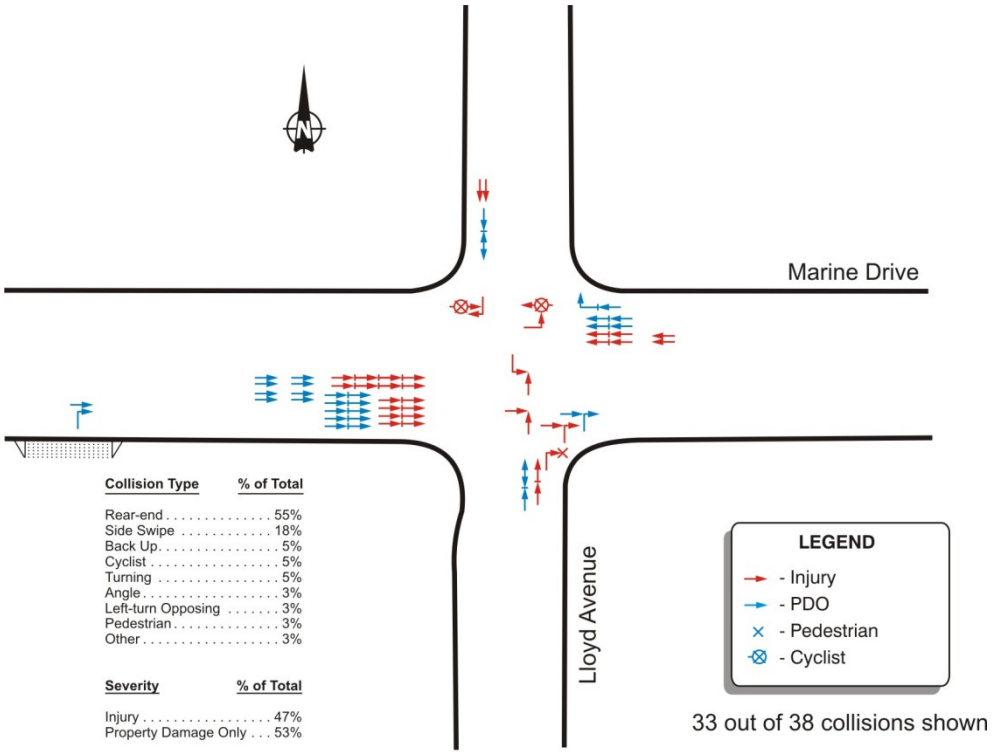


FIGURE C-7 LLOYD AVE INTERSECTION COLLISION DIAGRAM

A site visit was performed on Wednesday, June 17, 2009. A review of the observed characteristics along the corridor is summarized in TABLE C-2.

TABLE C-2 SUMMARY OF OBSERVATIONS – MARINE DRIVE CORRIDOR

	▪ Crosswalks at intersection were as narrow as 2.1 metres wide, which is less than the 2.5 metres suggested by TAC. ▪ Crosswalks were generally faded at intersections. ▪ Sidewalks were as narrow 1.4 metres wide, which is considered narrow for urban commercial areas. ▪ Letdowns were sometimes located where a pedestrian using them would require them to enter the roadway off the crosswalk. ▪ All of the above makes pedestrians less conspicuous and decreases pedestrian comfort. ▪ Pedestrian jaywalking was observed.
	▪ A high number of cyclists were observed along Marine Drive. With travel lanes of about 3.5 metres, motorists typically try to pass the cyclists without changing lanes. However, the lane width is too narrow for shared lane use.

	▪ There are numerous driveways along Marine Drive and close to the intersection. The driveways, in conjunction with heavy turning movement volumes can result in unexpected manoeuvres.

Based on the collision analysis in conjunction with the site visit, the following safety issues were identified:

- The relatively high number of pedestrians increases the pedestrian exposure to vehicles and increasing the likelihood of pedestrian-related collisions. The relatively narrow marked crosswalks and sidewalk letdowns further exacerbate pedestrian safety concerns.
- Narrow sidewalks do not specifically appear to be contributing to the pedestrian collisions. However, the narrow sidewalks when they are immediately adjacent to the travel lanes have a potentially high discomfort level. As well, narrow sidewalks could reduce mobility for pedestrians in wheelchairs.
- The lanes are considered narrow for a combined cyclist-vehicle use. This results in bicycle collisions where a vehicle sideswipes a cyclist, or another vehicle while avoiding a cyclist. Along locations with on-street parking, this also increases the likelihood of collisions with opening vehicle doors.

The overall analysis indicates that there is not a single contributing cause for the pedestrian collisions, but that they may be a result of various small issues, such as narrow facilities and pedestrian inconspicuity. High pedestrian demand, as well as unsafe pedestrian and driver behaviour exacerbates the collision risk.

Capilano Road Intersection Characteristics

The Marine Drive and Capilano Road intersection is a major junction in the District, and the intersection with the highest turning movement volumes. Similar to the rest of the Marine Drive corridor, land use through the section is commercial with residential areas surrounding the intersection.

The intersection features multiple lanes for the southbound right-turn and the eastbound left-turn movements. The intersection also features northbound and westbound channelized right-turn lanes, which was identified in the collision analysis as a potential collision issue. There is a gas station on the northeast quadrant of the intersection with driveways relatively close to the intersection.

The intersection collision diagram was prepared and was shown in FIGURE C-1. A site visit was performed on Wednesday, June 17, 2009. A review of the observed characteristics at the intersection is summarized in TABLE C-3.

TABLE C-3 SUMMARY OF OBSERVATIONS – CAPILANO ROAD INTERSECTION

	▪ Southbound right-turn lanes appear to be to narrow, with passenger vehicles observed to encroach into the adjacent lanes. The issue is worse when larger heavy vehicles make the turn, and is exacerbated with the relatively heavy right-turn volumes. Further review of the lane layout indicates that vehicles larger than a passenger vehicle would need to encroach into the adjacent lane to complete the turn.

	▪ Eastbound left-turn lanes appear to be tight, with passenger vehicles observed to encroach into the adjacent lanes. Vehicles were also observed to follow each other closely. When a vehicle slows unexpectedly (such as when entering the gas station on the northeast quadrant), heavy braking and rear-end conflicts were observed. The issue is exacerbated with the relatively heavy left-turn volumes.
	▪ The southbound left-turn and through lane can encounter long delays due to lack of a designated left-turning lane, heavy northbound through volumes, and lack of a southbound protected left-turn phase. Southbound through vehicles were observed to use the right-turn lane to circumvent the queues. The delays may result in impatient motorists and risk-taking manoeuvres. ▪ The skew of the north/south legs decrease visibility of opposing through vehicles for northbound left-turning vehicles when southbound through vehicles use the right-turn lane. This may result in southbound sideswiping and left-turn opposing conflicts.
	▪ The northbound approach is wide without pavement markings to guide motorists to where they should manoeuvre their vehicles. This is worsened with angle parking on the southwest quadrant. The lack of guidance can result in sideswipe conflicts. ▪ The lack of positive guidance may also confuse southbound left-turning motorists as to whether a northbound vehicle is turning left or driving through, and may result in left-turn opposing conflicts.

	▪ The heavy landscaping shrubbery on the east leg, in combination with the horizontal curve, may reduce sight distances to queued vehicles or jaywalking pedestrians. This may result in rear-end and pedestrian collisions.
	▪ Crosswalks at intersection were about 2.1 to 2.5 metres wide, which is less than the 2.5 metres suggested by TAC. Crosswalks were generally faded at the intersection. ▪ Some sidewalks were about 1.5 metres wide, which is considered narrow for urban commercial areas. TAC suggests a width of 2.0 – 3.5 metres for urban commercial areas. ▪ The eastbound right-turn channelized lane with YIELD control typically results in drivers looking for gaps in the northbound through or eastbound left-turn traffic to the left while needing to be wary of stopped vehicles on the right-turn lane in front. The divergent directions of attention results in rear-end conflicts on the right-turn lane.

Based on the collision analysis in conjunction with the site visit (and in addition to identified corridor-wide issues), the following safety issues were identified:

- The design of the southbound right-turn lanes and the eastbound left-turn lanes is tight for passenger vehicles, and too narrow for larger vehicles, resulting in frequent lane encroachment. This results in sideswipe collisions on the turn lanes.
- Due to the workload in watching for gaps in traffic and queued westbound right-turn vehicles, drivers on the eastbound right-turn lane are prone to rear-end collisions and conflicts.

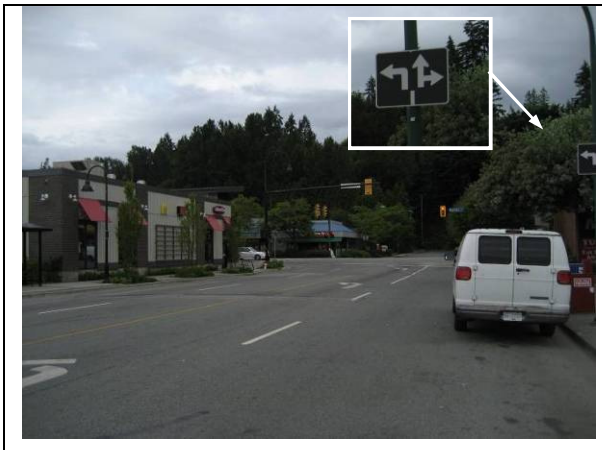
- Delays on the southbound approach during the afternoon peak period results in queuing and delays for the southbound left-turn and through movements. This in turn results in rear-end, left-turn opposing, and weaving on the approach.
- The southbound and northbound approaches are at an angle to each other and are resulting in left-turn opposing and secondary rear-end collisions.

Pemberton Avenue Intersection Characteristics

The Marine Drive and Pemberton Avenue intersection is an important junction to industrial areas to the south. Similar to the rest of the Marine Drive corridor, land use through the section is commercial. As such, the northbound lane approach is generally wide to accommodate larger vehicles.

The intersection collision diagram was prepared and was shown in FIGURE C-6. A site visit was performed on Wednesday, June 17, 2009. A review of the observed characteristics at the intersection not already identified as a corridor-wide issue is summarized in TABLE C-4.

TABLE C-4 SUMMARY OF OBSERVATIONS – CAPILANO ROAD INTERSECTION

	▪ Pemberton Avenue south of Marine Drive is generally wide, and provides access to industrial areas to the south for heavy vehicles. However, vehicle speeds were observed to be generally high. ▪ When there are vehicles parked along the northbound approach, the right-most travel lane is relatively narrow and may result in northbound vehicles on that lane encroaching onto the adjacent travel lane to the left. ▪ Other than a roadside sign and pavement arrows, there is no indication that the left-most travel lane becomes a left-turn lane and may result in sudden lane changing.

The collision analysis indicated sideswipe issues on the northbound approach. Based on the collision analysis in conjunction with the site visit (and in addition to identified corridor-wide issues), there are issues related to confusion to lane use and results in lane encroachment and sideswipe collisions.

C-2 Capilano Road Corridor

General Corridor Characteristics

Capilano Road north of Marine Drive provides vital access to the TransCanada Highway, as well as Grouse Mountain and the Capilano Suspension Bridge to the north. It is thus a heavily-used north-south thoroughfare for passenger vehicle, buses, and cyclists. As such, the corridor periodically experiences delays due to higher volumes during the morning and afternoon peak periods. Recent traffic volumes along the signalized intersections are shown in TABLE C-1, and indicate that the peak direction of traffic is typically westbound during the morning and eastbound during the afternoon.

As summarized in the overall District collision analysis, the major findings indicated relatively high collision frequencies at several intersections along Capilano Road. Individual intersection collision diagrams were also prepared and are shown in FIGURES B-8 through B-11.

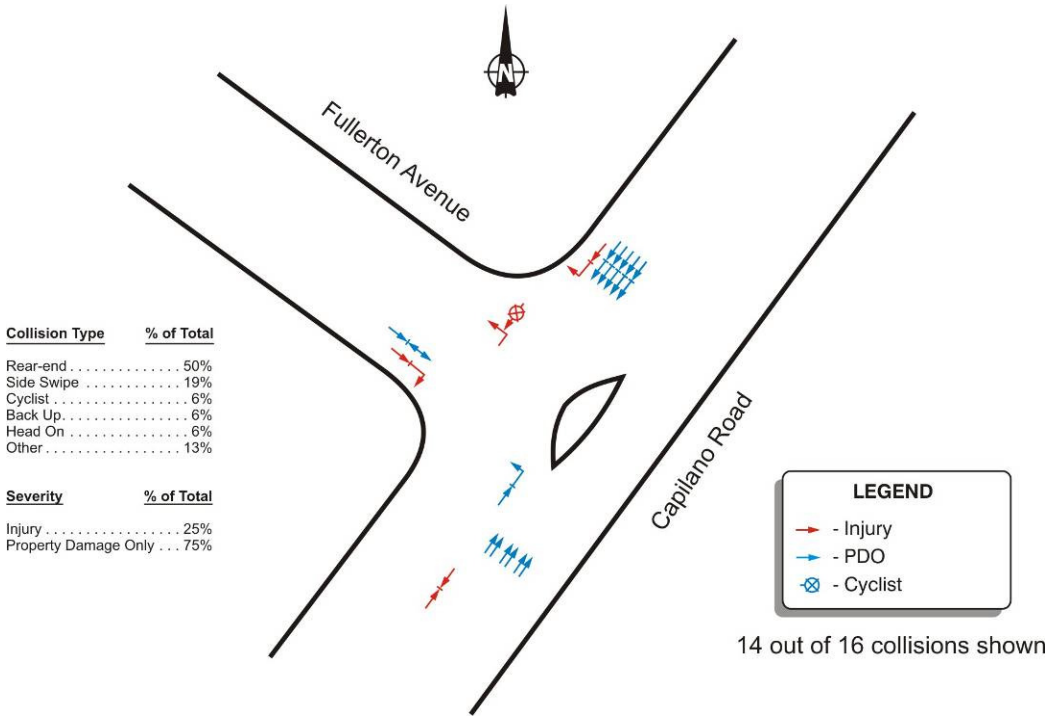


FIGURE C-8 FULLERTON AVE INTERSECTION COLLISION DIAGRAM

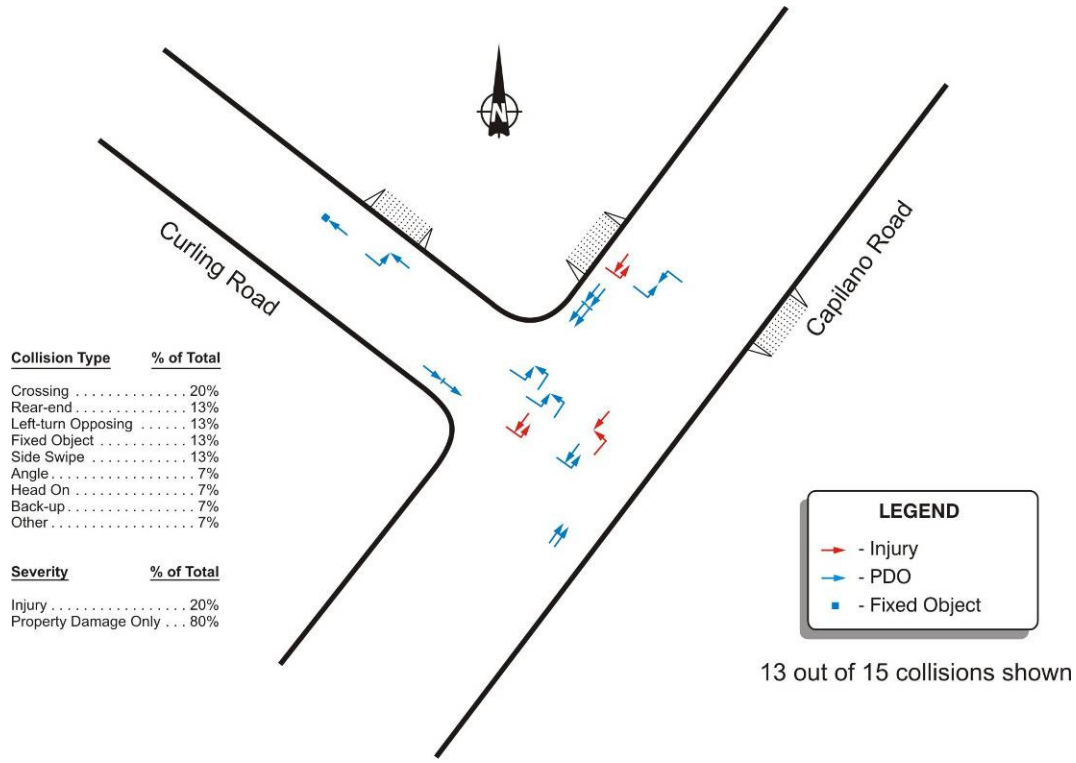


FIGURE C-9 CURLING ROAD INTERSECTION COLLISION DIAGRAM

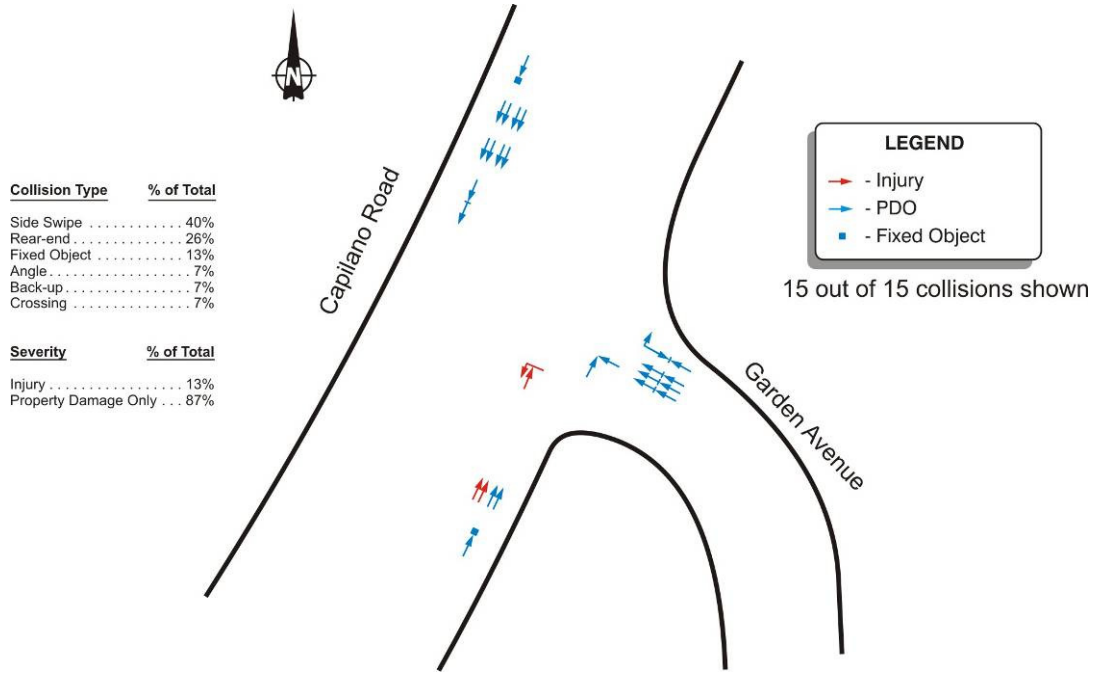


FIGURE C-10 GARDEN AVENUE INTERSECTION COLLISION DIAGRAM

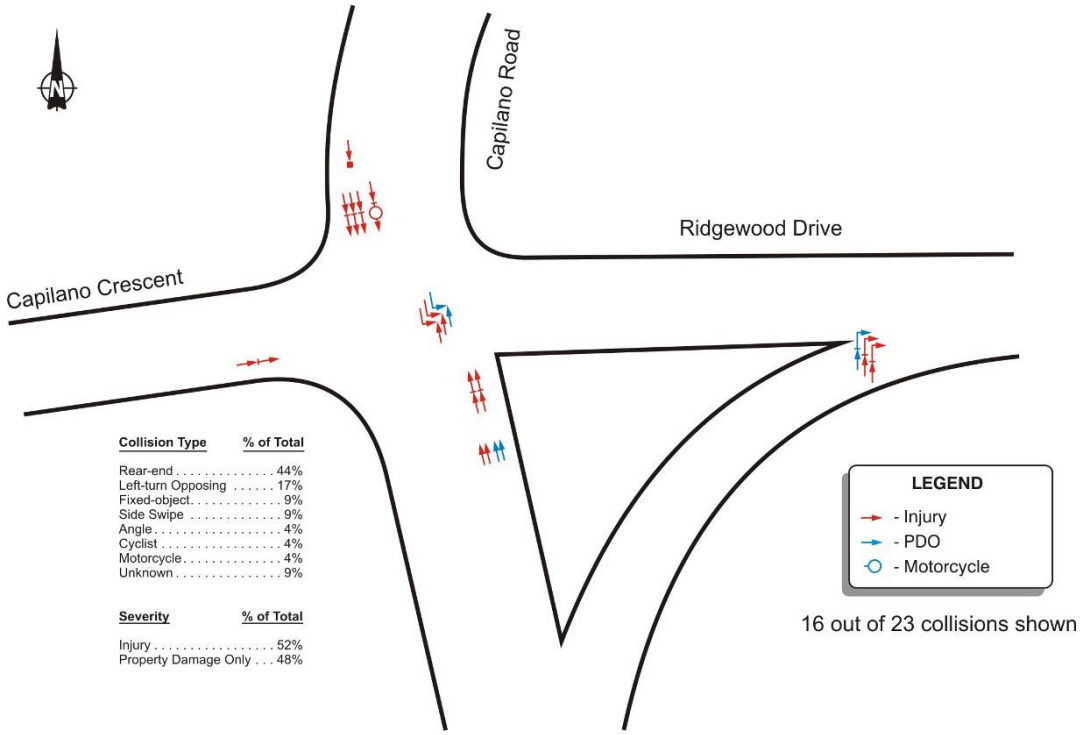


FIGURE C-11 RIDGEWOOD DRIVE INTERSECTION COLLISION DIAGRAM

A site visit along the corridor was performed on Wednesday, June 17, 2009. A review of the observed characteristics along the corridor is summarized in TABLE C-5.

TABLE C-5 SUMMARY OF OBSERVATIONS – CAPILANO ROAD CORRIDOR

	▪ Sidewalks were about 1.5 metres wide, which is considered narrow for urban commercial areas. Shrubbery was encroaching onto sidewalks, further narrowing the available walking space. ▪ Pedestrians were observed to jaywalk across Capilano Road. ▪ Some pedestrian-related signal hardware was out-of-date at the Fullerton Avenue intersection.
	▪ The northbound left-turn lane at the Curling Road intersection is short and located close to the Marine Drive intersection. When queuing spills onto the through lane, heavy braking was observed especially with the eastbound left-turn movements from Marine Drive.
	▪ Capilano Road lanes are generally narrow, with widths measured to be as narrow as 3.2 metres. When combined with high volumes and heavy vehicles, there is potential for sideswipe conflicts. ▪ The condition of the pavement was generally poor, and pavement markings were generally faded.

	▪ The sight distance for the eastbound left-turn movement out of Curling Road is poor due to roadside signs and geometry. This may result in conflicts involving eastbound and southbound vehicles at this intersection.
	▪ At the Garden Avenue intersection, the visibility of approaching northbound vehicles for the westbound approach is poor due to the skew of the intersection and the horizontal curve. This may result in conflicts involving westbound and northbound vehicles at this intersection.
	▪ At the Fullerton Avenue and Curling Road intersections, confusion of how to use the acceleration lane for the eastbound left-turn was observed.

Based on the collision analysis in conjunction with the site visit, the following safety issues were identified:

- The lanes are generally considered narrow for an arterial street, as well as for a combined cyclist-vehicle use. This results in some bicycle collisions where a vehicle sideswipes a cyclist, or another vehicle while avoiding a cyclist.
- The Fullerton Avenue intersection provided older pedestrian displays, and may be related to the pedestrian-related collisions (secondary rear-end collisions).
- Due to the restricted sight distances and delays, the left-turn movements at the Garden Avenue intersection result in northbound left-turn crossing and northbound rear-end collisions. The District has indicated that the westbound left-turn movement that contributes to these issues has been recently restricted.

Ridgewood Drive Intersection Characteristics

The Capilano Road and Ridgewood Drive intersection provides a channelized northbound right-turn lane to provide access from the TransCanada Highway and commercial areas to the south to residential areas in the Edgemont neighbourhood. The intersection collision diagram was prepared and was shown in FIGURE B-11. A site visit was performed on Wednesday, June 17, 2009. A review of the observed characteristics at the intersection is summarized in TABLE C-6.

The collision analysis indicated rear-end collisions based on the high volumes and sightline issues with vehicle queuing from the YIELD sign.

TABLE C-6 SUMMARY OF OBSERVATIONS – RIDGEWOOD DRIVE INTERSECTION

- The northbound right-turn channelized lane at the Riverside Drive intersection has limited sight distance around the shrubbery and rockface should there be any queuing at the YIELD sign. These conditions may result in rear-end conflicts.
- There is a bus stop at the end of the right-turn lane. When combined with the high volumes and visibility issues, there is a potential for a rear-end collision with a bus that has stopped at the bus stop.

As part of the channelized right-turn lane analysis, the northbound right-turn lane at the Ridgewood Drive intersection was reviewed further and is described APPENDIX D.

C-3 Mount Seymour Parkway Corridor

General Corridor Characteristics

Mt. Seymour Parkway between Lillooet Road and Mt. Seymour Road provides the major east-west access for areas west of the TransCanada Highway. The corridor provides two through lanes in each direction as well as a bicycle lane approximately 1.3 metres wide. The posted speed limit is 60 kilometres per hour. The land use through the area is generally residential.

A site visit along the corridor was performed on Thursday, June 18, 2009. A review of the observed characteristics along the corridor is summarized in TABLE C-7.

TABLE C-7 SUMMARY OF OBSERVATIONS – MT. SEYMOUR PARKWAY CORRIDOR

	▪ Much of the corridor has trees on both the median and roadside. Due to the foliage, lighting from the streetlights may be obscured. This may result in lower visibility during dark conditions and a higher nighttime collision risk for all road users. ▪ The landscaping can restrict sight distances at locations with horizontal curves.
	▪ Bicycle lanes of about 1.3 metres wide are provided in both eastbound and westbound directions. The bicycle lane is less than the 1.8 metre standard for the GVRD and may result in cyclists travelling closer to adjacent vehicular traffic than suggested.
	▪ Prevailing vehicle speeds were typically about 70 kilometres per hour or higher. This is higher than the posted speed limit of 60 kilometres per hour. A high-quality road with relatively wide lanes of 3.3 to 3.4 metres, few intersections and accesses, and high design speed result in this discrepancy.

A review of the collision characteristics failed to indicate whether the bicycle lane width contributed to the collisions. As well, there were little correlation between the lighting and speeding issues observed on site and the collisions.

The collision frequency at intersections along the corridor was summarized and is shown in TABLE C-8. The review indicates that Riverside Drive has considerably the highest collision frequency along the corridor. A detailed review of this intersection is in the following subsection.

TABLE C-8 MT. SEYMOUR PARKWAY CORRIDOR COLLISION LOCATIONS

INTERSECTION	ANNUAL COLLISION FREQUENCY		
	Injury	PDO	Total
Riverside Dr.	36	65	101
Mt. Seymour Rd./Roche Point Dr.	12	14	26
Berkley Rd.	11	15	26
Dollarton Hwy./Deep Cove Rd.	6	10	16
Seymour Blvd.	3	10	13
Lytton St.	5	7	12
Apex Ave.	2	2	4
Parkgate Ave.	2	2	4
Northlands Dr.	0	3	4
Strathaven Dr.	1	2	3
Plymouth Dr.	0	2	2

Riverside Drive Intersection Characteristics

The Mt. Seymour Parkway and Riverside Drive intersection provides a channelized northbound right-turn lane to provide access between Dollarton Highway to the south to Deep Cove and various residential areas to the east. The intersection collision diagram was prepared and is shown in FIGURE C-12.

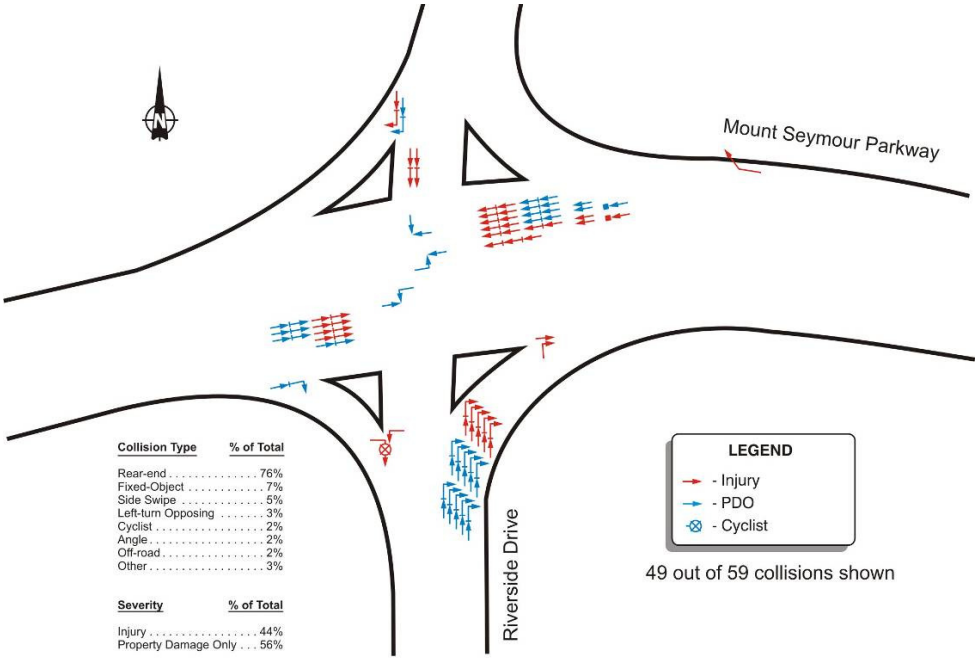


FIGURE C-12 RIVERSIDE DRIVE INTERSECTION COLLISION DIAGRAM

The collision analysis indicated rear-end collisions based on the high volumes and sightline issues with vehicle queuing from the YIELD sign, in addition to the sight distance issues. Rear-end collisions were also occurring on the Mount Seymour Parkway approaches, and may be related to the relatively high vehicle speeds.

A site visit was performed on Thursday, June 18, 2009. A review of the observed characteristics at the intersection is summarized in TABLE C-9.

TABLE C-8 SUMMARY OF OBSERVATIONS – RIVERSIDE DRIVE INTERSECTION

	▪ The northbound right-turn channelized lane has limited sight distance both around the lane and to the west to see eastbound through vehicles. These conditions may result in rear-end and right-turn conflicts. ▪ The design of right-turn channelized lanes with YIELD control typically results in drivers looking for gaps in the through traffic to the left while needing to be wary of stopped vehicles on the right-turn lane in front. This higher driver workload in opposing directions, combined with observed high volumes and limited sight distance can result in rear-end conflicts on the right-turn lane.

The District enquired whether an Advance Warning Flasher system on the westbound approach is appropriate. While there are some rear-end collisions that may be reduced with this measure, Advance Warning Flashers are typically installed on high speed roadways posted at 70 kilometres per hour or higher, where signal visibility is poor, or where there is a long distance from the previous traffic signal. Although the prevailing vehicle speeds are relatively high, none of the above are applicable for this location; is noted that signal visibility at this intersection appears to be adequate, and that there is a traffic signal about 800 metres to the east. It is also noted that Advance Warning Flashers may also result in higher rear-end collision risks if installed inappropriately.

C-4 Mitigating Measures And Prioritization

To address the identified safety issues, improvements strategies were developed and are described in detail below.

Marine Drive (Corridor-Wide)

- *Provide wider and more visible crosswalks and ensure letdowns are constructed correctly* – To address narrow crosswalks, it is suggested that all crosswalks provide widths of at least 2.0 metres wide. As well, the letdowns should be location such that pedestrians using them do not need to travel out of the marked crosswalks to navigate them.
- *Widen sidewalks were possible* – To improve on pedestrian comfort and to provide for the generally high pedestrian volumes, it is suggested that wider sidewalks be provided where possible. This may need to occur in stages as property redevelopment along Marine Drive occurs. A higher priority would be at locations where the travel lane is adjacent to the travel lanes, such as near intersections where there are no parking lanes buffering the pedestrians with moving traffic. It is noted that no collisions were attributed to this issue and therefore no documented collision reduction is expected.
- *Improve on-street bicycle facilities* – To reduce the conflict between cyclists and vehicles using a travel lane along Marine Drive, it is suggested that bicycle lanes be provided. The bicycle lanes separate the two road users and would improve on the safety of cyclists using Marine Drive. Should right-of-way to widen is unavailable, the District could consider providing a 4.3 metre shared lane, or provide a parallel bicycle route.

Marine Drive (at Capilano Road)

- *Redesign southbound right-turn and eastbound left-turn to reduce likelihood of lane encroachment* – The southbound right-turn and eastbound left-turn lanes should be widened to allow for vehicles to complete their turns without encroaching into the adjacent lanes. The intersection would need to be redesigned and widened in places, such as at the northeast and northwest corners. This redesign will result in fewer sideswipe and rear-end collisions for these movements.

- *Realign south leg to be straight with the north leg* – To improve on the potential visibility issues related to the angle of the northbound and southbound approaches, it is suggested that the south leg be realigned to the west to provide a straight alignment for Capilano Road. This addresses collisions related to the poor visibility.
- *Redesign the westbound channelized right-turn lane* – By removing the YIELD control for the westbound right-turn lane and providing a more conventional lane, the driver tasks to watch for queues in front and gaps in traffic is separated, and thus reduce driver workload. This is expected to reduce the rear-end collisions along this lane.
- *Provide delineation and/or signage to improve northbound approach guidance* – Guidance in the form of delineation or signage is suggested for the north approach, as the vast unmarked pavement may result in driver confusion as to where to drive. It is noted that no collisions were attributed to this issue and therefore no documented collision reduction is expected.
- *Provide letdown on south side of east crosswalk* – A letdown is recommended to allow pedestrians requiring a letdown to access the island. It is noted that no collisions were attributed to this issue and therefore no documented collision reduction is expected.
- *Consider southbound protected-permissive phase during the afternoon* – To reduce the delays for the southbound movements and reduce the likelihood of driver frustration, it is suggested that a protected-permissive phase be provided at the intersection. A capacity analysis would need to be completed, and should be considered with any other major geometrical design of the intersection. This is expected to reduce southbound approach collisions involving left-turn and through movements.
- Provide missing YIELD or STOP sign on northbound right-turn lane - It is noted that no collisions were attributed to this issue and therefore no documented collision reduction is expected.

Marine Drive (at Pemberton Avenue)

- *Provide curb extensions on south leg and a delineation of on-street parking stalls* – Curb extensions should reduce the likelihood of lane use confusion by separating parking lanes from turn lanes.

Capilano Road (Corridor-Wide)

- *Widen Road and/or Provide bicycle lanes* – To reduce the conflict between adjacent vehicles, as well as cyclists and vehicles, it is suggested that the lanes be widened to at least 3.5 metres wide, and if possible, bicycle lanes be provided.

Capilano Road (at Garden Avenue)

- *Restrict left-turn movements at Garden Avenue* – To address collisions caused by left-turning vehicles, it is suggested that the westbound left-turn movement be restricted at the intersection.

Capilano Road (at Fullerton Avenue)

- *Provide newer pedestrian signal control* – It is suggested that newer pedestrian signal control be provided to address potential pedestrian incompliance. The signals are more in line with other pedestrian controls are probably more easily understood. The District has indicated that this measure will be implemented in 2010.
- *Remove left-turn acceleration lane at Fullerton Avenue intersection* – To address driver confusion related to the left-turn acceleration lane, it is suggested that the lane be removed and more conventional intersection laning be provided. It is noted that no collisions were attributed to this issue and therefore no documented collision reduction is expected. The District has indicated that this measure will be implemented in 2010.

Capilano Road (at Curling Avenue)

- *Provide Traffic Signal* – To address the delays and risky manoeuvres at this intersection, it is suggested that the intersection be signalized. Coordination would be required between the Marine Drive intersection to the south and the Fullerton Avenue intersection to the north. It is noted that no collisions were attributed to this issue and therefore no documented collision reduction is expected.

- *Provide Right-In-Right-Out Control* – Conversely, right-in-right-out control can be provided at the intersection by restricting the left-turn movements at the intersection. However, an alternate route for these movements would need to be provided (for example, a connection between Curling Avenue and Fullerton Avenue to the north). This can be considered with redevelopment in the area.

Capilano Road (at Ridgewood Drive)

- *Redesign the northbound channelized right-turn lane* – It is suggested that the right-turn lane be redesigned to provide a more obtuse angle on the entry onto Ridgewood Drive and that a STOP control be provided. This separates the driver tasks of watching for queues in front and gaps in traffic is separated, and thus reduces the driver workload. This design would also reduce the likelihood of rear-end collisions with buses at the westbound farside bus stop. This is expected to reduce the rear-end collisions along this lane.

Mt. Seymour Parkway (Corridor-wide)

- *Trim foliage or removing trees along sections* – Portions of Mount Seymour Parkway have low street lighting levels and/or compromised sight distances due to tree foliage. The trimming or removal of foliage is expected to improve the nighttime visibility along the corridor and reduce the collision risk related to more visibility during dark conditions. It is noted that no collisions were attributed to this issue and therefore no documented collision reduction is expected.
- *Widen bicycle lanes* – To provide greater separation between cyclists and vehicles, it is suggested that the bicycle lanes be widened to at least 1.8 metres wide (the standard documented for the GVRD). The wider bicycle lane should reduce any potential conflicts between cyclists and vehicles in the adjacent lane. It is noted that no collisions were explicitly attributed to this issue and therefore no documented collision reduction is expected.

- *Provide visual environment appropriate to lower vehicle speeds* – Drivers tend to drive at speeds they feel are appropriate to the driving conditions. Currently, Mount Seymour Parkway provides a divided roadway with limited access and generally wide, smooth lanes that gives the impression that it is a high-speed roadway. To break up these visual cues, the following can be considered:
    - Narrow lanes;
    - Provide appearance of more urban setting (such as sidewalks or buildings, likely to be implemented with development);
    - Innovative pavement markings (such as wider lane lines or three-dimensional markings, likely to be implemented as a test pilot study);
    - Reduce speed limit (likely with limited results); and,
    - Increase enforcement and/or awareness (such as Speed Reader board).

Mt. Seymour Parkway (at Riverside Drive)

- *Redesign the northbound channelized right-turn lane* – It is suggested that the right-turn lane be redesigned by removing the YIELD control for the westbound right-turn lane and providing a more conventional lane. This separates the driver tasks of watching for queues in front and gaps in traffic is separated, and thus reduces the driver workload. This is expected to reduce the rear-end collisions along this lane.

C-5 Economic Evaluation

ICBC has indicated that funding may be available through the Road Improvement Program if favourable investment opportunities exist to reduce the number of motor vehicle collisions and the associated claims cost.

An economic evaluation of the proposed mitigation measures was conducted according to the methods described in the report titled Update to the Economic Evaluation Method for Road Improvement Investments (Hamilton Associates for ICBC, 1997). The investment criteria require that ICBC investments in projects be based on achieving a minimum of 50 percent Internal Rate of Return over two years post-implementation period for the short term mitigations and over five years post-implementation period for the long term mitigations.

The cost of the mitigation measure, annual claims cost savings, and potential ICBC investment are summarized in TABLE C-9. Based on the economic evaluation results, the measures that will provide the most savings are:

- Revising the northbound left-turn lane at the Mt. Seymour Parkway and Riverside Drive intersection; and
- Widening Capilano Road.

The measures with the most favourable benefit-cost ratio for the District are:

- Providing southbound left-turn permissive phasing at the Marine Drive and Capilano Road intersection; and
- Restricting left-turn movements at the Capilano Road and Garden Avenue intersection.

TABLE C-9 ECONOMIC EVALUATION RESULTS

IMPROVEMENT	Collision Type Reduced	COST	Annual Savings	Potential ICBC Investment	ICBC Benefit Cost Ratio	DNV Benefit Cost Ratio
Marine Drive Corridor						
Provide wider and more visible crosswalks	Rear-End, Left-Turn, and Angle	$20,000	$4,600	$5,200	1.8	0.5
Provide bicycle or shared lanes	Rear-End, Left-Turn, and Angle	$100,000	$2,600	$4,600	2.8	0.1
Marine Drive Corridor Total		$120,000	$7,200	$9,800	3.7	0.3
Marine and Capilano						
Redesign southbound right-turn and eastbound left-turn to reduce likelihood of lane encroachment	Rear-End, Left-Turn, and Angle	$150,000	$3,700	$6,600	2.8	0.1
Realign south leg to be straight with the north leg	Rear-End, Left-Turn, and Angle	$100,000	$6,600	$11,500	2.9	0.3
Provide delineation and/or signage to improve northbound approach guidance	Rear-End, Left-Turn, and Angle	$6,000	$800	$1,400	2.9	0.7
Consider southbound protected-permissive phase during the afternoon	Rear-End, Left-Turn, and Angle	$25,000	$5,900	$10,300	2.9	1.2
Revise current westbound RT lane	Rear-End, Left-Turn, and Angle	$50,000	$3,900	$6,900	2.8	0.4
Marine and Capilano Total		$331,000	$20,900	$36,700	2.8	0.3
Marine and Pemberton						
Provide curb extensions on south leg and a delineation of on-street parking stalls	Rear-End, Left-Turn, and Angle	$15,000	$300	$500	3.0	0.1
Marine and Pemberton Total		$15,000	$300	$500	3.0	0.1
Capilano Road Corridor						
Widen Capilano Road lanes to 3.5 metres and/or repave street	Rear-End, Left-Turn, and Angle	$7,000,000	$12,700	$22,200	2.9	<0.1
Provide newer pedestrian signal controls (such as countdown timers)	Rear-End, Left-Turn, and Angle	$15,000	$300	$600	2.5	0.1
Provide bicycle lanes	Rear-End, Left-Turn, and Angle	$100,000	$400	$800	2.5	<0.1
Restrict westbound left-turn movement at Garden Avenue	Rear-End, Left-Turn, and Angle	$10,000	$4,600	$8,000	2.9	2.3
Capilano Road Corridor Total		$625,000	$18,000	$31,600	2.8	<0.1
Right Turn Lane Locations						
Revise current northbound RT lane at Riverside and Mt. Seymour	Rear-End, Left-Turn, and Angle	$200,000	$12,100	$21,100	2.9	0.3
Revise current northbound RT lane at Capilano and Ridgewood	Rear-End, Left-Turn, and Angle	$200,000	$5,600	$9,700	2.9	0.1
Right Turn Lane Locations Total		$400,000	$17,700	$30,800	2.9	0.2
TOTAL		**$1,491,000**	**$64,100**	**$109,400**	**2.9**	**0.1**

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APPENDIX D

RIGHT-TURN LAYOUTS

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APPENDIX D
RIGHT-TURN LAYOUTS

Three locations have at least three collisions on the channelized right-turn lanes. The locations are:

- Marine Drive and Capilano Road;
- Mt. Seymour Parkway and Riverside Drive; and
- Capilano Road and Ridgewood Drive.

The conceptual layouts for the Capilano Road and Ridgewood Drive intersection and the Mount Seymour Parkway and Riverside Drive intersection are shown in FIGURES D-1 and D-2. The right-turn lane design for the third location at Marine Drive and Capilano Road intersection was part of a detailed overall concept plan layout that incorporates various safety measures, and is shown FIGURE D-3.

The District has noted that there is a pre-existing landscaping plan for the channelized island at the Capilano Road and Ridgewood Drive that includes the existing fountain sculpture and various plants. The suggested right-turn lane would traverse the middle of the island. The District would need to resolve this incompatibility if the suggested right-turn layout is used.

It is noted that the Marine Drive and Capilano Road concept plan is part of a larger design for a westbound transit priority lane on Marine Drive. The economic analysis summarized in APPENDIX C indicates that a higher level of savings and benefits to addressing the right-turn lane safety issue at the Mt. Seymour Parkway and Riverside Drive intersection over the Capilano Road and Ridgewood Drive intersection. As such, the implementation priority would be:

1. Marine Drive and Capilano Road, followed by
2. Mt. Seymour Parkway and Riverside Drive, and then
3. Capilano Road and Ridgewood Drive.

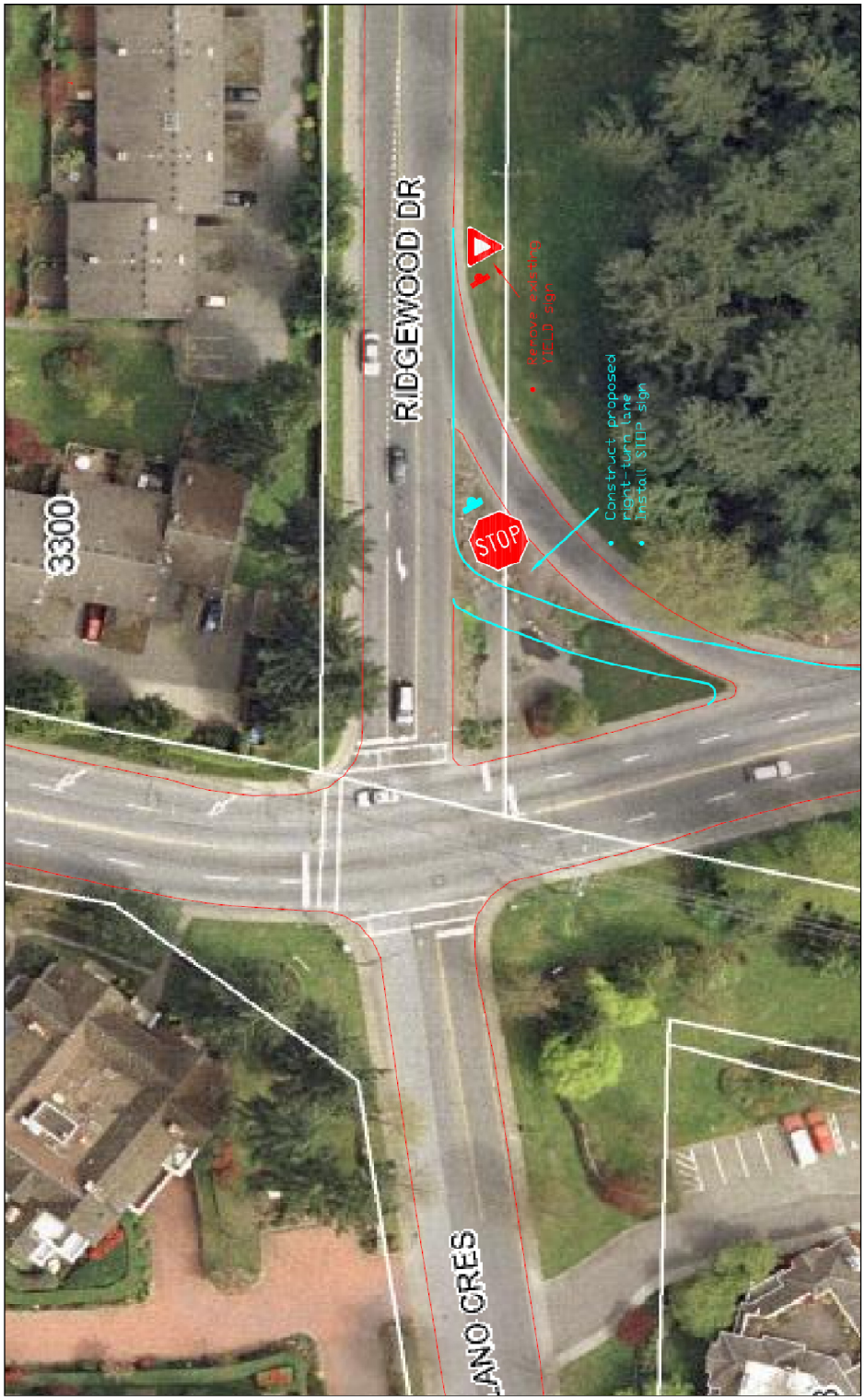

FIGURE D-1 CONCEPTUAL RIGHT TURN LAYOUT FOR THE CAPILANO ROAD AND RIDGEWOOD DRIVE INTERSECTION

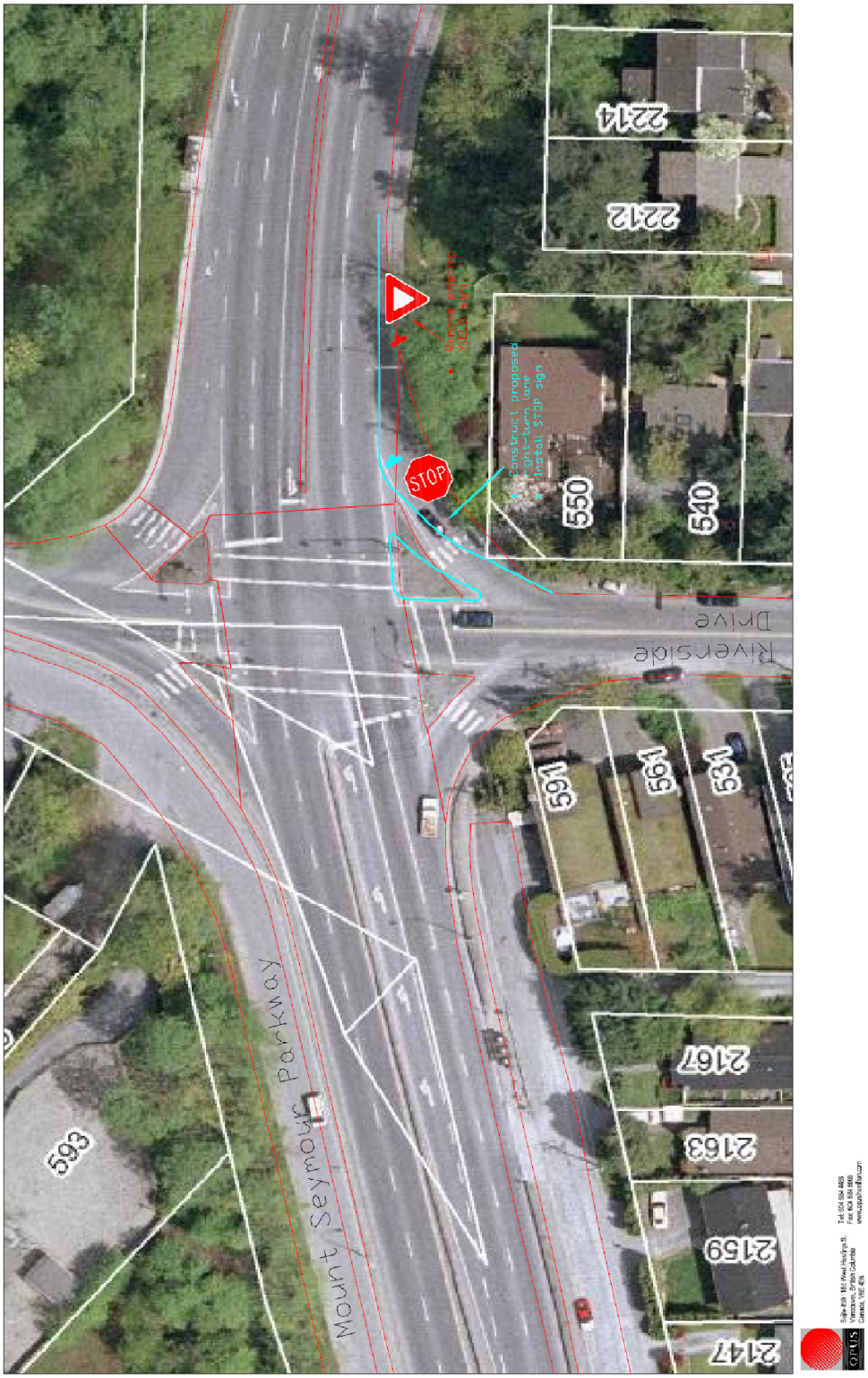

FIGURE D-2 CONCEPTUAL RIGHT TURN LAYOUT FOR THE MOUNT SEYMOUR PARKWAY AND RIVERSIDE DRIVE INTERSECTION

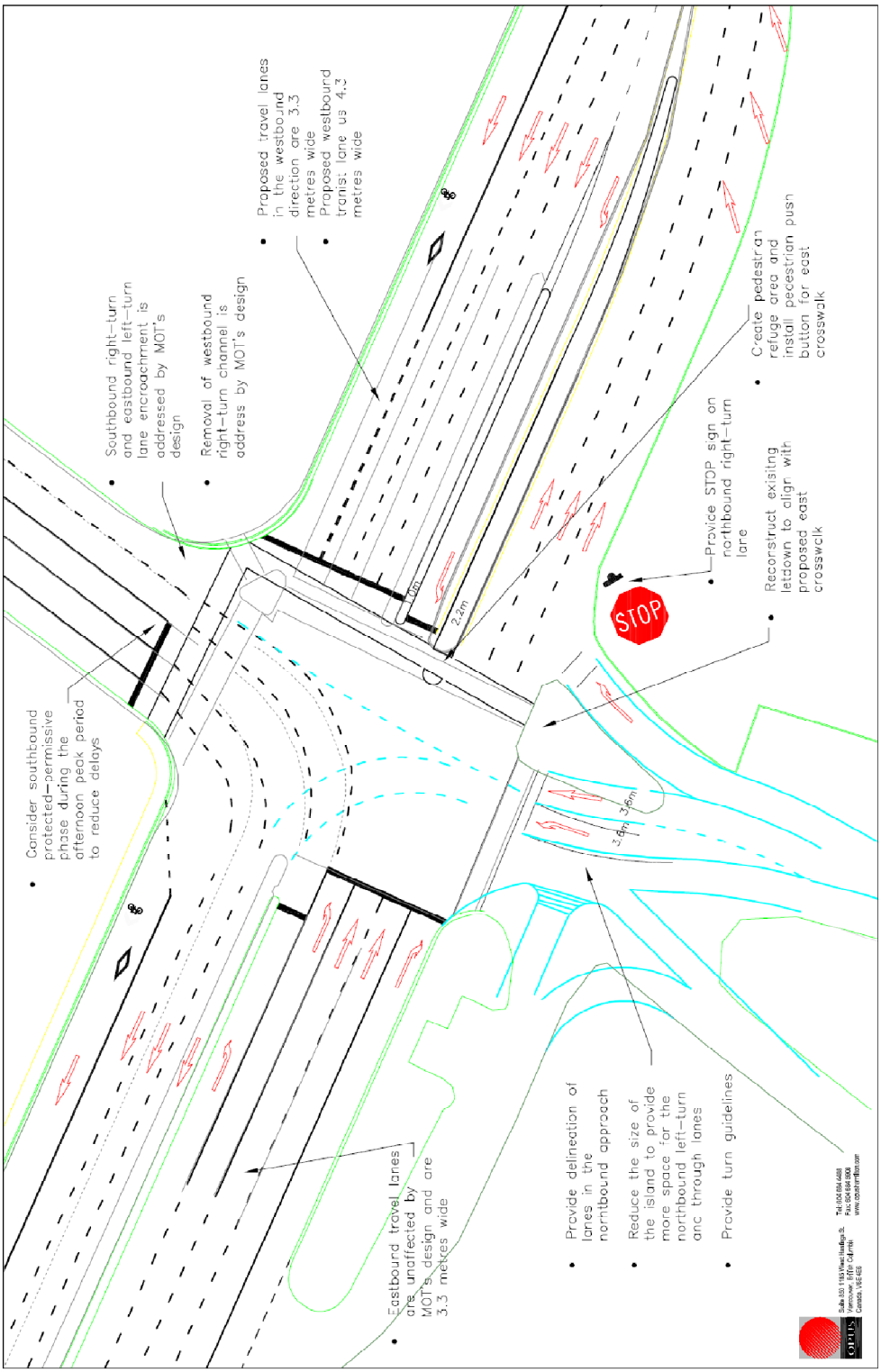

FIGURE D-3 CONCEPT PLAN FOR THE MARINE DRIVE AND CAPILANO ROAD INTERSECTION

- Traffic Operations
- Transportation Planning
- Road Safety Engineering
- Transit and Sustainability
- Asset Management
- Project Management