



GARIBALDI ESTATES TRANSPORTATION STUDY

DISTRICT OF SQUAMISH | FINAL REPORT

 MAY 2022



Table of Contents

Executive Summary	1
1.0 Introduction	1
1.1 Previous Studies	2
1.2 Objectives	3
1.3 Study Area	3
1.4 Key Intersections	4
2.0 Existing Conditions	6
2.1 Demographics and Transportation Patterns	6
2.2 Highway 99 and Traffic Patterns	8
2.3 Travel Demand Forecasting Model	10
2.4 Travel Demand Model Results	13
2.5 Intersection Operations	14
3.0 Future Condition Analysis	20
3.1 Land Use	20
3.2 Mode-Share	22
3.3 Road Network Changes	23
3.4 Travel Demand Model Results – 2040 Base	23
3.5 Intersection Operations – 2040 Base	24
3.6 Development Threshold – 2040 Base	29
4.0 Improvement Options.....	31
4.1 Initial Screening	32
4.2 Options Descriptions	32
4.3 Cost Estimate	33
4.4 Option 1	35
4.5 Option 2A	38
4.6 Option 2B	41
5.0 Conclusions	44

APPENDICES

Appendix A Cost Estimate Worksheets

Executive Summary

ISL Engineering has been retained by the District of Squamish to provide a transportation study for the Garibaldi Estates neighbourhood and surrounding developments. A transportation study is a critical precursor to engaging in neighbourhood planning for the area due to the potential for density increases in the area. Additional density through redevelopment in the Garibaldi Estates neighbourhood could have a large impact to many intersections in the study area when combined with existing, proposed and future development applications in the surrounding area.

The transportation study considers potential traffic volumes that theoretically could be generated under a high growth scenario at different stages of completion of both infill and greenfield developments in the Garibaldi Estates, Garibaldi Highlands and Tantalus areas, including significant future developments at the University, Newport Ridge and DL 509/510. The intention is to determine what the impacts of these developments will have on the local transportation network and the Highway 99 intersections with Mamquam Road, Garibaldi Way and Dowad Drive. At some level of increased density, the resulting traffic volume is anticipated to necessitate intersection and local road network upgrades.

A transportation model was used to forecast future traffic in the 2040 horizon year, taking future land use development and the trips generated from all the above areas into account. After calibration, the model was used to perform trip generation, distribution, and route assignment tasks. Traffic counts collected within the study area were used to calibrate the model as well as assess the existing conditions.

The study begins with a background review, study objectives, study area, and key intersections.

The existing condition analysis identifies existing travel patterns, and provides an overview of the components and data used in the travel forecasts and intersection analyses. It provides detailed descriptions of model components, assumptions, result analyses, insights, and findings.

The future condition analysis identifies population thresholds that trigger major transportation infrastructure upgrades based on projected growth. It provides detailed descriptions of projections and assumptions related to land use, mode share, and road network. Future travel forecasts, peak hour vehicle demand, and intersection operations were analyzed, along with insights, and findings. Even with the incorporation of suggestions from the recent *Highway 99 Squamish Corridor Review (BCMoTI 2021)*, there are still issues in the 2040 PM peak hour as follows:

- Highway 99 / Dowad Drive – westbound approach
- Highway 99 / Garibaldi Way – northbound, southbound, and westbound left turns
- Highway 99 / Mamquam Road – eastbound approach
- Garibaldi Way / Plaza Parking Access – northbound approach

This study identifies three potential improvement options for key intersections within the study area. The options are improvement packages to the key intersections. Between options, each improvement package could have features that are similar and features that are differing. They are developed to balance traffic operations, costs, and impacts to existing infrastructure. Option 1 was built upon suggestions from the *Highway 99 Squamish Corridor Review (BCMoTI 2021)*. Option 2 (A and B)



took Option 1 further with additional considerations to enhance benefits and limit constraints and impacts. Eventually, Option 2 diverged to Option 2A and 2B with certain trade-offs, with Option 2A having more lanes and widening on the cross streets, while Option 2B having more lanes and widening on Highway 99. Each option includes a brief description of the concept, an analysis of the traffic operations, and a high-level conceptual cost estimation for each of the major upgrades.

The main features that differ in the options are summarized in Table ES.1.

Table ES.1: Option Features

Feature	Option 1	Option 2A	Option 2B
Highway 99 / Dowad Drive Signal	Yes		
New Newport Ridge Drive Connection		Yes	Yes
Highway 99 Cross-Section			Wider
Garibaldi Way Cross-Section Near Highway 99	Wider	Wider	

Table ES.2 summarizes the benefits and constraints associated with each option.

Table ES.2: Benefits and Constraints Summary

Criteria	Option 1		Option 2A		Option 2B	
	Benefits	Constraints	Benefits	Constraints	Benefits	Constraints
Vehicle Travel Times and Operations		New Highway signal causing delays	No new Highway signal, Lower VKT		No new Highway signal, Lower VKT	
Impacts to Existing Infrastructure				Higher impact to existing infrastructure	Lower impact to existing infrastructure	
Costs	Lower cost			Higher cost		

Based on the required upgrades, and associated costs, Option 2B has an advantage over other options with improved vehicle travel times and operations with lower impact to existing infrastructure.

Option 2B is recommended for the long term, with the following main features:

- 70 km/h Speed Limit along Highway 99 extends north of Dowad Drive.
- New Newport Ridge Drive Connection between Highway 99 and Tantalus Road.
- No additional signal along Highway 99. Highway 99 / Dowad Drive remains unsignalized with right-in-right-out and westbound left turn out. Highway 99 / Newport Ridge Drive is also unsignalized with right-in-right-out and southbound left turn in.
- Single westbound left turn from Garibaldi Way to Highway 99. Garibaldi Way has a 3-lane cross-section on both sides of the Highway. A third northbound lane on Highway 99 starts before Garibaldi Way and extends to Newport Ridge Drive.
- Dual westbound left turn from Mamquam Road to Highway 99. A third northbound lane on Highway 99 starts before Mamquam Road and extends to the Garibaldi Village right turn in.

1.0 Introduction

Squamish is one of the fastest growing communities in British Columbia and is anticipated to continue growing at a similar rate. In addition to planned development within the downtown core, development outside of the downtown core would result in approximately double the existing population by 2040.

The District is developing a neighbourhood plan for the Garibaldi Estates neighbourhood in Squamish. Neighbourhood plans are comprehensive, long range plans prepared for a distinct geographic area and adopted by bylaw as a schedule to the Official Community Plan (OCP). Consistent with overall policies of the OCP, neighbourhood plans provide a greater level of detail respecting land use, density, community amenities and critical needs for a defined area based on detailed analyses and context.

The Garibaldi Estates neighbourhood plan area is shown in Figure 1.1 and encompass the land north of Mamquam Road, mostly east of Highway 99, south of any properties fronting Cheakamus Way and west of the foot of the slope leading up to the Garibaldi Highlands.

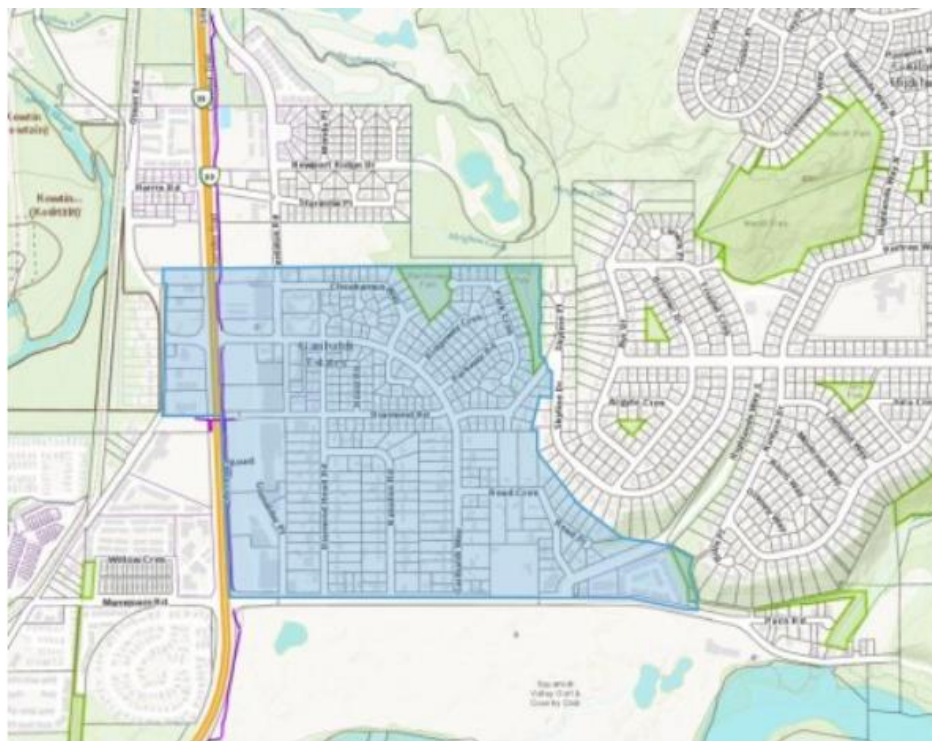


Figure 1.1: Garibaldi Estates Neighbourhood Plan Area

This study examines the transportation network and its ability to accommodate planned growth, support mode-shift and climate objectives, and improve the general livability.

1.1 Previous Studies

There have been previous studies undertaken to date relating to the Garibaldi Estates area. Relevant components of these have been extracted below.

Garibaldi Springs Transportation Impact Assessment (Bunt 2018)

The Garibaldi Springs is a new master-planned community containing approximately 310 residential units. It is located north of Garibaldi Estates and has access points at Dowad Drive and Newport Ridge Drive. Traffic counts were collected at 10 existing intersections during the Friday and Sunday peak traffic periods on the area road system, in particular, the intersections along the Highway 99 corridor.

The report identified the following improvements to improve traffic congestion:

- A new right-in/right-out access point to northbound Highway 99 at Newport Ridge Drive
- Signal timing modifications at two Highway 99 intersections (Garibaldi Way and Mamquam Road)
- Either
 - Eastward extension of Newport Ridge Drive up to the Garibaldi Highlands, or
 - New traffic signal at Highway 99 & Dowad Drive, new roundabout at Garibaldi Way & Tantalus Road, new right-out access from the shopping centre onto Highway 99

The traffic analysis did not account for other contemplated future developments such as Thunderbird Creek, Skyridge Phase 2, 1870 Dowad Drive, 40480 Tantalus Road which account for approximately 940 residential units and 58,000 square feet of commercial space. Highway 99 flyover ramps at Dowad Drive and Newport Ridge Drive were briefly mentioned. It recommended that a broader traffic study be undertaken that includes all these future developments.

Tantalus Road Intersection Realignment Analysis (ISL 2021) – Phase 1

The study reviewed traffic configuration options for Tantalus Road and Garibaldi Way intersection and surrounding area to improve traffic flow and active transportation safety. The objectives of the study were to:

- Identify the existing and future traffic operation and road safety issues for all road users based on the field review observations, recently-conducted public survey results, traffic operation analysis, and the latest 5-year insurance claims data review
- Develop improvement scenarios to mitigate the identified issues
- Undertake Multiple Account Evaluation (MAE) to determine the most effective solutions based on various criteria such as traffic operations, road safety, active transportation users, cost, etc.

Out of three corridor improvement scenarios, Scenario 1 (Tantalus Road South One-way Southbound) would improve the overall traffic operation and road safety along Garibaldi Way at a lower cost compared to other scenarios. These improvements were identified in the scenario:

- Plaza Parking Access:
 - Provide a dedicated right-turn bay for vehicles entering the Plaza from Highway 99
 - Provide a left-turn bay for vehicles entering the Plaza from the east
 - Install a special crosswalk/pedestrian signal at the immediate east of the Plaza parking access
- 7-Eleven / Petro-Canada Accesses:

- Close the easterly access on Garibaldi Way
- Tantalus Road Intersection:
 - Provide a dedicated left-turn bay for vehicles turning left onto Tantalus Road North
 - Convert Tantalus Road South to one-way southbound only

ISL have developed preliminary designs for the proposed improvement options. It should be noted that these could be removed and replaced in the future should a wider cross-section be required to provide improved traffic performance.

1.2 Objectives

A transportation study is a critical precursor to engaging in neighbourhood planning for the area due to the potential for density increases in the area. Additional density through redevelopment in the Garibaldi Estates neighbourhood could have a large impact to many intersections in the study area when combined with existing, proposed and future development applications in the surrounding area.

This transportation study considers traffic volumes that will be generated at different stages of completion of both infill and greenfield developments in the Garibaldi Estates, Garibaldi Highlands and Tantalus areas, including potential future developments at the University, Newport Ridge and District Lot (DL) 509/510. The intention of the study is to determine what the impacts of these developments will be on the local transportation network and the Highway 99 intersections with Mamquam Road, Garibaldi Way and Dowad Drive. At some level of increased density or population growth, the resulting traffic volume is anticipated to necessitate intersection and local road network upgrades. This transportation study determines the stages of required upgrades, and associated costs.

1.3 Study Area

Multiple large-scale developments are planned or may be planned in the surrounding area. Traffic generated by all of these areas would feed into streets and intersections within the neighbourhood. Potential growth within Garibaldi Estates neighbourhood by itself would not capture all the potential impacts to the streets and intersections within the neighbourhood. The potential combined growth of Garibaldi Estates neighbourhood and surrounding area, as well as the network effect are important to understand the existing and future performance of these key intersections. Therefore, the study area includes the surrounding area where the traffic generated are expected to use these key intersections. More accurate population growth projections are provided within the study area for this study. In order to understand the most significant potential traffic impacts in the area, significant development and infill activity was assumed for the Garibaldi Estates and surrounding area in order to generate a high impact population growth scenario for this study. These growth projections are not expected to occur with the identified time frame and may well never occur given that the outcome of the neighbourhood planning process is unknown at this time. However, future population projections are required for this analysis, therefore significant neighbourhood infill and development of lands designated as Future Residential Neighbourhood was assumed so as to not underestimate future traffic impacts.

The study area is bounded by the Highway 99 to the west, Mashiter Creek and District boundary to the east, Hop Ranch Creek to the north and Mamquam Road to the south as shown in Figure 1.2.

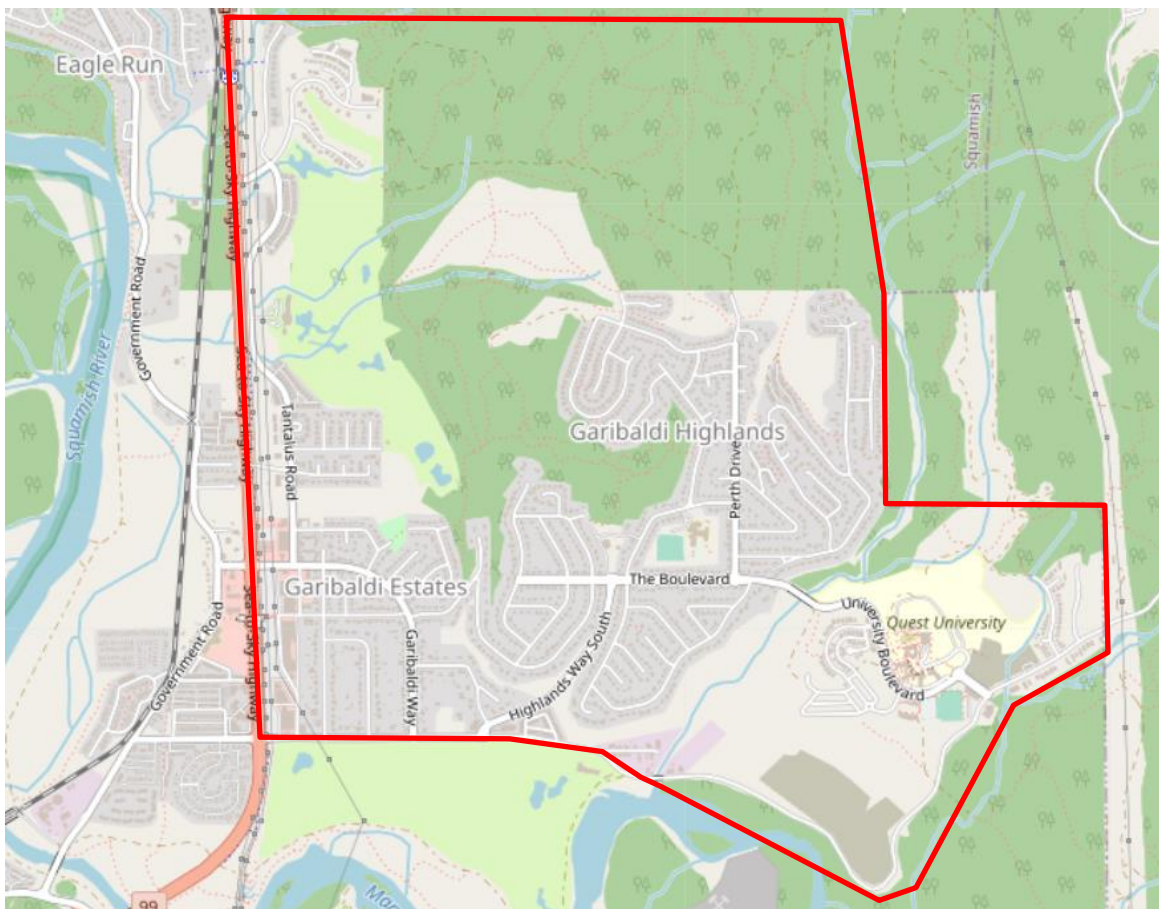


Figure 1.2: Study Area

1.4 Key Intersections

Intersections within the study area were reviewed and key intersections selected for further analysis in this study. Only those with high peak hour traffic volumes were considered. In addition to count data collected from previous studies, the District VISUM model was also used to forecast future intersection traffic volumes. The process narrowed the study intersections to 11 intersections. In addition, due to the lack of counts available and that can be collected on Mamquam Road currently due to a temporary road closure, the number of key intersections to be analyzed were reduced to the following seven intersections, as shown in Figure 1.3:

1. Highway 99 and Dowad Drive
2. Highway 99 and Garibaldi Way
3. Highway 99 and Mamquam Road
4. Tantalus Road and Dowad Drive
5. Tantalus Road and Newport Ridge Drive
6. Tantalus Road and Garibaldi Way
7. Garibaldi Way and Plaza Parking Access

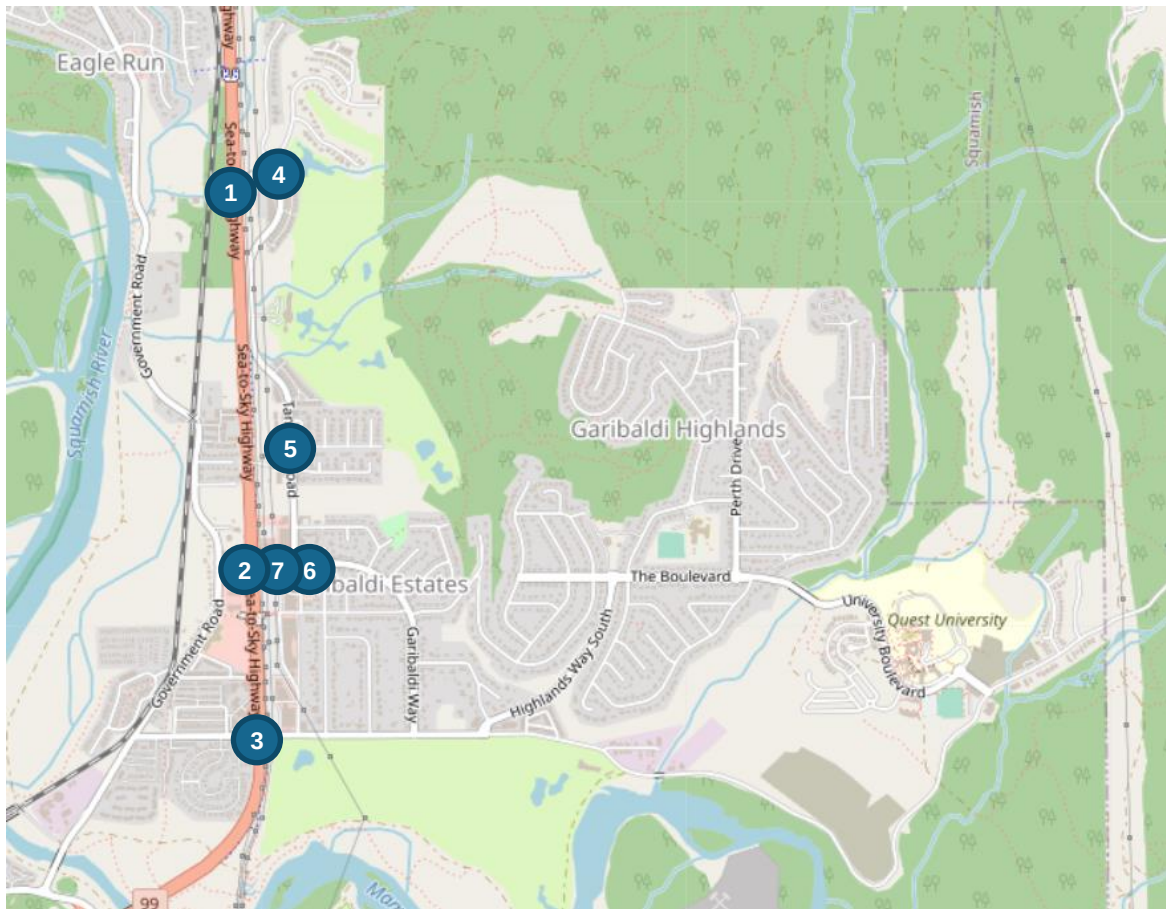


Figure 1.3: Key Intersections

2.0 Existing Conditions

The objective of the existing condition analysis is to identify existing travel patterns, and to provide an overview of the components and data used in the travel forecasts and intersection analyses.

This section is subdivided into Demographic Patterns, Traffic Patterns, Travel Demand Model, and Intersection Operations. The first two provide descriptions of existing patterns, while the latter two provide model components, assumptions, result analyses, insights, and findings.

2.1 Demographics and Transportation Patterns

The 2016 population of Squamish was 19,497¹. Based on the 2016 census, the dominant mode of commuting is the private vehicle accounting for 86% of all trips. Transit accounts for 3% of commuters, and walking and biking for 6% and 4% respectively as shown in Table 2.1. It should be noted that this is journey to work data, and not a complete analysis of mode share.

Table 2.1: Main Mode of Commute for Residents of Squamish (2016 Census)

Main Mode of Commuting	Squamish	Percent
Car, Truck, Van – as a Driver	7,380	77%
Car, Truck, Van – as a Passenger	830	9%
Public Transit	255	3%
Walked	605	6%
Bicycle	395	4%
Other Methods	160	2%

The top commuting destinations originating from Squamish include Squamish, Whistler, City of Vancouver and the North Shore. 65% of commuters from Squamish finish their trips in Squamish, and 35% of commuters finish their trips outside Squamish. Of the commutes that end outside of Squamish, 64% terminate south of Squamish and 36% terminate north of Squamish.

The top commuting origins arriving at Squamish are Whistler, the Squamish-Lillooet Regional District and Vancouver. Of these trips 58% begin their commutes south of Squamish, 42% of commuters begin their commutes north of Squamish.

Within the study area, a population overview is provided in Figure 2.1. Figure 2.2 shows active commute mode share ranging between 2.4% to 20.0%. Transit commute mode share ranges between 1.7% and 5.3%. In general, Garibaldi Estates residences travel more by sustainable modes for their commute.

¹ The 2021 population of Squamish was 23,819, a 22.2% increase from 2016. Other information from the 2021 Census has not been released yet.

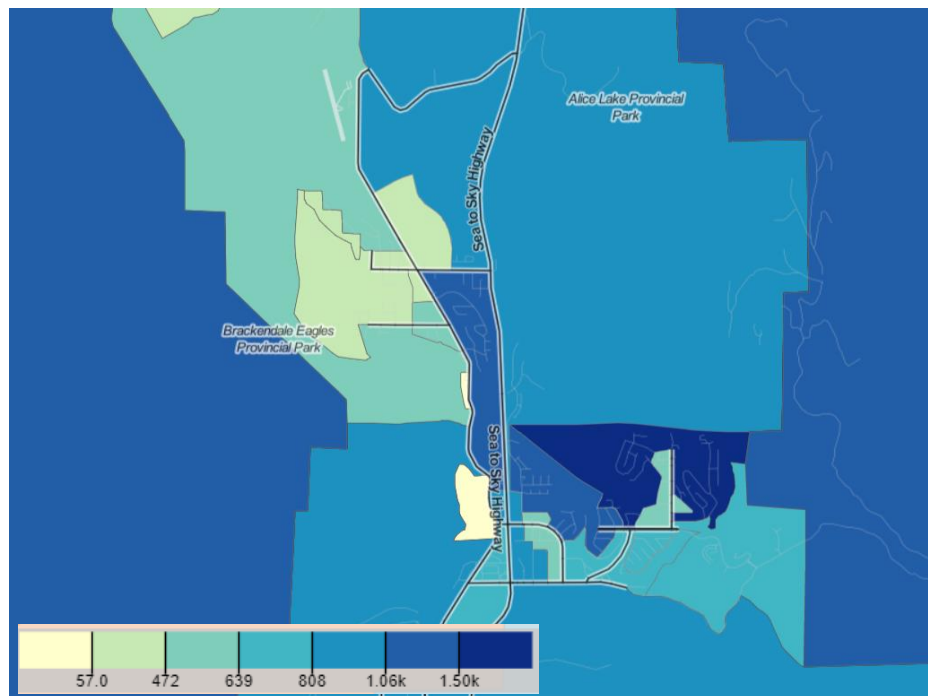


Figure 2.1: Population by Dissemination Area (2016 Census)

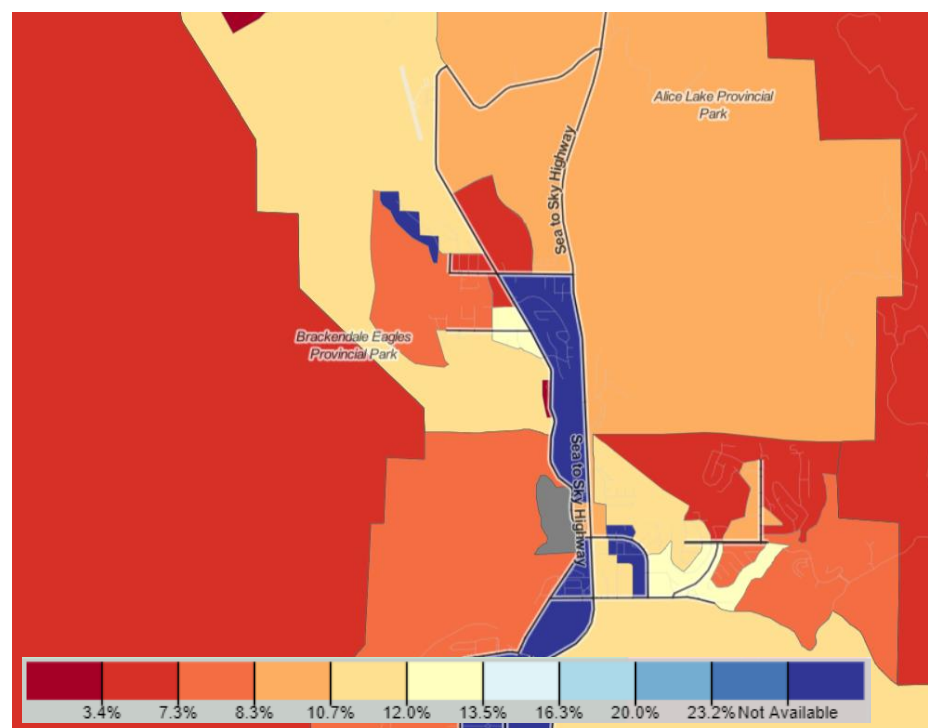


Figure 2.2: Active Commute Mode Share by Dissemination Area (2016 Census)

2.2 Highway 99 and Traffic Patterns

Highway 99 serves as a key north-south link that provides direct connection from the US Border and Vancouver to Whistler and beyond. As part of the 2010 Winter Olympics bid, the highway was widened to accommodate greater traffic loads. Within the District of Squamish, the Highway functions as a four-lane divided highway and has a posted speed limit of 60 km/hr or 80 km/hr. There are nine at grade signalized intersections along the roughly 20-kilometer corridor within the District boundary at the intersections of Shannon Falls Road, Valley Drive, Clarke Drive, Cleveland Avenue, Industrial Way, Commercial Way, Mamquam Road, Garibaldi Way, and Depot Road.

Traffic volume data was obtained from the BC Ministry of Transportation and Infrastructure. The permanent count station Cheekeye (P-15-3NS), about 3 kilometers north of the study area, is the closest count station on Highway 99 with continuous traffic data collected throughout the year. Highway 99 recorded 12,000 Annual Average Daily Traffic (AADT) vehicles per day north of Alice Lake in 2019 prior to the COVID-19 pandemic, with 15,000 August Monthly Average Weekday Traffic (MAWDT) and 18,000 Monthly Average Weekend Traffic (MAWET).

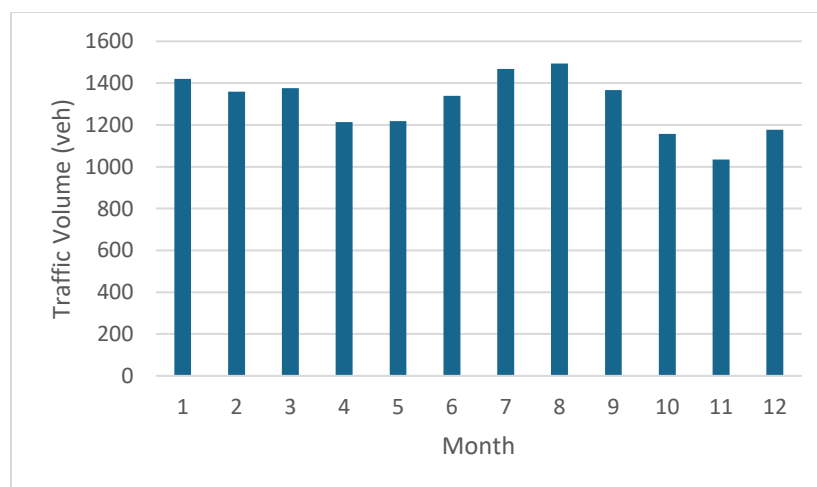


Figure 2.3: 2019 Friday Peak Hour Traffic Volume on Highway 99 (Cheekeye P-15-3NS)

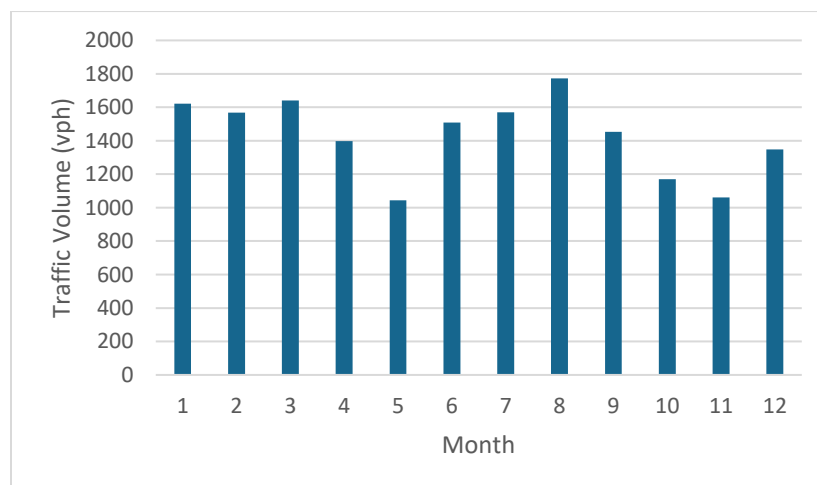


Figure 2.4: 2019 Sunday Peak Hour Traffic Volume on Highway 99 (Cheekeye P-15-3NS)

Traffic has been reduced due to the COVID-19 pandemic and has not returned to pre-pandemic level. It is anticipated that traffic levels will eventually return to pre-pandemic level. As a result, historical counts collected prior to 2020 are the only source of reliable information.

The available peak hour traffic data used for this study was counted on Friday February 17, 2017 and Sunday February 19, 2017. In general, February represents the fourth highest month in peak hour traffic volumes, as shown in Figures 2.3 and 2.4. In addition, the hourly profiles on Friday and Sunday, shown in Figures 2.5 and 2.6, demonstrate the peak hour traffic on both Friday and Sunday is around 4 PM.

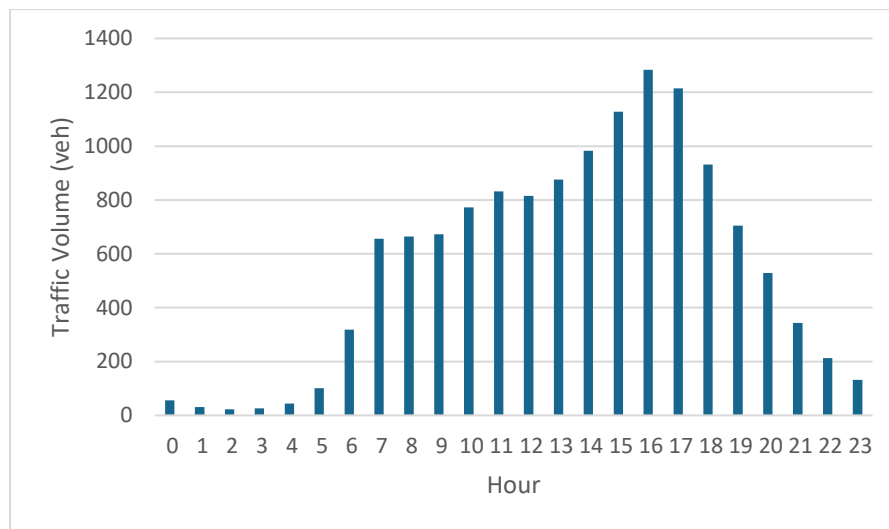


Figure 2.5: 2019 Friday Traffic Volume on Highway 99 (Cheekeye P-15-3NS)

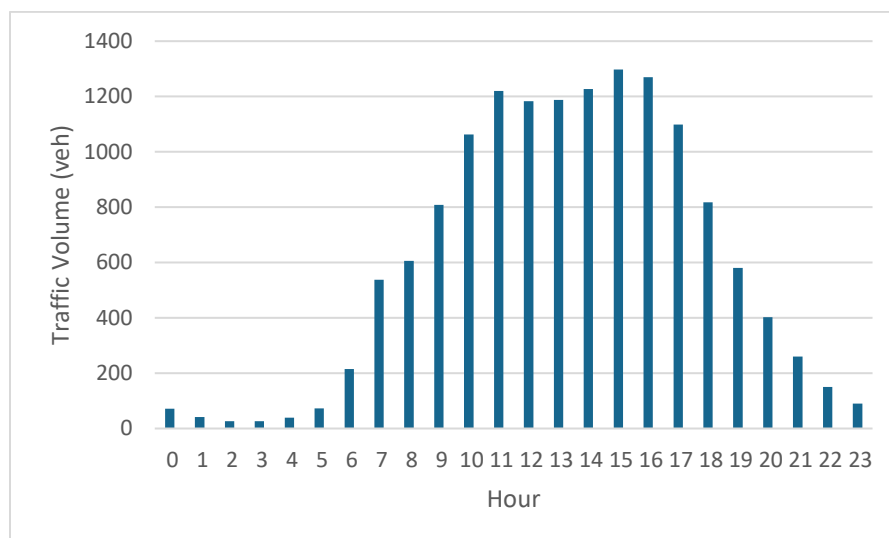


Figure 2.6: 2019 Sunday Traffic Volume on Highway 99 (Cheekeye P-15-3NS)

2.3 Travel Demand Forecasting Model

The travel demand model development and the analysis undertaken in this study used the VISUM 18 transportation planning software suite developed by PTV Group. This GIS-based travel forecasting model is a state-of-the-art transportation planning tool that can efficiently estimate changes in travel patterns and utilization of transportation systems in response to changes in land use, population, employment, and transportation infrastructure. It integrates mapping, land use planning, development projections, future traffic demand, and transportation networks to produce traffic forecasts that can be interpreted easily and presented in effective visual format.

The model includes the transportation network, be that existing or proposed, land use zones that include metrics to represent the existing or proposed land use including number of homes, employees, and students and with the transportation network connecting zones. Trips can be assigned from one zone to another using the available routes. Where congestion is present, the model will reassign trips onto different routes to balance demand across the network considering the time cost of the trip.

The traditional four-step travel demand modelling process was used for this study, as summarized in Figure 2.7 and below:

- **Trip Generation** – residential, commercial, industrial, and institutional land uses are used to determine the number of peak hour trips being generated for the study area;
- **Trip Distribution** – zone-to-zone trip distribution is based on the road network impedance (i.e., travel time) and determines a zone-to-zone origin-destination (OD) trip matrix;
- **Mode Split** – the OD trip matrix is split into various travel modes, such as driving, walking, and transit;
- **Trip Assignment** – the estimated OD trip matrix is assigned onto the established road network to get link volumes for the existing and future traffic scenarios.

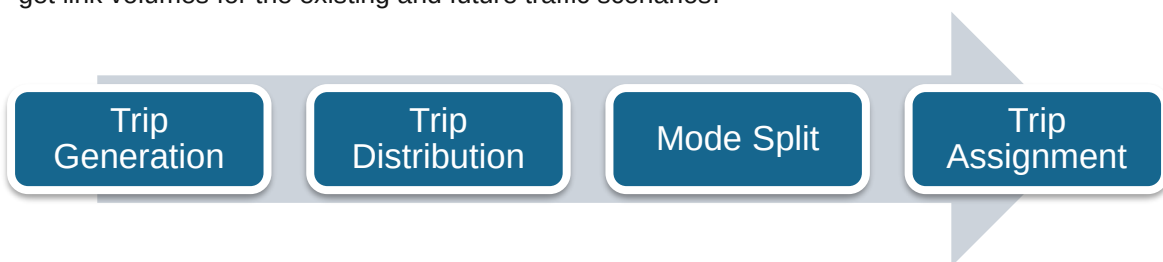


Figure 2.7: Traditional Four-Step Travel Demand Modelling Process

The existing travel demand model captures the existing travel patterns, including trip generation, trip distribution, model split, trip assignment, and pass-by traffic through Squamish. With a model calibrated to existing conditions, these characteristics can then be applied to the future transportation model of Squamish to forecast the future traffic volumes based on future land use and transportation network. The future transportation demand model provides Squamish with a scalable, flexible platform that can be readily adapted over time to include additional scenarios or transportation complexity as Squamish grows and intensifies.

2.3.1 Traffic Analysis Zones

The model consists of traffic analysis zones throughout the District. Traffic analysis zones are the source of trips and vehicles in the study area. Figure 2.8 shows traffic zones and road network within the study area with zones shown in green and the road network in grey.

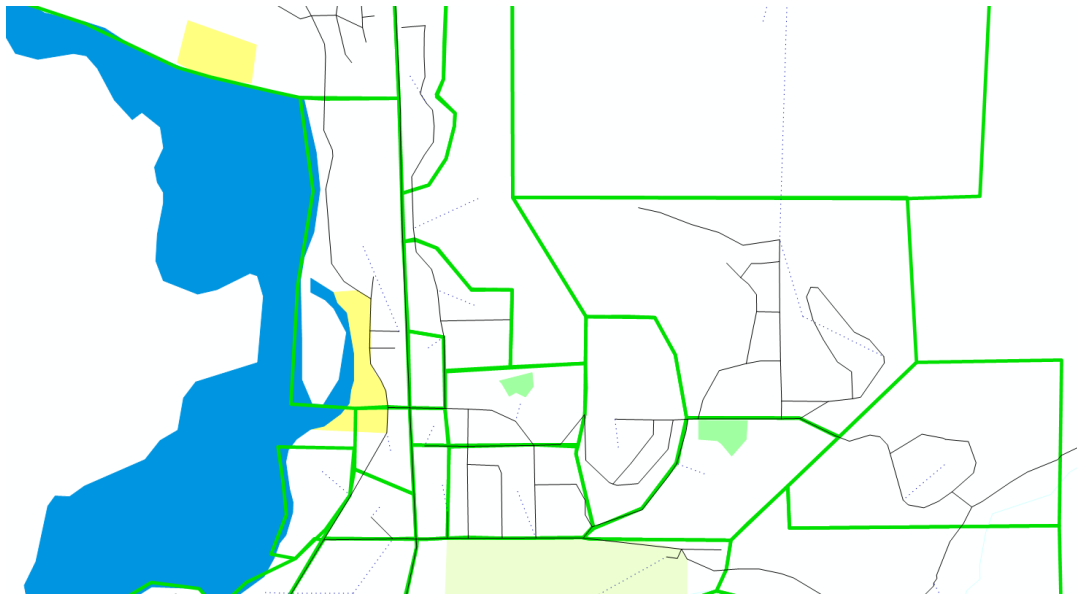


Figure 2.8: Model Traffic Analysis Zone (TAZ) and Road Network

2.3.2 Residential and Employment Data

Existing District-wide residential data was based on the number of households included in the 2018 BC Assessment data. This identifies every property within Squamish and its geolocation that is then cross-referenced with the traffic analysis zones.

District-wide employment data was gathered for the District based on the commuting flow data from the 2016 census. This overall number of employees was then distributed by traffic analysis zone based on known information regarding major employment locations, schools and universities.

Within the study area, residential and employment data were updated in Oct 2021 as part of this study.

2.3.3 Trip Origins and Destinations

Origin-Destination data was determined using Streetlight Data's OD service. This service utilizes "big data" to estimate origins and destinations based primarily on cell phone activity, with apps regularly pinging cell towers in the background or collecting location data actively while using GPS wayfinding or activity tracking apps. For this service to prove cost effective, the District was broken down into 10 primary OD zones with which to determine origins and destinations. An example of the number of trips originating Downtown during the PM peak hour is demonstrated in Figure 2.9. The information

was used directly in the development of the model, and indirectly in the calibration of the model, further described in Section 2.3.5.

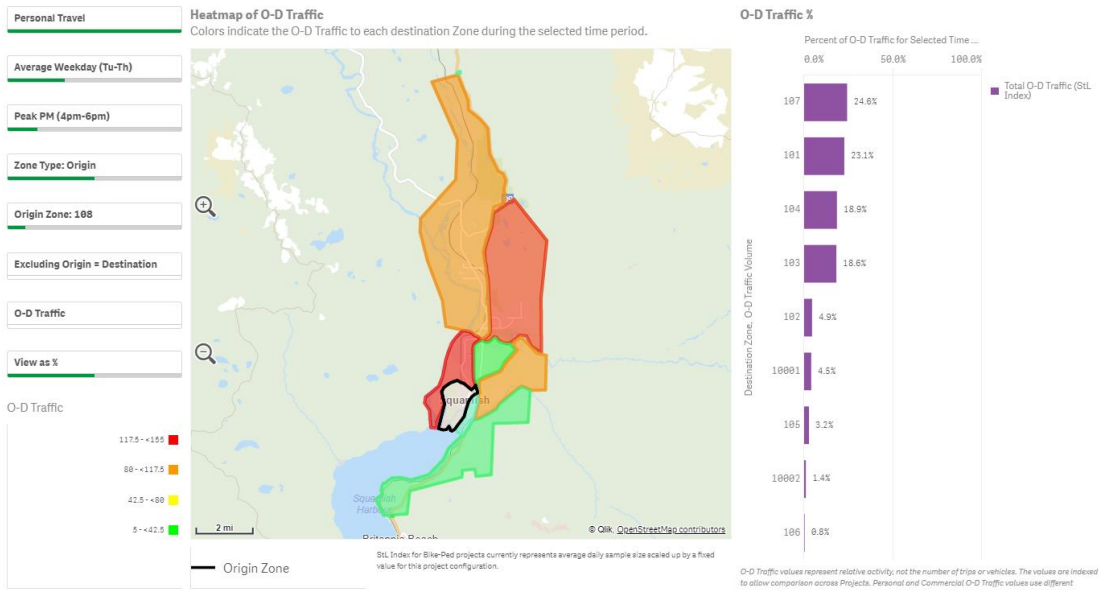


Figure 2.9: Weekday PM Peak Trips Originating Downtown

2.3.4 Road Network

The model consists of all major roads within the District. Each road modelled includes information about road class, number of lanes, speed, vehicle restrictions, intersection controls, turn restrictions. Roadway capacities used in the updated VISUM model are summarized in Table 2.2.

Table 2.2: Roadway Capacities

Road Classification	Capacity (veh/hr/lane)
Arterial (including Highway 99)	900-1,200
Collector	600-800
Local	400

The study area in the model was also reviewed in terms of access points, link speeds, capacities, intersection controls to reflect the existing condition.

2.3.5 Model Calibration

Prior to this study, traffic volume data from a number of locations throughout Downtown was used for the calibration of the base model. To improve model calibration within the study area, additional traffic volume data within the study area was used for the calibration of the base model. Traffic volumes were obtained from a number of existing traffic studies previously described in Section 1.1.

Using the updated transportation network, land use and traffic counts, the travel demand model was calibrated. Calibration plot of the base model for the weekday PM peak is provided in Figure 2.10. R-squared (R^2) is a statistical measure that compares the model data with observed data. R^2 values range from 0 to 1 with a value of 1 indicating that the model data matches the observed data perfectly. A model rarely ever provides an exact representation of observed conditions, the regression value (R^2) of 0.95 was obtained for the PM peak, which represents strong convergence with the existing traffic data.

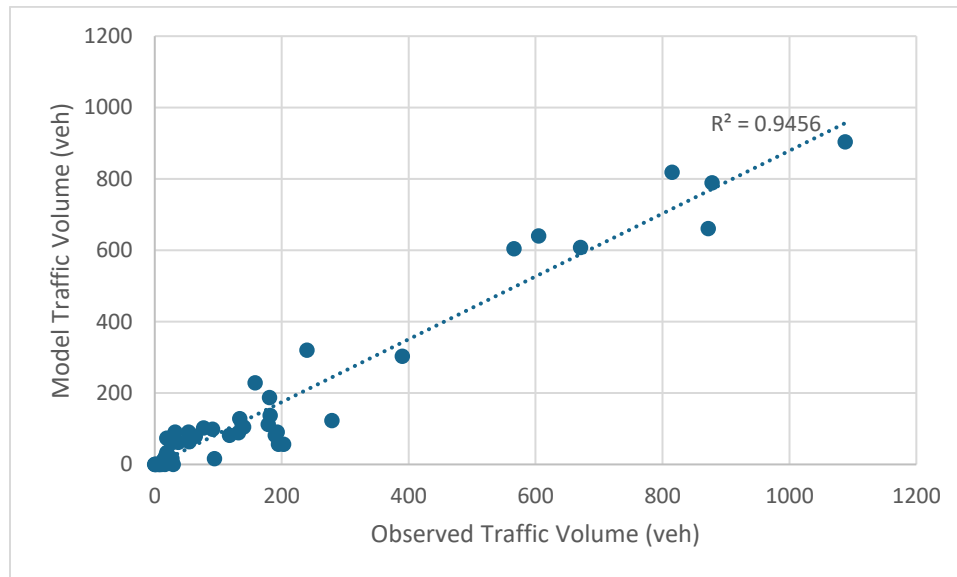


Figure 2.10: Modelled vs. Observed Traffic Volumes (2019 PM Base)

2.4 Travel Demand Model Results

Network travel time and network travel distance are represented by Vehicle Hours Travelled (VHT) and Vehicle Kilometers Travelled (VKT). VHT and VKT are an important metric to understand network traffic patterns and is useful in comparing different model scenarios. The 2019 VHT and VKT of the District road network, as modelled by VISUM, are reported in Table 2.3.

Table 2.3: Network Statistics

Scenario	VKT	VHT
2019 PM Base	38,650	1,800

A PM peak hour traffic volume plot of the study area is provided in Figure 2.11. The plot shows significant volume on Highway 99, as well as entering and leaving Garibaldi Highlands and Garibaldi Estates via Garibaldi Way and Mamquam Road. Traffic volumes on Mamquam Road just east of Highway 99 are nearly as high as Highway 99 north of Dowad Drive. It dissipates to the various side streets along Mamquam Road, Highland Way S, and The Boulevard.

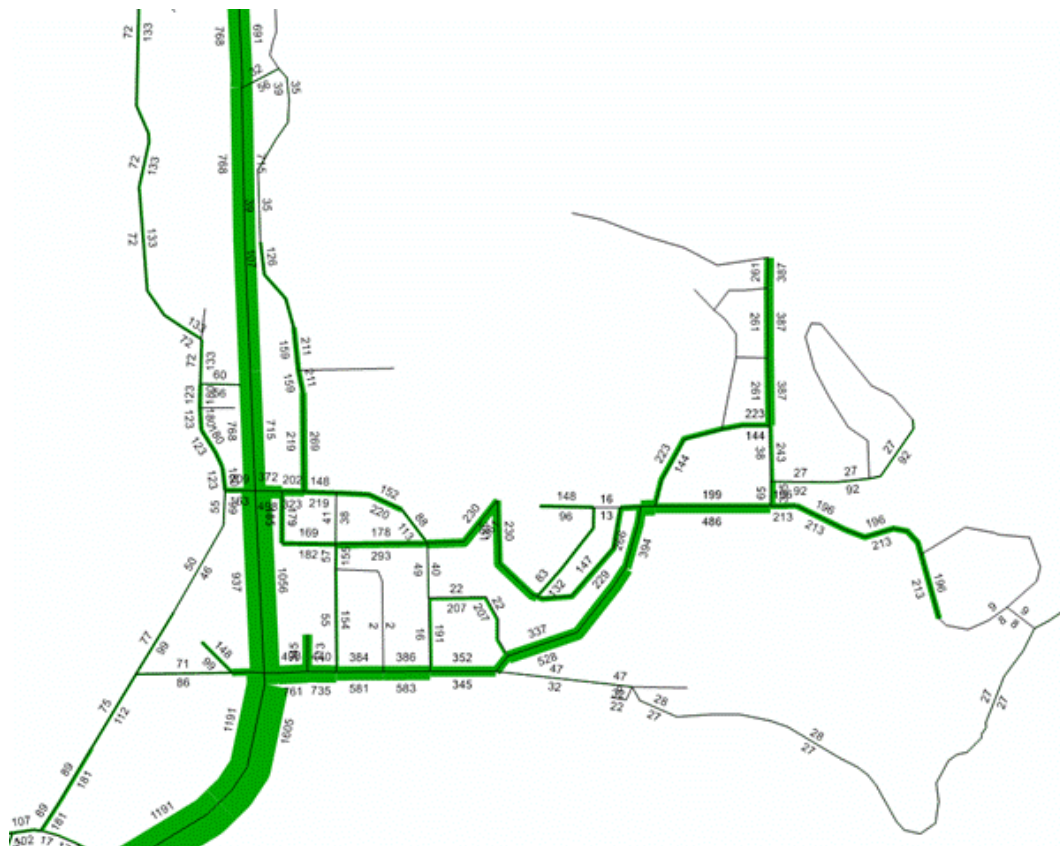


Figure 2.11: Link Volume Plot (2019 PM Base)

2.5 Intersection Operations

2.5.1 Methodology

Traffic operation performance was analyzed for the study intersections using *Synchro 10* software, which is based on the standard methods of the *Highway Capacity Manual (HCM)*. In *HCM*, measures of effectiveness are developed including control delay (seconds per vehicle) and Level of Service (LOS), which is defined based on the average control delay shown in Table 2.4.

Table 2.4: LOS Definition (HCM) for Signalized and Unsignalized Intersections

Traffic Control	Level of Service	A	B	C	D	E	F
Signalized	Delay (second/vehicle)	0-10	10-20	20-35	35-55	55-80	> 80
Unsignalized		0-10	10-15	15-25	25-35	35-50	> 50

For intersection capacity analysis in urban and suburban areas, LOS D or better has historically been considered as acceptable LOS for both signalized and unsignalized intersections. Intersections and/or individual movements that are operating at LOS E or F are highlighted for further investigations and potential mitigation measures. The terms of reference agreed with the BCMoTI stated that LOS E was acceptable. Traffic movements with V/C ratios above 0.9 are also highlighted for further investigations and potential mitigation measures. Queue length analysis was conducted

using *SimTraffic*, a traffic micro-simulation of *Synchro*. The 95th percentile queue length, which there is only a 5% chance to surpass during the peak hour, was used as the measures of effectiveness.

The LOS concept was first developed for highways in an era of rapid expansion in the use and availability of the private motor car. The primary concern was congestion, and it was commonly held that only the rapid expansion of the freeway network would keep congestion in check. However, aiming for high LOS is unrealistic in urban areas. In urban areas, the acceptance of poor LOS is becoming more common, due to skyrocketing land acquisition costs, and concerns on climate change, social equity, and community health. Many urban areas have standards that started with a few exceptions for LOS E, and eventually an overall acceptance of LOS E. Others have proposed measurements of LOS that takes other modes into account, instead of an automobile-focused one.

The understanding is that poor LOS can discourage further car trips from being generated. Where intersection improvements are made to accommodate future traffic, this reserve capacity can make driving more attractive in the short term and attract people from active modes or transit back into their automobile. While the study area could be considered suburban rather than urban, and people will have different expectations with respect to congestion, the principles of induced demand should be considered when reviewing the analysis and potential recommendations. Induced demand works for all modes and works in reverse, thus making it easier to drive means more people will drive, making it harder to drive will reduce trips or encourage people to combine trips or change their trip time to less congested periods. In addition, where improved walking, cycling, and transit alternatives are provided, the widened roadway and induced demand work against any effort made to provide safe, attractive, and efficient sustainable modes of transportation.

2.5.2 Traffic Volumes

The baseline traffic volumes were extracted from the *Garibaldi Springs Transportation Impact Assessment* (Final Report, May 2018). For this study, turning movement counts were first collected on February 17 (Friday) and 19 (Sunday) of 2017 at all study intersections. The second turning movement counts survey was conducted on December 8 (Friday) and 10 (Sunday) of 2017 at the intersections along Highway 99 and Tantalus Road to reflect the possible shift in travel patterns due to the new right-in-right-out connection to Highway 99 at Dowad Drive in June 2017. Since higher traffic volumes were observed during the February survey compared to December, the 2017 February peak hour traffic volumes were adjusted using the December data to account for the new intersection at Dowad Drive and Highway 99.

To estimate the 2019 peak hour traffic volumes, a linear annual traffic growth rate of 2% was applied to the Highway 99 through traffic volumes. For other turning movements, 1% growth rate was applied. Since turning movement counts were collected in different dates, volume balancing was undertaken where applicable. Overall, the Friday peak hour was identified as 4:30 to 5:30 pm, while the Sunday peak hour was found to be 3:45 to 4:45 pm. The 2019 peak hour traffic volumes and the traffic analysis results are provided in the following section. It is noted that the BCMoTI provided turning movement count data collected between November 12 (Wednesday) to November 19 (Wednesday) for the Highway 99 intersections at Mamquam Road and Garibaldi Way. Compared to the 2017 February data, it was found that there was about 20% reduction in total intersection entering traffic volumes during both Friday and Sunday peak hours, which could be mainly due to the COVID-19 pandemic. This traffic data was not used for this study.

2.5.3 Traffic Analysis Results

Friday Peak

The 2019 Friday peak traffic analysis results are summarized for the study intersections on Highway 99 and the ones within Squamish in Table 2.5 and 2.6, respectively.

Highway 99 Intersections – All intersections are currently operating at acceptable level of service (Intersection LOS C or better). No issues were identified at the Dowad Drive intersection. However, the following traffic issues for individual turn movements were noted at Garibaldi Way and Mamquam Road intersections:

- Garibaldi Way: The north/south left-turn movements from Highway 99 to Garibaldi Way (LOS E) are experiencing notable delays due to high traffic volumes (about 185 vehicle/h) and relatively short effective green times. Based on the 95th percentile queues, the eastbound through traffic (highest traffic movement on Garibaldi Way) could block access to the channelized right-turn lane. Moreover, the westbound left-turn traffic queue spills over to the through lane and could block the channelized right-turn lane as well.
- Mamquam Road: All turning movements operate at acceptable level of service. The queue length analysis indicated long traffic queues for the left-turn movements from Mamquam Road to Highway 99, especially the westbound left-turn (about 400 veh/h).

Table 2.5: 2019 Friday Peak Traffic Operation Performance for Highway 99 Intersections

Study Intersection along Highway 99 [control type]	Measure of Effectiveness (MOE)	Highway 99								Intersecting Street								Intersection OVERALL
		Northbound				Southbound				Eastbound				Westbound				
		Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	
Dowad Drive [WB STOP-controlled, RIRO]	Available Storage/Lane Length (m)	-	-	100	-	-	-	-	-	-	-	-	-	-	-	120	-	-
	Applied Volume (veh/hr)	-	907	28	935	Restricted	933	-	933	-	-	-	-	-	-	27	27	1,895
	Delay (s/veh)	-	0	0	0		0	-	0						-	12	12	0
	Level of Service	-	A	A	A		A	-	A						-	B	B	A
	Volume / Capacity	-	0.29	0.02	-		0.30	-	-						-	0.06	-	-
	95th %ile Queue (m)	-	0	0	-		0	-	-						-	0	-	-
Garibaldi Way [traffic signal]	Available Storage/Lane Length (m)	110	-	95	-	135	-	90	-	40	100	30	-	25	75	30	-	-
	Applied Volume (veh/hr)	186	710	245	1,141	183	654	96	933	28	208	135	371	162	199	197	558	3,003
	Delay (s/veh)	71	10	3	19	55	32	3	33	34	47	8	32	29	25	4	19	25
	Level of Service	E	B	A	B	E	C	A	C	C	D	A	C	C	A	B	C	
	Volume / Capacity	0.73	0.63	0.39	-	0.72	0.60	0.17	-	0.15	0.66	0.37	-	0.53	0.33	0.32	-	-
	95th %ile Queue (m)	64	51	0	-	60	70	0	-	23	62	38	-	42	56	31	-	-
Mamquam Road [traffic signal]	Available Storage/Lane Length (m)	110	-	75	-	125	-	100	-	20	450	30	-	35	125	125	-	-
	Applied Volume (veh/hr)	79	1,132	578	1,789	66	848	37	951	38	121	33	192	398	143	93	634	3,566
	Delay (s/veh)	51	37	9	29	41	24	2	24	46	54	1	43	54	22	5	40	30
	Level of Service	D	D	A	C	D	C	A	C	D	D	A	D	D	C	A	D	C
	Volume / Capacity	0.48	0.86	0.68	-	0.44	0.66	0.06	-	0.30	0.61	0.11	-	0.92	0.22	0.16	-	-
	95th %ile Queue (m)	36	110	50	-	26	78	0	-	23	48	20	-	68	107	0	-	-

The bold red values indicate critical movements (LOS E/F), v/c ratio above 0.90, or inadequate storage lengths.

Squamish Intersections – All intersections are currently operating at acceptable level of service (LOS A), except Garibaldi Way at the Plaza Parking Access (LOS E). No issues were identified for the Tantalus Road intersections at Dowad Drive and Newport Ridge Drive. However, the following traffic issues were noted at the Garibaldi Way intersections:

- Tantalus Road / Garibaldi Way: The northbound left-turn movement from Tantalus Road to Garibaldi Way (LOS E) is experiencing a notable delay due to limited available safe gap on

Garibaldi Way. This also causes the northbound left-turn queue to spill over to the through/right-turn lane.

- **Plaza Parking Access / Garibaldi Way:** The northbound left-turn movement from the Plaza Parking Access to Garibaldi Way (LOS F) is experiencing a significant delay due to high left-turn traffic volume (about 195 veh/h) and limited available safe gap on Garibaldi Way. This causes long left-turn queue spilling over to the northbound right-turn lane.

Table 2.6: 2019 Friday Peak Traffic Operation Performance for Squamish Intersections

Study Intersection within Squamish [control type]	Measure of Effectiveness (MOE)	Northbound				Southbound				Eastbound				Westbound				Intersection OVERALL
		Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	
		20	-	-	-	-	-	-	-	35	-	-	30	-	-	-	-	
Tantalus Road / Dowad Drive [4-way STOP-controlled]	Available Storage/Lane Length (m)	20	-	-	-	-	-	-	-	35	-	-	30	-	-	-	-	-
	Applied Volume (veh/hr)	18	12	17	47	2	9	2	13	4	9	15	28	30	7	0	37	125
	Delay (s/veh)	7	6	6	7	8	8	8	8	7	6	6	7	7	7	0	7	7
	Level of Service	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	Volume / Capacity	0.03	0.04	-	-	0.02	-	-	-	0.01	0.03	-	-	0.05	0.01	-	-	-
Tantalus Road / Newport Ridge Drive [WB STOP-controlled]	Available Storage/Lane Length (m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Applied Volume (veh/hr)	-	127	25	152	0	95	-	95	-	-	-	-	19	-	0	19	266
	Delay (s/veh)	-	0	0	0	0	0	-	0	-	-	-	-	10	-	10	10	1
	Level of Service	-	A	A	A	A	A	-	A	-	-	-	-	B	-	B	B	A
	Volume / Capacity	-	0.10	-	-	0.00	-	-	-	-	-	-	-	0.03	-	0.03	-	-
Tantalus Road / Garibaldi Way [SB STOP-controlled]	Available Storage/Lane Length (m)	15	160	-	-	40	-	-	-	45	-	-	75	-	-	-	-	-
	Applied Volume (veh/hr)	63	18	7	88	43	12	137	192	185	227	59	471	10	132	38	180	931
	Delay (s/veh)	45	20	20	38	18	18	18	18	2	4	4	4	0	1	1	1	10
	Level of Service	E	C	C	E	C	C	C	C	A	A	A	A	A	A	A	A	A
	Volume / Capacity	0.44	0.11	-	-	0.34	0.34	-	-	0.16	-	-	-	0.01	-	-	-	-
Garibaldi Way / Plaza Parking Access [NB STOP-controlled]	Available Storage/Lane Length (m)	25	165	-	-	-	-	-	-	75	-	-	45	-	-	-	-	-
	Applied Volume (veh/hr)	195	7	73	275	7	2	29	38	34	413	189	636	42	334	4	380	1,329
	Delay (s/veh)	251	14	14	182	17	17	17	17	0	1	1	1	1	2	2	2	39
	Level of Service	F	B	B	F	C	C	C	C	A	A	A	A	A	A	A	A	E
	Volume / Capacity	1.36	0.19	-	-	0.12	-	-	-	0.03	-	-	-	0.05	-	-	-	-
Garibaldi Way / Plaza Parking Access [NB STOP-controlled]	Available Storage/Lane Length (m)	41	56	-	-	16	-	-	-	25	-	-	28	-	-	-	-	-
	Applied Volume (veh/hr)	195	7	73	275	7	2	29	38	34	413	189	636	42	334	4	380	1,329
	Delay (s/veh)	251	14	14	182	17	17	17	17	0	1	1	1	1	2	2	2	39
	Level of Service	F	B	B	F	C	C	C	C	A	A	A	A	A	A	A	A	E
	Volume / Capacity	1.36	0.19	-	-	0.12	-	-	-	0.03	-	-	-	0.05	-	-	-	-
	95th %ile Queue (m)	41	56	-	-	16	-	-	-	25	-	-	28	-	-	-	-	-

The bold red values indicate critical movements (LOS E/F), v/c ratio above 0.90, or inadequate storage lengths.

Sunday Peak

The 2019 Sunday peak traffic analysis results are summarized for the study intersections on Highway 99 and the ones within Squamish in Table 2.7 and 2.8, respectively.

Highway 99 Intersections – All intersections are currently operating at acceptable level of service (Intersection LOS C or better). No issues were identified at the Dowad Drive intersection. However, the following traffic issues were noted at Garibaldi Way and Mamquam Road intersections:

- **Garibaldi Way:** The southbound left-turn (LOS E) and the eastbound through (LOS E) are experiencing notable delays. The poor traffic performance of the southbound left-turn and eastbound through are due to high traffic volumes and relatively short effective green times. Based on the 95th percentile queues, similar to the Friday peak, the eastbound through traffic could block the right-turn channelized lane. Moreover, the westbound left-turn traffic queue spills over to the through lane.
- **Mamquam Road:** The left-turn movements from Highway 99 to Mamquam Road are experiencing significant delays (LOS E) due to relatively short effective green times. The eastbound through traffic is also operating poorly (LOS E) for the same reason. Similar to the

Friday peak, a long westbound left-turn queue was identified, which is due to high traffic volume (about 310 veh/h).

Table 2.7: 2019 Sunday Peak Traffic Operation Performance for Highway 99 Intersections

Study Intersection along Highway 99 [control type]	Measure of Effectiveness (MOE)	Highway 99								Intersecting Street								Intersection OVERALL
		Northbound				Southbound				Eastbound				Westbound				
		Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	
Dowad Drive [WB STOP-controlled, RIRO]	Available Storage/Lane Length (m)	-	-	100	-	-	-	-	-	-	-	-	-	-	-	120	-	-
	Applied Volume (veh/hr)	-	506	20	526	Restricted	1,235	-	1,235	-	-	-	-	-	11	11	1,772	
	Delay (s/veh)	-	0	0	0		0	-	0									
	Level of Service	-	A	A	A		A	-	A					-	B	B	A	
	Volume / Capacity	-	0.16	0.01	-		0.39	-	-					-	0.02	-	-	
	95th %ile Queue (m)	-	0	0	-		0	-	-					-	0	-	-	
Garibaldi Way [traffic signal]	Available Storage/Lane Length (m)	110	-	95	-	135	-	90	-	40	100	30	-	25	75	30	-	-
	Applied Volume (veh/hr)	113	400	138	651	210	907	123	1,240	20	156	179	355	147	139	106	392	2,638
	Delay (s/veh)	49	50	29	45	70	27	5	32	43	56	10	32	38	33	6	28	35
	Level of Service	D	D	C	D	E	C	A	C	D	E	B	C	D	C	A	C	C
	Volume / Capacity	0.61	0.30	0.21	-	0.81	0.59	0.17	-	0.12	0.61	0.50	-	0.53	0.28	0.21	-	-
	95th %ile Queue (m)	43	63	6	-	69	84	0	-	16	58	33	-	44	48	18	-	-
Mamquam Road [traffic signal]	Available Storage/Lane Length (m)	110	-	75	-	125	-	100	-	20	450	30	-	35	125	125	-	-
	Applied Volume (veh/hr)	44	714	322	1,080	64	1,136	28	1,228	22	65	33	120	308	95	61	464	2,892
	Delay (s/veh)	59	23	4	19	70	17	0	19	54	58	1	42	49	29	6	39	23
	Level of Service	E	C	A	B	E	B	A	B	D	E	A	D	D	C	A	D	C
	Volume / Capacity	0.37	0.44	0.36	-	0.47	0.67	0.03	-	0.22	0.42	0.14	-	0.79	0.18	0.13	-	-
	95th %ile Queue (m)	24	69	6	-	34	76	0	-	17	33	6	-	66	84	0	-	-

The bold red values indicate critical movements (LOS E/F), v/c ratio above 0.90, or inadequate storage lengths.

Squamish Intersections – All intersections are currently operating at acceptable level of service (LOS A). No issues were identified for the study intersections along Tantalus Road. However, the northbound left-turn movement from the Plaza Parking Access to Garibaldi Way is experiencing a notable delay (LOS E) due to high left-turn traffic volume (about 175 veh/h) and limited available safe gap on Garibaldi Way. This causes a long left-turn queue spilling over to the northbound right-turn lane.

Table 2.8: 2019 Sunday Peak Traffic Operation Performance for Squamish Intersections

Study Intersection within Squamish [control type]	Measure of Effectiveness (MOE)	Northbound				Southbound				Eastbound				Westbound				Intersection OVERALL
		Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	
		Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	
Tantalus Road / Dowad Drive [4-way STOP-controlled]	Available Storage/Lane Length (m)	20	-	-	-	-	-	-	-	35	-	-	-	30	-	-	-	-
	Applied Volume (veh/hr)	8	10	18	36	0	10	3	13	4	7	9	20	15	0	4	19	88
	Delay (s/veh)	7	6	6	6	8	8	8	8	7	6	6	6	7	0	6	7	7
	Level of Service	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	Volume / Capacity	0.01	0.04	-	-	0.02	-	-	-	0.01	0.02	-	-	0.02	0.00	-	-	-
	95th %ile Queue (m)	10	12	-	-	11	-	-	-	3	11	-	-	11	5	-	-	-
Tantalus Road / Newport Ridge Drive [WB STOP-controlled]	Available Storage/Lane Length (m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Applied Volume (veh/hr)	-	97	17	114	2	68	-	70	-				16	-	0	16	200
	Delay (s/veh)	-	0	0	0	0	0	-	0					10	-	10	10	1
	Level of Service	-	A	A	A	A	A	-	A					A	-	A	A	A
	Volume / Capacity	-	0.07	-	-	0.00	-	-	-					0.02	-	0.02	-	-
	95th %ile Queue (m)	-	0	-	-	1	-	-	-					11	-	11	-	-
Tantalus Road / Garibaldi Way [SB STOP-controlled]	Available Storage/Lane Length (m)	15	160	-	-	-	-	40	-	45	-	-	-	75	-	-	-	-
	Applied Volume (veh/hr)	31	7	4	42	28	10	77	115	126	173	54	353	8	91	17	116	626
	Delay (s/veh)	19	14	14	18	12	12	12	12	1	3	3	3	0	1	1	1	5
	Level of Service	C	B	B	C	B	B	B	B	A	A	A	A	A	A	A	A	A
	Volume / Capacity	0.12	0.03	-	-	0.13	0.13	-	-	0.09	-	-	-	0.01	-	-	-	-
	95th %ile Queue (m)	14	9	-	-	16	14	-	-	22	-	-	-	1	-	-	-	-
Garibaldi Way / Plaza Parking Access [NB STOP-controlled]	Available Storage/Lane Length (m)	25	165	-	-	-	-	-	-	75	-	-	-	45	-	-	-	-
	Applied Volume (veh/hr)	173	6	80	259	6	7	29	42	32	300	171	503	30	190	5	225	1,029
	Delay (s/veh)	44	12	12	33	14	14	14	14	1	1	1	1	1	1	1	1	10
	Level of Service	E	B	B	D	B	B	B	B	A	A	A	A	A	A	A	A	A
	Volume / Capacity	0.69	0.16	-	-	0.10	-	-	-	0.03	-	-	-	0.03	-	-	-	-
	95th %ile Queue (m)	30	24	-	-	15	-	-	-	41	-	-	-	18	-	-	-	-

The bold red values indicate critical movements (LOS E/F), v/c ratio above 0.90, or inadequate storage lengths.

■ 3.0 Future Condition Analysis

The primary objective of the future condition analysis is to identify population thresholds that trigger major transportation infrastructure upgrades based on projected growth.

This section is subdivided into Land Use, Mode Share, Road Network, Travel Forecasts, Intersection Operations, and Development Thresholds. The first three provide descriptions of projections and assumptions, while the latter three provides result analyses, insights, and findings.

3.1 Land Use

There are three main categories of land use projections: residential, employment, and university enrolment. Each of them was treated differently. Estimations within the study area were provided by District staff.

3.1.1 Population Projections

The population in Squamish is projected to increase from 20,800 in the year 2019 to 45,600 by the year 2040, under a high growth scenario described in the OCP. The doubling of the population is equivalent to an annual increase of 3.8% per year compounded. Residential developments were projected by area, including major new sub-area plans of the following areas:

- Newport Beach (3700 units)
- Downtown (3300 units)
- Waterfront Landing (1100 units)
- Scott Crescent (435 units)

This population projection for the community roughly correlates to the high growth scenario contemplated in development of the 2040 Official Community Plan and reflects an assumption of significant population growth across the community over the next decades. The intention is to identify where traffic issues may arise, recognizing that the identified timeline for issues arising is likely slower and some of the projected traffic challenges may not ultimately manifest. The goal is to ensure that the study contemplates a high impact growth scenario so as to not underestimate potential traffic challenges.

A revised population projection within the study area was provided by District staff. Table 3.1 and 3.2 reflect an assumption regarding the maximum potential development (infill and greenfield) that could occur within the study area over the time frame of this study ending in 2040. Estimates of additional dwelling unit numbers include approved developments and developments currently under application. The estimates also include full build out of secondary suites and accessory dwelling units where appropriate across the plan area as well as several potential large greenfield developments that are designated both Neighbourhood Residential and Future Neighbourhood Residential. These include developments on District Lots 509 and 510, District Lots 510 and 511, and Parcel A located north of Quest University. Within the Garibaldi Estates Neighbourhood estimates include a broad application of missing middle housing forms that reflect the size of existing permitted single family dwelling units, a limited number of attached multifamily dwellings and a limited amount of new mixed use buildings. Recognizing that the outcome of the planning process has not been determined, these estimates reflect a high growth scenario that maximizes the traffic impact within the context of this study,

recognizing that the identified timeline for issues arising is likely much slower and some of the projected traffic challenges may not ultimately manifest.

Table 3.1 shows the number of dwelling units within the study area in addition to existing number of dwelling units.

Table 3.1: Study Area Additional Dwelling Units

Area	Multi-Family Units
Garibaldi North-South	19
Resort+ Executive Inn	155
Garibaldi East-North	107
Garibaldi Commercial	222
Garibaldi East	376
Highlands	907
DL 509/510	550

3.1.2 Employment Projections

The initial employment projection was primarily for Downtown and Newport Beach. However, the imbalance in population and employment would cause the model to account for it by having residents commute to locations far away from Squamish. A subsequent employment projection examines the possibility of increasing employment in other areas in Squamish. In this projection, the employment in Squamish is expected to increase by 130%, which translates into a growth rate of 4.0% per year compounded from 2019 to 2040. The *Employment Lands Strategy (2015 EcoPlan)* was used to locate vacant parcels in Squamish. Employment was projected by area, including major new employment lands of the following areas:

- Downtown (1600 employees)
- Newport Beach (2100 employees)
- Squamish Business Park (2600 employees)

A revised employment projection within the study area was provided by District staff. Table 3.2 shows the number of employees within the study area in addition to existing number of employees.

Table 3.2: Study Area Additional Employees

Area	Retail Employees	Service Employees
Garibaldi North-South	12	0
Resort+ Executive Inn	0	0
Garibaldi East-North	11	45
Garibaldi Commercial	21	78
Garibaldi East	84	204
Highlands	39	45
DL 509/510	14	0

3.1.3 University Student Projections

An additional 200 university students within the study area are estimated at Quest University.

3.2 Mode-Share

The District has ambitious targets to increase travel by sustainable modes which have been reflected in past traffic forecasts and continue to be considered in this study. When forecasting traffic, if existing mode-share is used, this can result in over designing improvements to accommodate demand that the district does not want, inducing that auto demand. By forecasting for a larger sustainable mode share, the district can estimate the transportation network improvements required to accommodate a population that travels more sustainably than it does today. After the initial review of traffic count data, this section of Highway 99 is mixed with long-distance regional trips and short distance local trips. For long-distance trips, while BC Transit has a long-term plan to provide regional transit services, connecting Vancouver, Squamish, and Whistler, the service during the weekday PM peak hour would not be frequent enough to provide a substantial mode shift. However, for short-distance trips, not only is BC Transit planning to increase transit mode share with increased local services through the Garibaldi area, the District of Squamish is actively planning and building walking and cycling connections and facilities to enable and accommodate this planned mode shift. As such, the analysis part of this study is based on the following mode shares in the 2040 horizon year:

- 100% External Traffic (long-distance regional)
- 75% Internal Traffic (short-distance local)

BC is committed to reducing greenhouse gas emissions by 16% below 2007 levels by 2025, 40% by 2030, 60% by 2040 and 80% by 2050. Different levels of government are taking action to meet their climate goals, prepare for the impacts of climate change, and transition to a net zero future. Local governments recognize that together they have direct or indirect influence over more than half of BC's provincial inventory of GHG emissions. They also recognise that climate action also supports the health, well-being, and environmental and fiscal sustainability of their communities. 516 municipalities have declared a climate emergency in Canada. Some have made climate action a priority, and set bold targets for increasing sustainable mode share. Table 3.3 shows an example of current targets that some BC municipalities are working towards.

Table 3.3: Sustainable Mode Share Targets

Municipality	Current	Target	Year
Richmond	27%	50%	2041
Coquitlam	20%	30%	2031
New Westminster	35%	60%	2041
White Rock	18%	33%	2040
Port Moody	17%	40%	2030
Pitt Meadows	11%	20%	2031
Courtenay	15%	30%	2038
Victoria	37%	60%	2041
Saanich	24%	50%	2050
Colwood	11%	30%	2038

These are ambitious targets, and it is common practice to create aspiration targets. Some have made policies and sustainable transportation investments central to their latest transportation plans. These policies could include transportation demand management and changes to infrastructure such as controlling the demand for the use of unsustainable modes, expanding the availability of sustainable alternatives, and providing incentives and penalties.

Squamish will soon be updating their Transportation Master Plan, and a new sustainable mode share target will be developed as part of this process. The older 2031 Multi-Modal Transportation Study had a target to reduce single occupant vehicle trips to 63% by 2031. While Squamish is not likely to attain that target, a 25% sustainable mode share by 2040 a reasonable goal, and is in line with those set by other municipalities (note that denser, more urban areas are able to meet higher sustainable transportation goals than less dense, rural areas).

3.3 Road Network Changes

Based on discussions with the District of Squamish, future road connections outside the study area that are assumed to be built by 2040 include:

- Pemberton Bridge
- Bailey-Buckley Connection at Third Avenue
- Pioneer-Government Connection
- Valleycliffe-Finch Drive Connection

These road network improvements are included in the 2040 Base scenario.

Concurrently with this study, the BCMoTI is conducting a Highway 99 Squamish Corridor Review. The review identified the following future road improvements within the study area, which are assumed to be built by 2040:

- Highway 99 / Dowad Drive Conversion to Protected-T Intersection
- Highway 99 / Garibaldi Way Dual Westbound Left Turn Lanes, and Smart Channel Right Turns
- Highway 99 / Mamquam Road Dual Westbound Left Turn Lanes, and Smart Channel Right Turns

These road network improvements are included in the 2040 Base + scenario.

3.4 Travel Demand Model Results – 2040 Base

Network travel time and network travel distance are represented by Vehicle Hours Travelled (VHT) and Vehicle Kilometers Travelled (VKT). VHT and VKT are an important metric to understand changes in traffic patterns and is useful in comparing different model scenarios. The 2040 VHT and VKT of the District road network, as modelled by VISUM, are reported in Table 3.4.

Table 3.4: Network Statistics

Scenario	VKT	VHT
2040 PM Base	65,713	3,137
2040 PM Base +	65,516 (-197)	3,122 (-15)

It should be noted that even with the substantial reduction in auto mode share, there is still a significant increase in VHT and VKT as population growth outpaces the change in mode share.

PM peak hour traffic volume plots of the study area for the Base and Base+ scenarios are provided in Figure 3.1. The plot shows significant volume increases on Highway 99, as well as entering and leaving Garibaldi Highlands and the new development areas via Dowad Drive, Garibaldi Way, and Newport Ridge Drive. Nominal increases are shown on Mamquam Road and the eastern part of Garibaldi Way, as existing population in developed areas shifts to more sustainable modes.

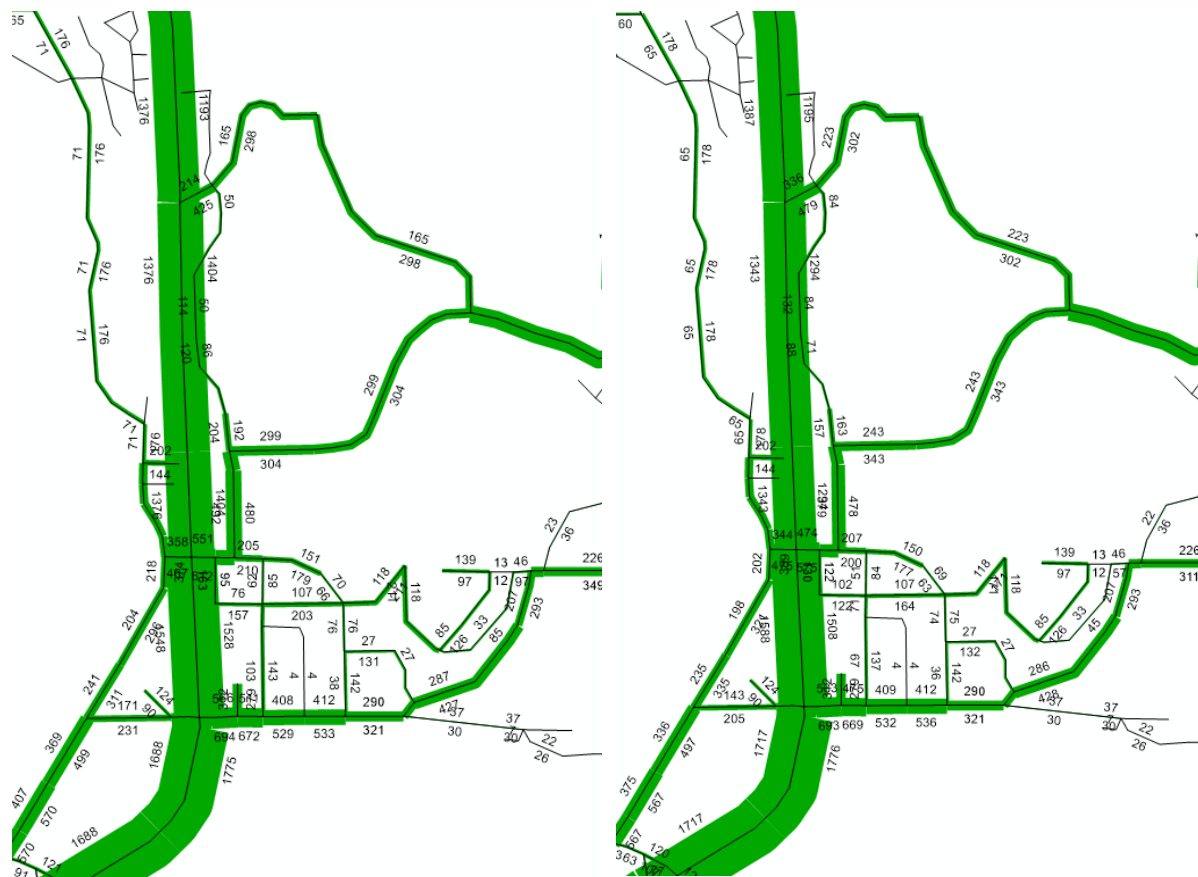


Figure 3.1: Link Volume Plot (Left: 2040 PM Base, Right: 2040 PM Base +)

3.5 Intersection Operations – 2040 Base

3.5.1 Traffic Volumes

Given the assumptions discussed for future land use projections in Section 3.1, it is anticipated that the key study intersections will continue experiencing higher traffic volumes during the Friday peak as compared to the Sunday peak. Therefore, the future intersection operation analysis is focused only on the Friday peak hour (worst-case scenario).

The 2040 future traffic volumes were determined by adding the vehicle trips generated by future land uses with 50% buildout to the 2019 base traffic volumes. The 2040 Friday peak hour traffic volumes and traffic analysis results are provided and discussed in the following sections.

3.5.2 Traffic Analysis Results

2040 Base Scenario

The 2040 Friday peak traffic analysis results under existing lane configurations and traffic controls are summarized for the study intersections on Highway 99 and the ones within Squamish in Table 3.5 and 3.6, respectively. It is noted that signal optimization was performed for the signalized intersections on Highway 99.

Highway 99 Intersections – All intersections will be operating at acceptable overall levels of service (Intersection LOS D or better). Similar to the existing condition, no issues were identified at the Dowad Drive intersection. However, the following traffic issues were noted at Garibaldi Way and Mamquam Road intersections:

- Garibaldi Way: The left-turn movements from Highway 99 to Garibaldi Way would experience increased average delays (from LOS E to F) with vehicle queue spillover to the Highway 99 through lanes (up to 277 m in the southbound direction). Moreover, the northbound through traffic queue (167 m) would block access to the right-turn lane. For the Garibaldi Way approaches, notable delays are expected at the eastbound approach (from LOS C to E) with potential queue spillover to Government Road. The westbound left-turn traffic would experience increased delay (from LOS C to F) with potential queue backed up to the Plaza access.
- Mamquam Road: By 2040, the north-south left-turn movements from Highway 99 to Mamquam Road as well as the northbound through traffic would experience increased delay (from LOS D to E/F). Although the left-turn storage lengths were found sufficient, long northbound traffic queue could block access to the right-turn lane. The average delays for vehicles exiting Mamquam Road to the highway would be almost doubled (from LOS D to E/F). The traffic queues on Mamquam Road approaches were found to extend above 200 m, impacting the traffic signal at Glenalder Place, and blocking access to Diamond Head Road.

Table 3.5: 2040 Friday Peak Traffic Operation Performance for Highway 99 Intersections – Base

Study Intersection along Highway 99 [control type]	Measure of Effectiveness (MOE)	Highway 99								Intersecting Street								Intersection OVERALL
		Northbound				Southbound				Eastbound				Westbound				
		Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	
Dowad Drive [WB STOP-controlled, RIRO]	Available Storage/Lane Length (m)	-	-	100	-	-	-	-	-	-	-	-	-	-	-	120	-	-
	Applied Volume (veh/hr)	-	1,227	397	1,624	Restricted	1,541	-	1,541	-	-	-	-	-	209	209	3,374	
	Delay (s/veh)	-	0	0	0		0	-	0					-	25	25	2	
	Level of Service	-	A	A	A		A	-	A					-	C	C	A	
	Volume / Capacity	-	0.39	0.25	-		0.49	-	-					-	0.56	-	-	
	95th %ile Queue (m)	-	0	0	-		0	-	-					-	0	-	-	
Garibaldi Way [traffic signal]	Available Storage/Lane Length (m)	110	-	95	-	135	-	90	-	40	100	30	-	25	75	30	-	-
	Applied Volume (veh/hr)	173	1,296	144	1,613	246	1,151	144	1,541	146	359	170	675	241	314	182	737	4,566
	Delay (s/veh)	91	41	2	43	125	40	4	51	75	103	21	76	107	35	12	53	52
	Level of Service	F	D	A	D	F	D	A	D	E	F	C	E	F	D	B	D	D
	Volume / Capacity	0.94	1.02	0.24	-	1.07	0.87	0.22	-	0.80	1.03	0.47	-	1.06	0.52	0.33	-	-
	95th %ile Queue (m)	124	167	105	-	194	277	20	-	75	118	63	-	65	98	57	-	-
Mamquam Road [traffic signal]	Available Storage/Lane Length (m)	110	-	75	-	125	-	100	-	20	450	30	-	35	125	125	-	-
	Applied Volume (veh/hr)	5	1,531	437	1,973	90	1,409	61	1,560	85	169	5	259	401	184	119	704	4,496
	Delay (s/veh)	56	59	10	48	90	25	3	28	98	110	0	104	92	30	7	62	46
	Level of Service	E	E	A	D	F	C	A	C	F	F	A	F	F	C	A	E	D
	Volume / Capacity	0.06	1.02	0.54	-	0.91	0.79	0.07	-	0.81	0.96	0.02	-	1.05	0.30	0.21	-	-
	95th %ile Queue (m)	29	199	161	-	62	101	0	-	77	206	21	-	70	264	112	-	-

The bold red values indicate critical movements (LOS E/F), v/c ratio above 0.90, or inadequate storage lengths.

Squamish Intersections – The study intersections along Tantalus Road (except at Garibaldi Way) would operate at acceptable levels of service (Intersection LOS A/B) with no identified delay/queue issues for the turning movements. However, the following traffic operation issues were found for the intersections along Garibaldi Way:

- **Tantalus Road / Garibaldi Way:** This intersection will be highly used by traffic generated from the future developments along Tantalus Road north (50% traffic increase), especially the trips to/from Highway 99 south. Therefore, the major traffic movements will be the southbound right-turn and the eastbound left-turn. Vehicles exiting Tantalus Road onto Garibaldi Way (stop-controlled) would experience significant delays (LOS E/F) with a shortage of storage lengths. This results in failure of overall intersection condition (from LOS C to F). The eastbound queue (caused by left-turn vehicles) was found just within the available spacing to the Plaza access (45 m).
- **Plaza Parking Access / Garibaldi Way:** The northbound left-turn movement would continue operating at failing conditions (LOS F) with increased queue length (138 m). The westbound queue (caused by left/right-turn vehicles) could extend up to Tantalus Road.

Table 3.6: 2040 Friday Peak Traffic Operation Performance for Squamish Intersections – Base

Study Intersection within Squamish [control type]	Measure of Effectiveness (MOE)	Northbound				Southbound				Eastbound				Westbound				Intersection OVERALL
		Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	
		Available Storage/Lane Length (m)	20	-	-	-	-	-	-	35	-	-	-	30	-	-	-	
Tantalus Road / Dowad Drive [4-way STOP-controlled]	Applied Volume (veh/hr)	37	12	17	66	2	9	2	13	4	298	93	395	30	162	0	192	666
	Delay (s/veh)	9	8	8	8	9	9	9	9	7	14	14	14	8	9	9	9	12
	Level of Service	A	A	A	A	A	A	A	A	A	B	B	B	A	A	A	A	B
	Volume / Capacity	0.07	0.05	-	-	0.02	-	-	-	0.01	0.59	-	-	0.05	0.25	-	-	-
	95th %ile Queue (m)	13	13	-	-	11	-	-	-	6	28	-	-	14	17	-	-	-
Tantalus Road / Newport Ridge Drive [WB STOP-controlled]	Available Storage/Lane Length (m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Applied Volume (veh/hr)	-	80	298	378	31	109	-	140	-				289	-	29	318	836
	Delay (s/veh)	-	0	0	0	0	2	-	2					22	-	22	22	9
	Level of Service	-	A	A	A	A	A	-	A					C	-	C	C	A
	Volume / Capacity	-	0.24	-	-	0.03	-	-	-					0.62	-	0.62	-	-
Tantalus Road / Garibaldi Way [SB STOP-controlled]	95th %ile Queue (m)	-	10	-	-	13	-	-	-					34	-	34	-	-
	Available Storage/Lane Length (m)	15	160	-	-	-	40	-	-	45	-	-	-	75	-	-	-	-
	Applied Volume (veh/hr)	61	37	9	107	49	13	404	466	335	214	55	604	12	129	80	221	1,398
	Delay (s/veh)	954	58	58	568	44	44	44	44	3	7	7	7	0	1	1	1	61
	Level of Service	F	F	F	F	E	E	E	E	A	A	A	A	A	A	A	A	F
Garibaldi Way / Plaza Parking Access [NB STOP-controlled]	Volume / Capacity	2.42	0.43	-	-	1.03	1.03	-	-	0.29	-	-	-	0.01	-	-	-	-
	95th %ile Queue (m)	23	24	-	-	100	57	-	-	45	-	-	-	5	-	-	-	-
	Available Storage/Lane Length (m)	25	165	-	-	-	-	-	-	75	-	-	-	45	-	-	-	-
	Applied Volume (veh/hr)	115	7	68	190	7	2	29	38	34	553	163	750	47	592	4	643	1,621
	Delay (s/veh)	616	20	20	380	35	35	35	35	1	1	1	1	1	2	2	2	47
	Level of Service	F	C	C	F	E	E	E	E	A	A	A	A	A	A	A	A	E
	Volume / Capacity	2.02	0.25	-	-	0.26	-	-	-	0.04	-	-	-	0.06	-	-	-	-
	95th %ile Queue (m)	48	138	-	-	16	-	-	-	53	-	-	-	48	-	-	-	-

The bold red values indicate critical movements (LOS E/F), v/c ratio above 0.90, or inadequate storage lengths.

2040 Base + Scenario

To develop Base + scenario in Synchro, the following assumptions were made:

- Highway 99 / Dowad Drive: A shared left/right-turn lane at the westbound approach; a 40-m left-turn lane at the southbound approach; and conversion of northbound right-turn movement from free flow to yield controlled.
- Highway 99 / Garibaldi Way & Mamquam Road (both intersections): A dual left-turn lane at the westbound approach with protected-only left-turn phase (from existing protected-permissive); conversion of the existing permissive left-turn phase at the eastbound approach to a lagging protected-only phase due to turning paths conflict of concurrent left-turn movements.
- Garibaldi Way / Tantalus Road (as per *Tantalus Road Intersection Realignment Analysis* by ISL): A 15-m eastbound left-turn bay; conversion of Tantalus Road south to one-way southbound traffic.

The 2040 Friday peak traffic analysis results under Base + scenario are summarized for the study intersections on Highway 99 and the ones within Squamish in Table 3.7 and 3.8, respectively. The comparison of the traffic analysis results between the 2040 Base + scenario and the 2040 Base scenario is provided below.

Highway 99 Intersections – With the assumed modifications, the overall intersection delay would be increased at Dowad Drive (from LOS A to LOS C), while it would be decreased at the two signalized intersections (from LOS D to LOS D/C). Similar to the 2040 Base scenario, all intersections will be operating at acceptable levels of service (LOS D or better). However, the following traffic operation issues were identified:

- **Dowad Drive:** A significant delay (LOS F) is expected at the westbound approach due to lack of safe gaps on Highway 99 to allow left-turn vehicles cross two lanes. This would cause a vehicle queue that could extend to Tantalus Road. A 40-m storage length was found to be sufficient to accommodate high southbound left-turn volume (171 veh/h).
- **Garibaldi Way:** With the provision of southbound left-turn movement at Dowad Drive, the southbound left-turn volume at the Garibaldi Way intersection will be reduced by 50%. As such, the average delay was reduced, and the existing left-turn storage length was found to be sufficient (58m queue). Although a second westbound left-turn lane was considered, no significant changes were identified to the traffic operations for the east-west approaches. This is mainly due to the reduced effective green times resulted from both the conversion of left-turn phase to protected-only (i.e. the elimination of permissive phases) and relatively longer green time assigned to high opposing eastbound through traffic.
- **Mamquam Road:** No significant changes were noted for Highway 99 approaches compared to the 2040 Base scenario. However, the average delays for the east-west left-turn movements would be reduced (from LOS F to E). The queue lengths on Mamquam Road approaches would also be decreased from 200+ m to about 100 m. Moreover, the westbound queue would no longer impact the traffic signal at Glenalder Place.

Table 3.7: 2040 Friday Peak Traffic Operation Performance for Highway 99 Intersections – Base +

Study Intersection along Highway 99 [modifications]	Measure of Effectiveness (MOE)	Highway 99								Intersecting Street								Intersection OVERALL
		Northbound				Southbound				Eastbound				Westbound				
		Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	
Dowad Drive [all movements allowed, 40m SBL, yield-controlled NBR]	Available Storage/Lane Length (m)	-	-	100	-	40	-	-	-	-	-	-	-	120	-	120	-	-
	Applied Volume (veh/hr)	-	1,234	280	1,514	171	1,380	-	1,551	-				127	-	204	331	3,396
	Delay (s/veh)	-	0	0	0	16	0	-	2					882	-	882	882	18
	Level of Service	-	A	A	A	C	A	-	A					F	-	F	F	C
	Volume / Capacity	-	0.39	0.18	-	0.36	0.44	-	-					3.13	-	3.13	-	-
	95th %ile Queue (m)	-	0	5	-	36	0	-	-					122	-	122	-	-
Garibaldi Way [dual WBL, lead protected- only WB LT phase, lag protected-only EBL phase]	Available Storage/Lane Length (m)	110	-	95	-	135	-	90	-	40	100	30	-	25	75	30	-	-
	Applied Volume (veh/hr)	176	1,200	217	1,593	105	1,249	154	1,508	137	390	156	683	197	287	177	661	4,445
	Delay (s/veh)	102	23	4	29	86	49	4	47	77	78	14	63	86	60	18	57	45
	Level of Service	F	C	A	C	F	D	A	D	E	E	B	E	F	E	B	E	D
	Volume / Capacity	1.02	0.85	0.31	-	0.80	0.96	0.24	-	0.78	0.97	0.38	-	0.88	0.82	0.47	-	-
	95th %ile Queue (m)	98	82	0	-	58	143	46	-	77	124	64	-	45	95	63	-	-
Mamquam Road [dual WBL, lead protected- only WB LT phase, lag protected-only EBL phase]	Available Storage/Lane Length (m)	110	-	75	-	125	-	100	-	20	450	30	-	35	125	125	-	-
	Applied Volume (veh/hr)	5	1,534	436	1,975	94	1,447	60	1,601	61	167	5	233	392	158	119	669	4,478
	Delay (s/veh)	51	37	6	30	92	9	0	13	59	96	0	84	76	50	10	58	31
	Level of Service	D	D	A	C	F	A	A	B	E	F	A	F	E	D	A	E	C
	Volume / Capacity	0.05	0.93	0.50	-	0.87	0.74	0.06	-	0.41	0.92	0.02	-	0.93	0.58	0.37	-	-
	95th %ile Queue (m)	20	159	96	-	50	31	0	-	46	80	13	-	66	108	0	-	-

The bold red values indicate critical movements (LOS E/F), v/c ratio above 0.90, or inadequate storage lengths.

Squamish Intersections – Compared to the 2040 Base scenario, no modifications were considered for Tantalus Road intersections at Dowad Drive and Newport Ridge Drive due to acceptable traffic performance. For the other two stop-controlled intersections on Garibaldi Way, the following results were noted:

- **Tantalus Road / Garibaldi Way:** With the proposed one-way southbound for Tantalus Road south, the average vehicle delays at the southbound approach would be reduced (from LOS E to D) due to lower number of conflicting traffic movements. Although the proposed 15-m eastbound left-turn storage length would not be sufficient, it would reduce the queue length on Garibaldi Way and minimize the potential for queue spillover to the Plaza access.

- **Plaza Parking Access / Garibaldi Way:** The overall performance of the intersection would not change. However, the provision of eastbound right-turn bay would reduce the queue length on Garibaldi Way (from 53 m to 24 m). Moreover, the average delay and vehicle queue would be reduced for vehicles exiting the Plaza, since drivers would be able to better distinguish high eastbound right-turn traffic from other movements and find a safe gap to turn onto Garibaldi Way.

Table 3.8: 2040 Friday Peak Traffic Operation Performance for Squamish Intersections – Base +

Study Intersection along Highway 99 [modifications]	Measure of Effectiveness (MOE)	Northbound				Southbound				Eastbound				Westbound				Intersection OVERALL
		Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	
		20	-	-	-	-	-	-	-	35	-	-	-	30	-	-	-	
Tantalus Road / Doward Drive [-]	Available Storage/Lane Length (m)	71	12	17	100	2	9	2	13	4	303	139	446	30	221	0	251	810
	Applied Volume (veh/hr)	10	8	8	9	10	10	10	10	8	17	17	17	8	10	10	10	14
	Delay (s/veh)	A	A	A	A	A	A	A	A	A	C	C	C	A	B	B	A	B
	Level of Service	0.15	0.05	-	-	0.03	-	-	-	0.01	0.69	-	-	0.05	0.36	-	-	-
	Volume / Capacity	12	13	-	-	13	-	-	-	6	64	-	-	15	20	-	-	-
Tantalus Road / Newport Ridge Drive [-]	Available Storage/Lane Length (m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Applied Volume (veh/hr)	-	51	338	389	30	63	-	93	-	-	-	-	235	-	27	262	744
	Delay (s/veh)	-	0	0	0	0	3	-	3	-	-	-	-	16	-	16	16	6
	Level of Service	-	A	A	A	A	A	-	A	-	-	-	-	C	-	C	C	A
	Volume / Capacity	-	0.25	-	-	0.03	-	-	-	-	-	-	-	0.47	-	0.47	-	-
Tantalus Road / Garibaldi Way [15m EBL bay, one-way SB traffic only for Tantalus Rd S]	Available Storage/Lane Length (m)	-	-	-	-	40	-	-	15	45	-	-	75	-	-	-	-	-
	Applied Volume (veh/hr)	-	-	-	-	44	12	295	351	336	211	54	601	12	194	114	320	1,272
	Delay (s/veh)	-	-	-	-	29	29	29	29	10	0	0	5	0	0	0	0	11
	Level of Service	-	-	-	-	D	D	D	D	A	A	A	A	A	A	A	A	B
	Volume / Capacity	-	-	-	-	0.68	0.68	-	-	0.32	0.17	-	-	0.01	-	-	-	-
Garibaldi Way / Plaza Parking Access [15m EBR bay]	Available Storage/Lane Length (m)	25	165	-	-	-	-	-	-	75	15	-	-	45	-	-	-	-
	Applied Volume (veh/hr)	142	7	68	217	7	2	29	38	34	549	130	713	47	489	4	540	1,508
	Delay (s/veh)	412	16	16	274	25	25	25	25	1	1	0	1	1	2	2	2	41
	Level of Service	F	C	C	F	C	C	C	C	A	A	A	A	A	A	A	A	E
	Volume / Capacity	1.65	0.20	-	-	0.19	-	-	-	0.04	0.08	-	-	0.06	-	-	-	-
Garibaldi Way / Plaza Parking Access [15m EBR bay]	95th %ile Queue (m)	37	37	-	-	15	-	-	-	24	5	-	-	38	-	-	-	-

The bold red values indicate critical movements (LOS E/F), v/c ratio above 0.90, or inadequate storage lengths.

3.6 Development Threshold – 2040 Base

For Highway 99 intersections, all failing movements (LOS F) in the 2040 Base scenario are selected to determine at what point each movement starts failing. Assuming linear growth, Figure 3.2 shows when individual movements start failing. The resulting year and dwelling units provide an estimate of when improvements are required.

The Highway 99 / Garibaldi Way southbound left turn movement starts failing around 2027 when there are 3,480 residential units within the study area. The Highway 99 / Mamquam Road eastbound through movement starts failing around 2029 when there are 3,730 residential units within the study area.

It should be noted that these are forecasts only and are dependent on many factors, such as tourism, District and regional growth, and alternative mode share scenarios. If growth takes a different path from the assumptions outlined above, these development thresholds would also change.

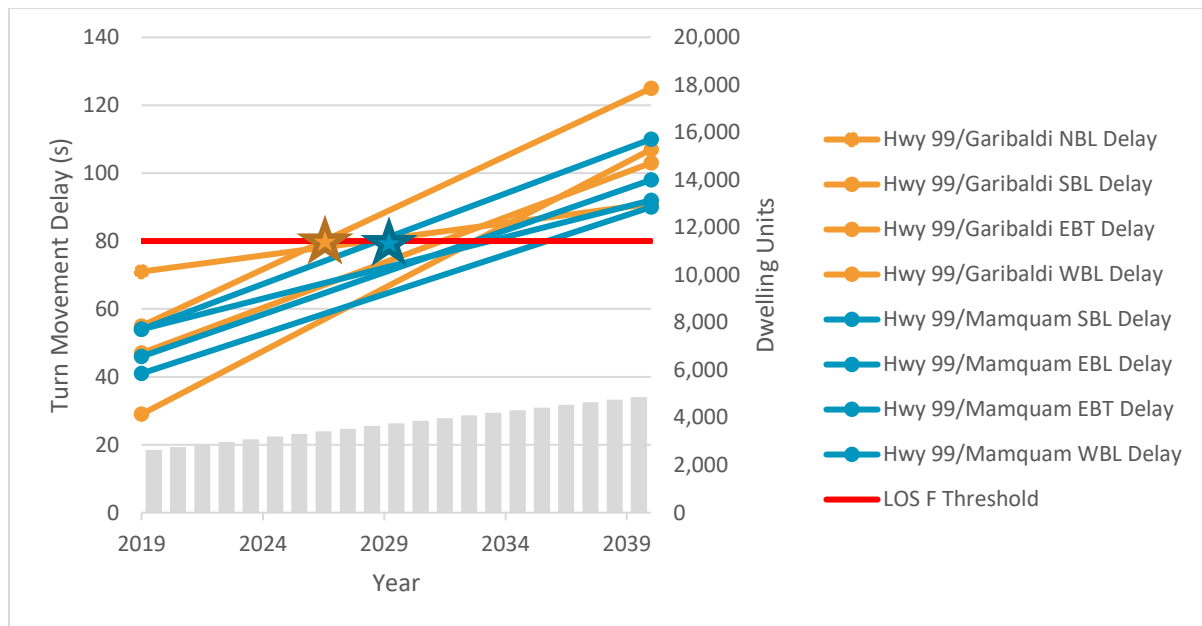


Figure 3.2: Threshold for Highway 99 Intersections

4.0 Improvement Options

The purpose of this study is to investigate the traffic impacts of potential theoretical additional development in the study area on the transportation network and to provide options to mitigate any issues identified.

Transportation issues are typically issues of vehicle delay beyond traditional thresholds of what is considered acceptable, for example exceeding a certain level of delay which more often than not relates to having to wait for more than one cycle of a traffic signal to pass through an intersection. Where an intersection does not have the capacity to accommodate the demand, queues will get incrementally longer until traffic demand reduces and allows the built up queue to dissipate.

The above approach has been the historically accepted approach to traffic engineering, however, in recent times an alternative approach is becoming popular. With traffic creating bigger picture issues over and above just vehicle delay, topics such as health, livability, and climate change effects of traffic on our day-to-day life are being considered as higher priorities.

The options presented below serve to provide an appreciation of the scale of improvements required to reduce vehicle delays to traditionally acceptable levels for a given amount of development and traffic growth. Furthermore, the future traffic volumes are based on a future conditions travel demand model that assumes a future auto mode share of 75%. Thus, even if the District is to achieve a significant mode shift away from the motor vehicle, the results presented could still materialize. It is then at the discretion of the District to what degree they wish to support such traffic levels, or accept longer vehicle delays with the intent of constraining further growth in traffic.

In addition to the traffic capacity improvements proposed, there are other options to reduce vehicle delays from those forecast, including restricting the amount of development, providing alternative network connections to better distribute traffic, or more aggressively pursuing active modes improvements, transit improvements, and other travel demand management measures.

In the study area, the primary active transportation infrastructure is the Corridor Trail, a paved multi-use pathway from Tantalus Road all the way to Downtown Squamish. The District has committed to extending the Corridor Trail north past Dowad Drive to the pedestrian overpass that connects to Brackendale. Further to this, the District is currently in the design phases to improve active transportation facilities on Garibaldi Way and Mamquam Road directly within the study area as well as other locations outside of the study area.

The Corridor Trail would benefit from a better connection into Downtown and possibly improvements with respect to personal safety (i.e., a lack of eyes on the trail and lighting may discourage some from using the trail) where it passes through woodland around Loggers Lane.

If capacity improvements are pursued at the Garibaldi Way and Mamquam Road intersections with Highway 99, there could be additional lanes required on the Highway and/or Local Roads that would impact the currently planned improvements and require them to be reconstructed closer to property line, if not requiring property acquisition.

In addition to the Corridor Trail, the District is also planning active transportation improvements to Garibaldi Highlands, and the Government/Queen's route paralleling the highway will also see active transportation improvements in places in the near future, and likely more over time.

It is not anticipated that active transportation facilities would be a priority at the Highway 99/Dowad Drive intersection as the Highway is not suitable for all ages and abilities, and the Corridor Trail offers a better alternative, particularly if extended north to Dowad Drive. Similarly, the possible Newport Ridge Drive intersection would not require active transportation facilities, however if it is accompanied by a right-turn lane drop from the Highway, this may impact the alignment of the existing Corridor Trail and push it further east which may incur property costs.

For the Garibaldi Way and Mamquam intersections with the Highway, active transportation crossings should be provided and the facilities along the approaches to these intersections should be maintained, if not enhanced. Ideally positioning the facility behind the curb and separating it from the roadway with a landscaped boulevard.

4.1 Initial Screening

Garibaldi Village Right Turn Out: A new right turn out from Garibaldi Village to Highway 99 northbound was contemplated north of the existing right turn in as a possible operational improvement to operational issues at Garibaldi Way / Plaza Parking Access. Despite the lack of interest from the Ministry due to the potential traffic increase on the Highway, this was tested in the travel demand model. The result showed that this right turn out from Garibaldi Village would not be well utilized because the majority of traffic that egress the Garibaldi Village at Garibaldi Way is to make two left turns to head southbound. So even with this right turn out in place, it does little to relieve current operational issues at Garibaldi Way / Plaza Parking Access. As such, the right turn out **will not be considered** in the options.

Highway 99 / Newport Ridge Drive All Movements Allowed: For the potential Newport Ridge Drive connection between Highway 99 and Tantalus Road, full movements were contemplated at this intersection. This was tested in the travel demand model. The result showed that this intersection would require signalization with the high projected traffic volumes entering and exiting the Highway. Due to the lack of interest from the Ministry to add additional signals on the Highway, other options that do not require adding signals are desired. As such, all movements allowed at this intersection **will not be considered** in the options.

4.2 Options Descriptions

This study identified three potential options for key intersections within the study area. They were developed to balance traffic operations, costs, and impacts to existing infrastructure.

Option 1: Base + Improved

- 70 km/h Speed Limit along Highway 99 extends north of Dowad Drive.
- Signalized intersection at Highway 99 / Dowad Drive with all movements allowed.
- Dual westbound left turn from Garibaldi Way to Highway 99. Garibaldi Way has a 5-lane cross-section on both sides of the Highway.
- Dual westbound left turn from Mamquam Road to Highway 99.

Option 2A: Newport Ridge Drive Connection (Wider Garibaldi Way Both Sides of the Highway)

- 70 km/h Speed Limit along Highway 99 extends north of Dowad Drive.
- New Newport Ridge Drive Connection between Highway 99 and Tantalus Road. Highway 99 / Newport Ridge Drive is unsignalized with right-in-right-out and southbound left turn in.
- No additional signal along Highway 99. Highway 99 / Dowad Drive remains unsignalized with right-in-right-out and westbound left turn out.
- Single westbound left turn from Garibaldi Way to Highway 99. Garibaldi Way has a 5-lane cross-section on both sides of the Highway.
- Dual westbound left turn from Mamquam Road to Highway 99.

Option 2B: Newport Ridge Drive Connection (Third Northbound Lane on Highway 99 at Garibaldi Way)

- 70 km/h Speed Limit along Highway 99 extends north of Dowad Drive.
- New Newport Ridge Drive Connection between Highway 99 and Tantalus Road. Highway 99 / Newport Ridge Drive is unsignalized with right-in-right-out and southbound left turn in.
- No additional signal along Highway 99. Highway 99 / Dowad Drive remains unsignalized with right-in-right-out and westbound left turn out.
- Single westbound left turn from Garibaldi Way to Highway 99. Garibaldi Way has a 3-lane cross-section on both sides of the Highway. A third northbound lane on Highway 99 starts before Garibaldi Way and extends to Newport Ridge Drive.
- Dual westbound left turn from Mamquam Road to Highway 99. A third northbound lane on Highway 99 starts before Mamquam Road and extends to the Garibaldi Village right turn in.

Detailed intersection laning diagrams are provided in Sections 4.4 to 4.6 for the three options. The main features that differ in the options are summarized in Table 4.1.

Table 4.1: Option Features

Feature	Option 1	Option 2A	Option 2B
Highway 99 / Dowad Drive Signal	Yes		
New Newport Ridge Drive Connection		Yes	Yes
Highway 99 Cross-Section			Wider
Garibaldi Way Cross-Section Near Highway 99	Wider	Wider	

4.3 Cost Estimate

As the study intersections that require cost estimates are primarily under the jurisdiction of the BC Ministry of Transportation and Infrastructure, the Ministry's parametric estimating method was used to provide planning level cost estimates for this assignment.

The parametric method produces a high-level estimate using various factors (parameters) developed from past projects, historical databases, engineering practices, and technologies, such as:

- cost per lane-kilometre of roadway
- cost per interchange
- cost per square metre of a bridge structure
- cost per intersection.

This approach is beneficial when little or no design information is available. The parametric method is primarily intended to be used at the very early stages of project development, prior to any detailed project planning. It can also be used as part of a quality assurance check on a more detailed cost estimate prepared during project planning or preliminary design. It should not be used as the basis for approving a project budget.

Widening of each highway intersection could include widening on the east/west legs or the north/south legs, or both depending on the level of service required for individual turning movements. ISL utilized the MOTI's cost element worksheet, unit rates from the Ministry's latest available 2013 cost guide, factored to 2021 rates assuming 2% inflation per annum. All costs are presented in 2021 dollars.

The total cost estimate includes the basic construction estimate, as well as planning, design, property, and environmental remediation. Allowances have been provided with respect to many elements of a potential design.

It is anticipated that significant widening may be required on all approaches to accommodate additional turn lanes or through lanes. This in turn may require property acquisition, particularly if other elements such as boulevards and active transportation facilities are provided. This widening will likely require relocation, if not replacement of existing traffic signals, street lights, utility poles, and reconstruction of channelized turn islands. Using similar costs from other Ministry projects the following high-level costs were determined and should be used only to inform the planning study and determine direction. Where lower levels of service can be accepted, the costs can be significantly reduced.

To calculate the costs for the planned improvements, ISL utilized the 2013 rates factored to 2021 at a rate of 2% per annum. Table 4.2 highlights the rate assumptions:

Table 4.2: Unit Rates Extracted from MOTI 2013 Cost Guide

Element	2013 Rate	2021 Rate at 2% per Annum
Urban traffic signal	\$301,100	\$352,787
Intersection lighting	\$27,100	\$31,752
Asphalt surfacing	\$80,000 per lane km	\$93,733 per lane km
Grading (easy conditions)	\$271,000 per lane km	\$317,520 per lane km
Curb and gutter	\$112 per l/m	\$131 per l/m
Sidewalk or MUP	\$77 per m ²	\$90 per m ²

For some options, it was anticipated that property acquisition would be required to provide a wider right-of-way. Based on local BC Assessment rates, land value was assumed at \$855 per m².

For other costs, allowances were included for removals, utility relocations, drainage, environmental compensation, and landscaping. While the Ministry cost estimating spreadsheet also auto calculates amounts for project management, planning, design, property variable costs, and construction supervision.

A 40% contingency has been applied to all costs. Planning level estimates are presented in the subsequent sections for each option, while the worksheets are provided in Appendix A.

4.4 Option 1

Modifications (compared to Base scenario):

• Full traffic signal • SBL bay (90m) with lag pt-only phase • Yield-controlled NBR • WBL bay (50m)	• Dual NBL bay (90m) • Lead NBL/lag SBL phase • Additional EBT lane • Extended EBL bay (from 20m to 70m) • Dual WBL bay (one in 40m pocket) • Lag pt-only EBL/lead pt-only WBL phase	• Extended NBR bay (from 75m to 90m) • Lag NBL/lead SBL phase • Additional EBT lane (in 40m pocket) • Extended EBL bay (from 20m to 40m) • Dual WBL bay (one in 65m pocket) • Shortened WBR bay (from 225m to 60m) • Lag pt-only EBL and lead pt-only WBL phase	No changes are proposed.
No changes are proposed.	• Two WB receiving lanes	• EB curb lane dropped to right-turn lane • Two WB lanes	

Notes: L = Left, T = Thru, R = Right, EB = Eastbound, WB = Westbound, NB = Northbound, SB = Southbound, Pt= Protected, Pm= Permissive

Operations [ID number]:

1. Highway 99 / Dowad Drive: The signalization would eliminate the failing performance (LOS F) noted for the westbound left-turn movement in the Base + scenario.
2. Highway 99 / Garibaldi Way: All the failing movements with LOS F (EBT, WBL, NBL, SBL) noted in the Base scenario would be eliminated. The eastbound vehicle queue would no longer extend to Government Road, while the westbound queue could block the Plaza parking access.
3. Highway 99 / Mamquam Road: All the failing movements with LOS F (EBL, EBT, WBL, SBL) noted in the Base scenario would be eliminated.

4. Tantalus Road / Dowad Drive: No issues were identified (similar to the Base scenario).
5. Tantalus Road / Newport Ridge Drive: No issues were identified (similar to the Base scenario).
6. Tantalus Road / Garibaldi Way: No issues were identified (similar to the Base + scenario).
7. Garibaldi Way / Plaza Parking Access: Although the intersection performance was improved from LOS E to C, the northbound left-turn movement would still fail (LOS F), similar to the Base and Base + scenarios. Additional safety considerations may be needed to remove some of the conflicting movements here.

Level of service for the study intersections and all individual movements are illustrated in Figure 4.1.

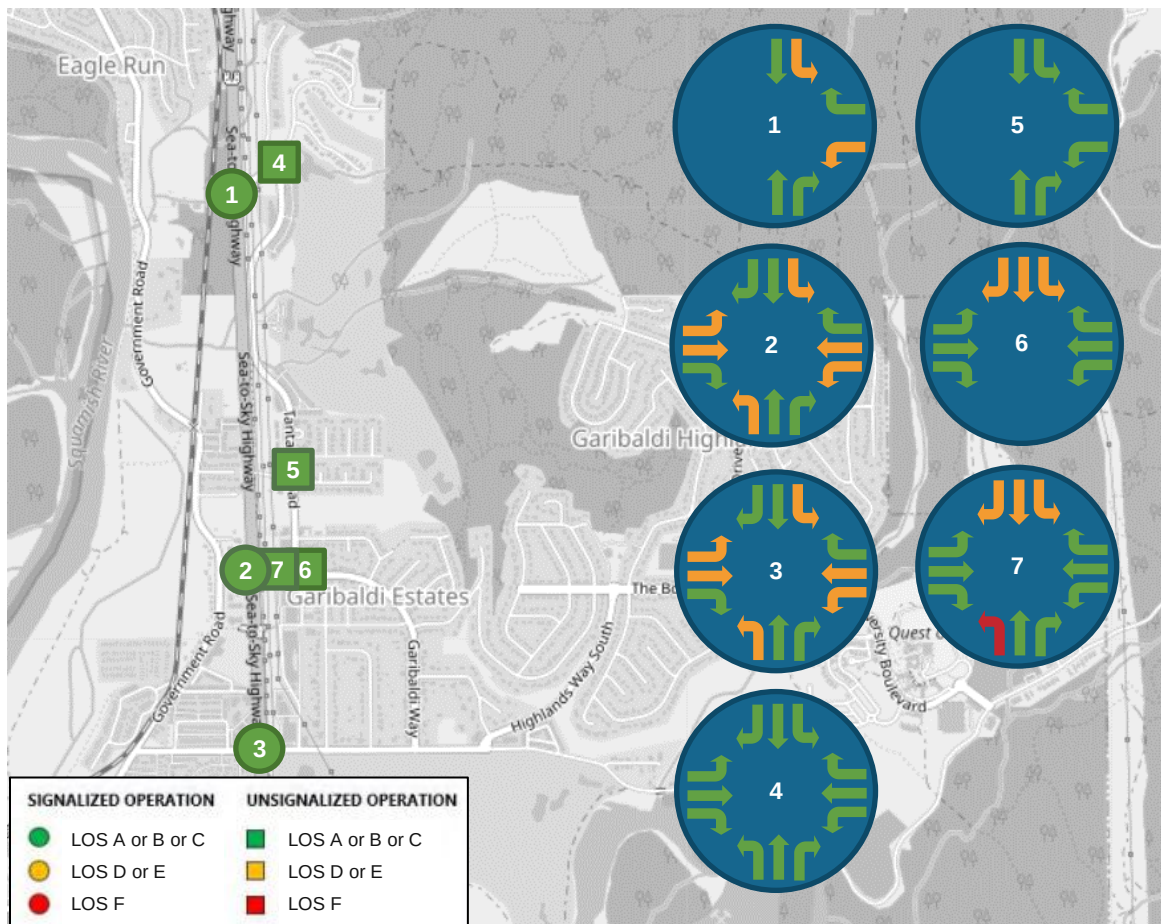


Figure 4.1: Traffic Operation Performance for Option 1

Impacts to Existing Properties and Infrastructure:

- Properties both sides of Garibaldi Way and Mamquam Road
 - Garibaldi Way is most constrained having generally a 19m right-of-way on the east side. It should be noted that ISL have prepared preliminary design for improvements in this section, some of which would be replaced. Acquiring property may be possible but it would impact parking lot and landscaping, and the gas stations further back. On the west

side, the right-of-way varies but tapers down to approximately 20m at it's narrowest.

Acquiring property may be possible but it would impact parking lot and the gas station.

- Widening the highway at Garibaldi Way increased the northbound left turn lanes from one to two lanes requiring additional right-of-way on the east side of the highway where it appears the property line is adjacent to the existing highway through lanes.
- Mamquam Road has a more generous right of way on the east side of the highway providing 29m of available right of way. ISL have also been working on concept designs for active transportation improvements along this corridor that may be replaced. On the west side, the available right-of-way is much less at approximately 21m, meaning property acquisition would be necessary here and would impact rear yards and parking lot.
- All signal poles Highway 99 at Garibaldi Way and Mamquam Road
- All Hydro poles Highway 99 at Garibaldi Way and Mamquam Road
- All sidewalks Highway 99 at Garibaldi Way and Mamquam Road
- Short section of MUP east of Highway 99

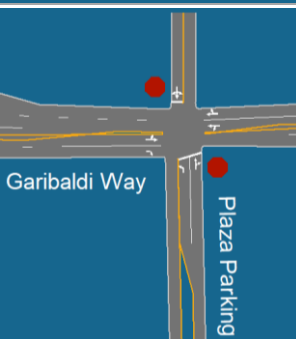
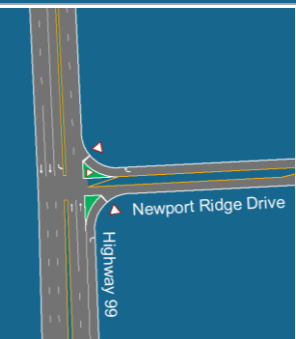
Cost: Est. \$13M. Table 4.3 provides a summary of the high-level assumptions for each intersection and the total cost calculated from the Ministry template. Travel time delay caused by the new signalized intersection at Highway 99 / Dowad Drive is estimated to add another \$7M on top.

Table 4.3: High Level Improvement Assumptions and Cost Estimates for Option 1

Intersection	Assumptions	Construction	Property	Other	Contingency	Total Cost
Highway 99/ Dowad Drive	Traffic signal; Utilize existing median; Minor concrete and asphalt	\$388,715	\$0	\$70,461	\$183,670	\$642,846
Highway 99/ Newport Ridge Drive	n/a	\$0	\$0	\$0	\$0	\$0
Highway 99/ Garibaldi Way	Widen Highway to 6 lanes and Garibaldi Way to 5 lanes with properties; New signal, lighting, sidewalk or MUP with boulevard	\$2,671,101	\$2,407,029	\$725,933	\$2,321,625	\$8,125,688
Highway 99/ Mamquam Road	Widen Mamquam Road to 5 lanes with properties; New signal, lighting, sidewalk or MUP with boulevard	\$1,731,103	\$801,630	\$468,633	\$1,200,547	\$4,201,913
Tantalus Road/ Newport Ridge Drive	n/a	\$0	\$0	\$0	\$0	\$0
	Total	\$4,790,919	\$3,208,659	\$1,265,027	\$3,705,842	\$12,970,447

4.5 Option 2A

Modifications (compared to Base scenario):

			
• WBL bay (50m)	• Extended NBL bay (from 110m to 130m) • Lead NBL/lag SBL phase • Additional EBT lane • Extended EBL bay (from 20m to 65m) • Additional WBT lane • Pt-pm EBL phase	• Extended NBR bay (from 75m to 180m) • Lag NBL/lead SBL phase • Additional EBT lane (in 50m pocket) • Extended EBL bay (from 20m to 50m) • Dual WBL bay (one in 60m pocket) • Shortened WBR bay (from 225m to 60m) • Lag pt-only EBL and lead pt-only WBL phase	No changes are proposed.
			
• Full traffic signal with E-W pt-pm left-turn phase • Introduction of EB approach with a dedicated EBL bay (45m) • Dedicated WBL bay (45m)	Same as Option 1.	Same as Option 1.	• Yield-controlled NBR bay (120m) • SBL bay (90m) • Yield-controlled WBR

Notes: L = Left, T = Thru, R = Right, EB = Eastbound, WB = Westbound, NB = Northbound, SB = Southbound, Pt= Protected, Pm= Permissive

Operations [ID number]:

1. Highway 99 / Dowad Drive: The significant delay noted for the westbound left-turn movement in the Base + scenario would be reduced to about 1 minute, yet with LOS F.
2. Highway 99 / Garibaldi Way: All the failing movements with LOS F (EBT, WBL, NBL, SBL) noted in the Base scenario would be eliminated, and the east-west vehicle queues would no longer extend to Government Road and the Plaza Parking Access.

3. Highway 99 / Mamquam Road: All the failing movements with LOS F (EBL, EBT, WBL, SBL) noted in the Base scenario would be eliminated.
4. Tantalus Road / Dowad Drive: No issues were identified (similar to the Base scenario).
5. Tantalus Road / Newport Ridge Drive: No issues were identified, and the signalization plus the introduction of the west leg would not have any impact on the Highway.
6. Tantalus Road / Garibaldi Way: No issues were identified (similar to the Base + scenario).
7. Garibaldi Way / Plaza Parking Access: The level of service for the northbound left-turn movement would be improved from LOS F to E. Additional safety considerations may be needed to remove some of the conflicting movements here.
8. Highway 99 / Newport Ridge Drive: No issues were identified.

Level of service for the study intersections and all individual movements are illustrated in Figure 4.2.

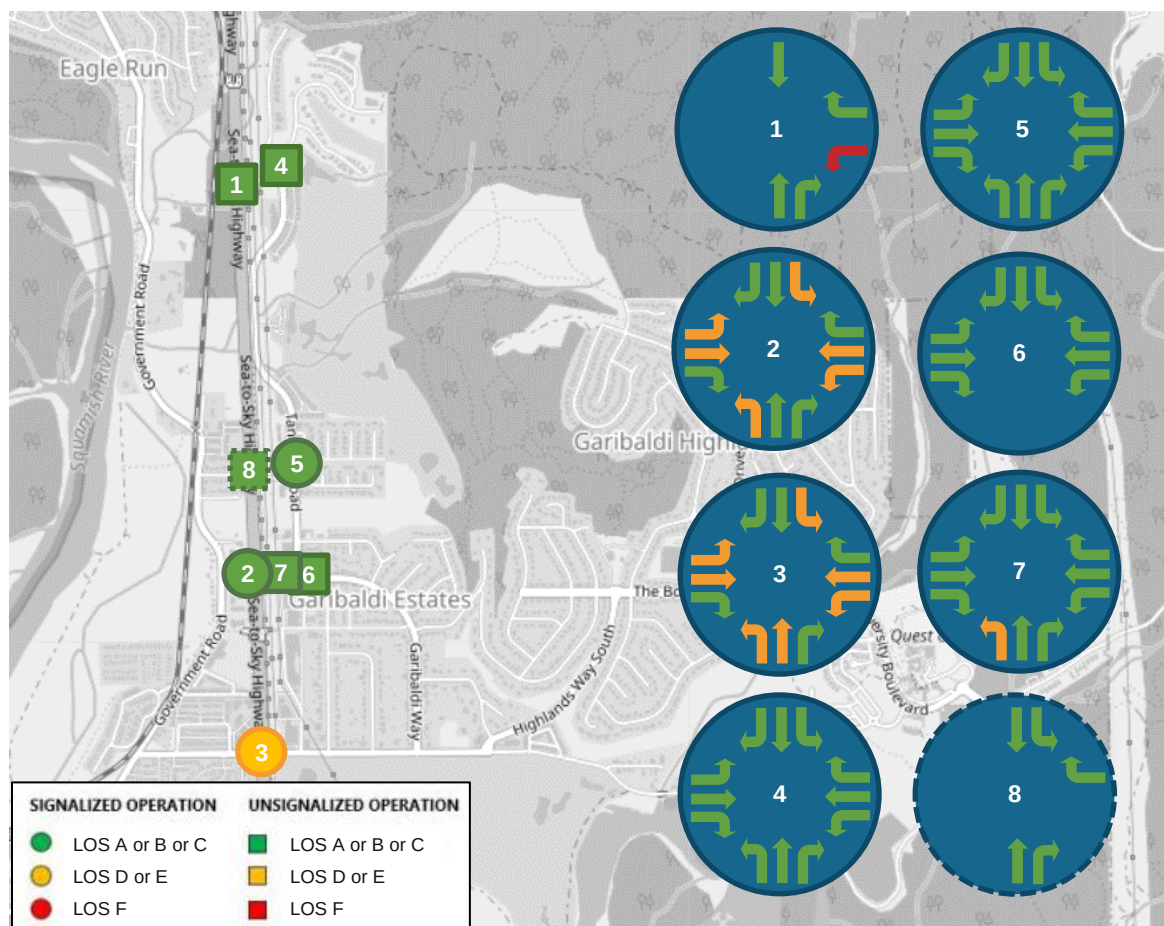


Figure 4.2: Traffic Operation Performance for Option 2A

Impacts to Existing Properties and Infrastructure:

- Properties for the new Newport Ridge Drive connection
- Properties both sides of Garibaldi Way and Mamquam Road
 - Garibaldi Way is most constrained having generally a 19m right-of-way on the east side. It should be noted that ISL have prepared preliminary design for improvements in this

- section, some of which would be replaced. Acquiring property may be possible but it would impact parking lot and landscaping, and the gas stations further back. On the west side, the right-of-way varies but tapers down to approximately 20m at it's narrowest. Acquiring property may be possible but it would impact parking lot and the gas station.
- Mamquam Road has a more generous right of way on the east side of the highway providing 29m of available right of way. ISL have also been working on concept designs for active transportation improvements along this corridor that may be replaced. On the west side, the available right-of-way is much less at approximately 21m, meaning property acquisition would be necessary here and would impact rear yards and parking lot.
 - All signal poles Highway 99 at Garibaldi Way and Mamquam Road
 - All Hydro poles Highway 99 at Garibaldi Way and Mamquam Road
 - All sidewalks Highway 99 at Garibaldi Way and Mamquam Road
 - Short section of MUP east of Highway 99

Cost: Est. \$16M. Table 4.4 provides a summary of the high-level assumptions for each intersection and the total cost calculated from the Ministry template.

Table 4.4: High Level Improvement Assumptions and Cost Estimates for Option 2A

Intersection	Assumptions	Construction	Property	Other	Contingency	Total Cost
Highway 99/ Dowad Drive	Protected-T; Utilize existing median; Widen for SB receiving lane; Moderate concrete and asphalt	\$260,090	\$0	\$47,503	\$123,037	\$430,630
Highway 99/ Newport Ridge Drive	Properties for Newport Ridge connection; Widen for SBL and NBR; Sidewalk on both sides	\$704,064	\$3,206,522	\$399,922	\$1,724,203	\$6,034,711
Highway 99/ Garibaldi Way	Widen Garibaldi Way to 5 lanes with properties; New signal, lighting, sidewalk or MUP with boulevard	\$1,731,103	\$1,605,399	\$508,633	\$1,538,054	\$5,383,189
Highway 99/ Mamquam Road	Widen Mamquam Road to 5 lanes with properties; New signal, lighting, sidewalk or MUP with boulevard	\$1,833,917	\$801,630	\$491,717	\$1,250,906	\$4,378,170
Tantalus Road/ Newport Ridge Drive	Traffic signal; Minor asphalt, curb/gutter, sidewalk	\$696,244	\$0	\$129,087	\$330,133	\$1,155,464
Total		\$4,529,174	\$5,613,551	\$1,447,775	\$4,636,200	\$16,226,700

4.6 Option 2B

Modifications (compared to Base scenario):

Same as Option 2A.	• Additional NBT lane • Lead NBL/lag SBL phase • Pt-pm EBL phase	• Additional NBT lane • Lag NBL/lead SBL phase • Extended EBL bay (from 20m to 60m) • Dual WBL bay (one in 65m pocket) • Shortened WBR bay (from 225m to 60m) • Lag pt-only EBL and lead pt-only WBL phase	No changes are proposed.
Same as Option 2A.	No changes are proposed (compared to Base + scenario).	No changes are proposed (compared to Base + scenario).	• Yield-controlled NBR lane (dropped from curb lane) • Yield-controlled WBR • SBL bay (90m)

Notes: L = Left, T = Thru, R = Right, EB = Eastbound, WB = Westbound, NB = Northbound, SB = Southbound, Pt= Protected, Pm= Permissive

Operations [ID number]:

1. Highway 99 / Dowad Drive: The traffic operations are similar to Option 2A (failing westbound left-turn).
2. Highway 99 / Garibaldi Way: All the failing movements with LOS F (EBT, WBL, NBL, SBL) noted in the Base scenario would be eliminated. The eastbound vehicle queue would no longer extend to Government Road, while the westbound queue could block the Plaza parking access (similar to Option 1).
3. Highway 99 / Mamquam Road: All the failing movements with LOS F (EBL, EBT, WBL, SBL) noted in the Base scenario would be eliminated.
4. Tantalus Road / Dowad Drive: No issues were identified (similar to the Base scenario).

5. Tantalus Road / Newport Ridge Drive: No issues were identified (similar to Option 2A).
6. Tantalus Road / Garibaldi Way: No issues were identified (similar to the Base + scenario).
7. Garibaldi Way / Plaza Parking Access: Although the intersection performance was improved from LOS E to B, the northbound left-turn movement would still fail (LOS F), similar to the Base, Base +, and Option 1 scenarios.
8. Highway 99 / Newport Ridge Drive: No issues were identified (similar to Option 2A).

Level of service for the study intersections and all individual movements are illustrated in Figure 4.3.

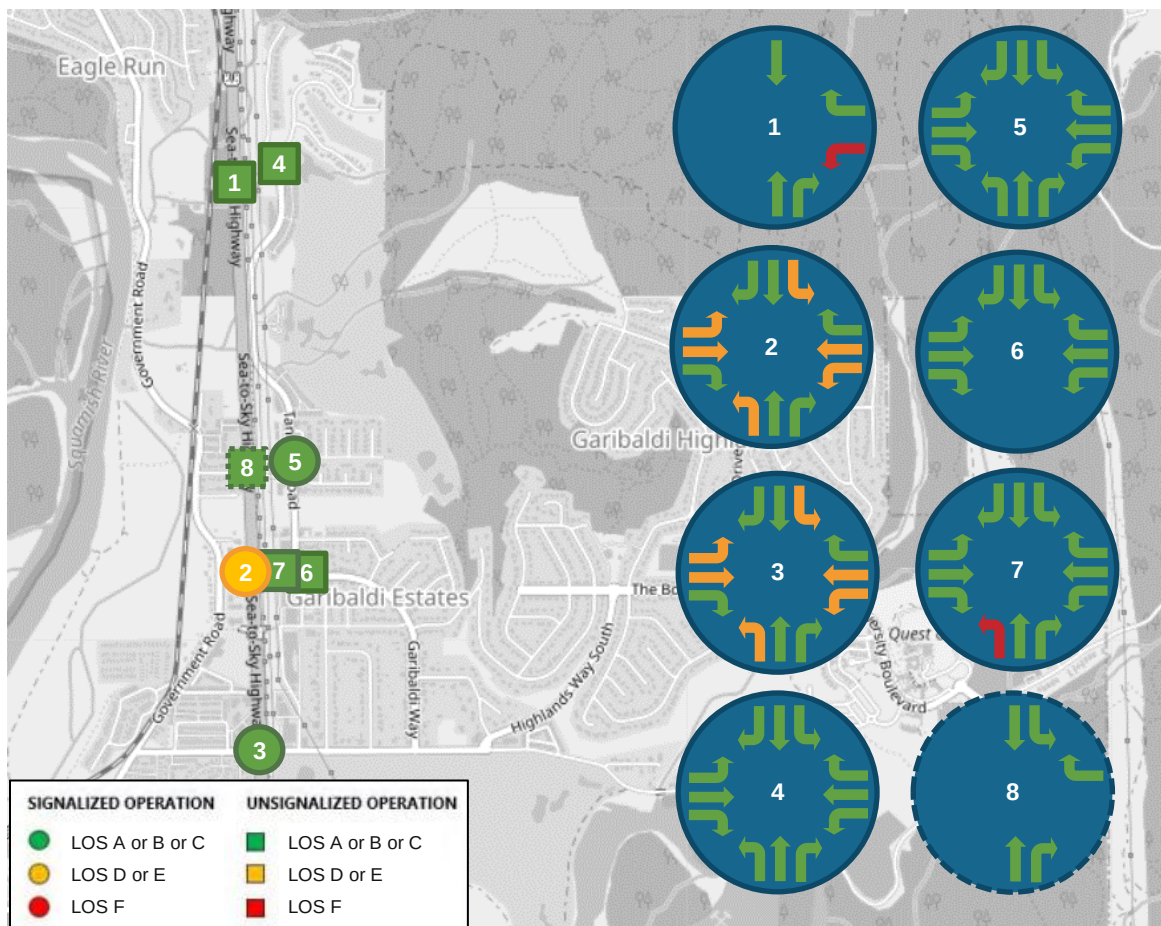


Figure 4.3: Traffic Operation Performance for Option 2B

Impacts to Existing Properties and Infrastructure:

- Properties for the new Newport Ridge Drive connection
- Properties along Highway 99
 - Widening the highway at Garibaldi Way increased the northbound through lanes from two to three requiring additional right-of-way on the east side of the highway where it appears the property line is adjacent to the existing highway through lanes.
 - Widening the highway at Mamquam Road on the northbound receiving lanes requires no curb modifications, but the westbound channelized right turn would now have to yield. To feed those three receiving lanes, widening would be required south of the highway in the

northbound direction and while there appears to be sufficient right-of-way, there are utility poles, the Corridor Trail and the drainage ditch to consider in the design phase.

- Half of the signal poles Highway 99 at Garibaldi Way and Mamquam Road
- Most of the Hydro poles Highway 99 at Garibaldi Way and Mamquam Road
- No impact to sidewalks Highway 99 at Garibaldi Way and Mamquam Road
- Long section of MUP east of Highway 99

Cost: Est. \$14M. Table 4.5 provides a summary of the high-level assumptions for each intersection and the total cost calculated from the Ministry template.

Table 4.5: High Level Improvement Assumptions and Cost Estimates for Option 2B

Intersection	Assumptions	Construction	Property	Other	Contingency	Total Cost
Highway 99/ Dowad Drive	Protected-T; Utilize existing median; Widen for SB receiving lane; Moderate concrete and asphalt	\$260,090	\$0	\$47,503	\$123,037	\$430,630
Highway 99/ Newport Ridge Drive	Properties for Newport Ridge connection; Widen for SBL and NBR; Sidewalk on both sides	\$704,064	\$3,206,522	\$399,922	\$1,724,203	\$6,034,711
Highway 99/ Garibaldi Way	Widen Highway to 6 lanes with properties; New signal, lighting, sidewalk or MUP with boulevard	\$1,585,777	\$1,605,399	\$484,573	\$1,470,299	\$5,146,048
Highway 99/ Mamquam Road	Widen Highway to 6 lanes; New signal, lighting, sidewalk or MUP with boulevard	\$1,585,777	\$0	\$404,573	\$796,140	\$2,786,490
Tantalus Road/ Newport Ridge Drive	Traffic signal; Minor asphalt, curb/gutter, sidewalk	\$696,244	\$0	\$129,087	\$330,133	\$1,155,464
	Total	\$4,135,708	\$4,811,921	\$1,336,571	\$4,113,679	\$14,397,879

5.0 Conclusions

The transportation study considers potential traffic volumes that theoretically could be generated under a high growth scenario at different stages of completion of both infill and greenfield developments in the Garibaldi Estates, Garibaldi Highlands and Tantalus areas, including significant future developments at the University, Newport Ridge and DL 509/510. The intention is to determine what the impacts of these developments will have on the local transportation network and the Highway 99 intersections with Mamquam Road, Garibaldi Way and Dowad Drive. At some level of increased density, the resulting traffic volume is anticipated to necessitate intersection and local road network upgrades.

Table 5.1 summarizes the benefits and constraints associated with each option.

Table 4.4: Benefits and Constraints Summary

Criteria	Option 1		Option 2A		Option 2B	
	Benefits	Constraints	Benefits	Constraints	Benefits	Constraints
Vehicle Travel Times and Operations		New Highway signal causing delays	No new Highway signal, Lower VKT		No new Highway signal, Lower VKT	
Impacts to Existing Infrastructure				Higher impact to existing infrastructure	Lower impact to existing infrastructure	
Costs	Lower cost			Higher cost		

Based on the required upgrades, and associated costs, Option 2B has an advantage over other options with improved vehicle travel times and operations with lower impact to existing infrastructure.

Option 2B is recommended for the long term, with the following main features:

- 70 km/h Speed Limit along Highway 99 extends north of Dowad Drive.
- New Newport Ridge Drive Connection between Highway 99 and Tantalus Road. Highway 99 / Newport Ridge Drive is unsignalized with right-in-right-out and southbound left turn in.
- No additional signal along Highway 99. Highway 99 / Dowad Drive remains unsignalized with right-in-right-out and westbound left turn out.
- Single westbound left turn from Garibaldi Way to Highway 99. Garibaldi Way has a 3-lane cross-section on both sides of the Highway. A third northbound lane on Highway 99 starts before Garibaldi Way and extends to Newport Ridge Drive.
- Dual westbound left turn from Mamquam Road to Highway 99. A third northbound lane on Highway 99 starts before Mamquam Road and extends to the Garibaldi Village right turn in.

The implementation of these improvements depends on the rate of residential development at Garibaldi Springs and DL 509/510, and commercial development at Garibaldi Estates. The intersection of Highway 99 / Garibaldi Way remained the highest congestion hotspot causing issues throughout the analysis. However, any of the above improvements would help relieve congestion at this intersection.

The reduced speed limit and the Highway 99 / Dowad Drive westbound left turn out should be combined together. The new Newport Ridge Drive Connection and its intersection at Highway 99

should provide benefit in combination. Improvements along Garibaldi Way should provide benefit in combination.

Therefore, if developments within the study area and connecting internal roads are developed from the Highway to east, prioritization should consider these combinations from north to south. On the contrary, if new developments within the study area and connecting internal roads are developed from south to north, prioritization should consider these combinations from south to north.



APPENDIX
Cost Estimate Worksheets

A

PROJECT COST ESTIMATE

Project No. 33033

Option 1 - Highway 99 / Dowad Drive

Cost Element Worksheet

Notes:

Data Entry Cells = Amounts entered are **SAMPLES ONLY**. These cells are directly data entered and used as the basis for calculating amounts in other cells. The amounts shall be established by the Estimator based on knowledge and information available at the time the estimate is developed.

Contingency % Cells = Percentage (%) shown is a **SAMPLE ONLY** and should only be used as a guide. The actual %ages used in these cells shall be set by the Estimator based on the assessed level of risk and uncertainty associated with each cost element at the time the estimate is developed.

Non-Data Entry Cells = Amounts calculated are **SAMPLES ONLY**. These cells contain formulas. The formulas should be used as a guide only. The calculated amounts for each cost element shall be reviewed, adjusted and established by the Estimator as necessary for each cost element based on their knowledge and information at the time the estimate is developed.

COST ELEMENT	BASE ESTIMATE	CONTINGENCY		TOTAL ESTIMATE	COMMENTS
		%	\$		
PROJECT MANAGEMENT	20,000	40%	8,000	28,000	3.5% of Total Project Estimate
PLANNING	3,487	40%	1,395	4,882	1% of Construction Base Estimate
DESIGN					
PRELIMINARY DESIGN	6,974	40%	2,790	9,764	2% of Construction Base Estimate
DETAILED DESIGN SERVICES	40,000	40%	16,000	56,000	See Assumptions Worksheet
DESIGN TOTAL	46,974	40%	18,790	65,764	
PROPERTY					
MARKET VALUE OF LAND	0	40%	0	0	
VARIABLE COSTS	0	40%	0	0	25% of Market Value
LESS: SURPLUS LAND RECOVERIES	0		0	0	Residual land sales from surplus property
PROPERTY TOTAL	0	#DIV/0!	0	0	
ENVIRONMENT					
ENVIRONMENTAL COMPENSATION	0	40%	0	0	
ENVIRONMENT TOTAL	0	#DIV/0!	0	0	
CONSTRUCTION					
ROAD CONSTRUCTION					
REMOVALS	50,000	40%	20,000	70,000	Allowance
PAVING	3,749	40%	1,500	5,249	Assumes 1 lane of 40m for WBL
CURB AND GUTTER	6,561	40%	2,625	9,186	Assumes 50m total
SIDEWALKS	0	40%	0	0	
DRAINAGE	0	40%	0	0	
LANDSCAPING	0	40%	0	0	
URBAN TRAFFIC SIGNAL	264,590	40%	105,836	370,426	Per MOTI Upper Range *0.75 for 3-leg
LIGHTING	23,814	40%	9,526	33,340	Per MOTI Upper Range *0.75 for 3-leg
UTILITY RELOCATION	0	40%	0	0	
ROAD CONSTRUCTION SUB-TOTAL	348,715	40%	139,486	488,200	
STRUCTURAL CONSTRUCTION	0	40%	0	0	
CONSTRUCTION TOTAL	348,715	40%	139,486	488,200	
CONSTRUCTION SUPERVISION	40,000	40%	16,000	56,000	See Assumptions Worksheet
OTHER COSTS					
<INSERT ITEMS>	0	40%	0	0	describe each item in detail
OTHER COSTS TOTAL	0	#DIV/0!	0	0	
PAST COSTS (prior to <insert date>)	0	n/a	n/a	0	
MANAGEMENT RESERVE (if applicable)					maintained by CPB (5% of total estimate)
TOTAL	459,176	40%	183,670	642,846	

PROJECT COST ESTIMATE

Project No. 33033

Option 2A & 2B - Highway 99 / Dowad Drive

Cost Element Worksheet

Notes:

Data Entry Cells = Amounts entered are **SAMPLES ONLY**. These cells are directly data entered and used as the basis for calculating amounts in other cells. The amounts shall be established by the Estimator based on knowledge and information available at the time the estimate is developed.

Contingency % Cells = Percentage (%) shown is a **SAMPLE ONLY** and should only be used as a guide. The actual %ages used in these cells shall be set by the Estimator based on the assessed level of risk and uncertainty associated with each cost element at the time the estimate is developed.

Non-Data Entry Cells = Amounts calculated are **SAMPLES ONLY**. These cells contain formulas. The formulas should be used as a guide only. The calculated amounts for each cost element shall be reviewed, adjusted and established by the Estimator as necessary for each cost element based on their knowledge and information at the time the estimate is developed.

COST ELEMENT	BASE ESTIMATE	CONTINGENCY		TOTAL ESTIMATE	COMMENTS
		%	\$		
PROJECT MANAGEMENT	10,000	40%	4,000	14,000	3.5% of Total Project Estimate
PLANNING	2,501	40%	1,000	3,501	1% of Construction Base Estimate
DESIGN					
PRELIMINARY DESIGN	5,002	40%	2,001	7,003	2% of Construction Base Estimate
DETAILED DESIGN SERVICES	30,000	40%	12,000	42,000	See Assumptions Worksheet
DESIGN TOTAL	35,002	40%	14,001	49,003	
PROPERTY					
MARKET VALUE OF LAND	0	40%	0	0	
VARIABLE COSTS	0	40%	0	0	25% of Market Value
LESS: SURPLUS LAND RECOVERIES	0		0	0	Residual land sales from surplus property
PROPERTY TOTAL	0	#DIV/0!	0	0	
ENVIRONMENT					
ENVIRONMENTAL COMPENSATION	0	40%	0	0	Allowance
ENVIRONMENT TOTAL	0	#DIV/0!	0	0	
CONSTRUCTION					
ROAD CONSTRUCTION					
REMOVALS	50,000	40%	20,000	70,000	Allowance
PAVING	28,120	40%	11,248	39,368	Assumes 1 lane of 40m for WBL
GRADING	95,256	40%	38,102	133,358	Assumes 300m of widening
CURB AND GUTTER	39,368	40%	15,747	55,115	Assumes 50m total
PROTECTED T MEDIAN	13,533	40%	5,413	18,946	Assumes 150m2 concrete median islands
DRAINAGE	0	40%	0	0	
LANDSCAPING	0	40%	0	0	
URBAN TRAFFIC SIGNAL	0	40%	0	0	
LIGHTING	23,814	40%	9,526	33,340	Per MOTI Upper Range *0.75 for 3-leg
UTILITY RELOCATION	0	40%	0	0	Allowance
ROAD CONSTRUCTION SUB-TOTAL	250,090	40%	100,036	350,126	
STRUCTURAL CONSTRUCTION	0	40%	0	0	
CONSTRUCTION TOTAL	250,090	40%	100,036	350,126	
CONSTRUCTION SUPERVISION	10,000	40%	4,000	14,000	See Assumptions Worksheet
OTHER COSTS					
<INSERT ITEMS>	0	40%	0	0	describe each item in detail
OTHER COSTS TOTAL	0	#DIV/0!	0	0	
PAST COSTS (prior to <insert date>)	0	n/a	n/a	0	
MANAGEMENT RESERVE (if applicable)					maintained by CPB (5% of total estimate)
TOTAL	307,593	40%	123,037	430,630	

PROJECT COST ESTIMATE

Project No. 33033

Option 2A & 2B - Highway 99 / Newport Ridge Drive

Cost Element Worksheet

Notes:

Data Entry Cells = Amounts entered are **SAMPLES ONLY**. These cells are directly data entered and used as the basis for calculating amounts in other cells. The amounts shall be established by the Estimator based on knowledge and information available at the time the estimate is developed.

Contingency % Cells = Percentage (%) shown is a **SAMPLE ONLY** and should only be used as a guide. The actual %ages used in these cells shall be set by the Estimator based on the assessed level of risk and uncertainty associated with each cost element at the time the estimate is developed.

Non-Data Entry Cells = Amounts calculated are **SAMPLES ONLY**. These cells contain formulas. The formulas should be used as a guide only. The calculated amounts for each cost element shall be reviewed, adjusted and established by the Estimator as necessary for each cost element based on their knowledge and information at the time the estimate is developed.

COST ELEMENT	BASE ESTIMATE	CONTINGENCY		TOTAL ESTIMATE	COMMENTS
		%	\$		
PROJECT MANAGEMENT	200,000	40%	80,000	280,000	3.5% of Total Project Estimate
PLANNING	6,641	40%	2,656	9,297	1% of Construction Base Estimate
DESIGN					
PRELIMINARY DESIGN	13,281	40%	5,313	18,594	2% of Construction Base Estimate
DETAILED DESIGN SERVICES	80,000	40%	32,000	112,000	See Assumptions Worksheet
DESIGN TOTAL	93,281	40%	37,313	130,594	
PROPERTY					
MARKET VALUE OF LAND	2,565,217	40%	1,026,087	3,591,304	20m (3,000m2) ROW on strata lot
VARIABLE COSTS	641,304	40%	256,522	897,826	25% of Market Value
LESS: SURPLUS LAND RECOVERIES	0		0	0	Residual land sales from surplus property
PROPERTY TOTAL	3,206,522	40%	1,282,609	4,489,130	
ENVIRONMENT					
ENVIRONMENTAL COMPENSATION	100,000	40%	40,000	140,000	Allowance
ENVIRONMENT TOTAL	100,000	40%	40,000	140,000	
CONSTRUCTION					
ROAD CONSTRUCTION					
REMOVALS	100,000	40%	40,000	140,000	Allowance
PAVING	56,240	40%	22,496	78,736	Assumes 4 lanes at 150m
GRADING	190,512	40%	76,205	266,717	Assumes 4 lanes at 150m
CURB AND GUTTER	39,368	40%	15,747	55,115	Assumes 300m
SIDEWALKS	54,131	40%	21,652	75,783	Assumes both sides of new connection
DRAINAGE	100,000	40%	40,000	140,000	Allowance
LANDSCAPING	100,000	40%	40,000	140,000	Allowance
URBAN TRAFFIC SIGNAL	0	40%	0	0	
LIGHTING	23,814	40%	9,526	33,340	Per MOTI Upper Range *0.75 for 3-leg
UTILITY RELOCATION	0	40%	0	0	
ROAD CONSTRUCTION SUB-TOTAL	664,064	40%	265,626	929,689	
STRUCTURAL CONSTRUCTION	0	40%	0	0	
CONSTRUCTION TOTAL	664,064	40%	265,626	929,689	
CONSTRUCTION SUPERVISION	40,000	40%	16,000	56,000	See Assumptions Worksheet
OTHER COSTS					
<INSERT ITEMS>	0	40%	0	0	describe each item in detail
OTHER COSTS TOTAL	0	#DIV/0!	0	0	
PAST COSTS (prior to <insert date>)	0	n/a	n/a	0	
MANAGEMENT RESERVE (if applicable)					maintained by CPB (5% of total estimate)
TOTAL	4,310,508	40%	1,724,203	6,034,711	

PROJECT COST ESTIMATE

Project No. 33033

Option 2A & 2B - Tantalus Road / Newport Ridge Drive

Cost Element Worksheet

Notes:

Data Entry Cells = Amounts entered are **SAMPLES ONLY**. These cells are directly data entered and used as the basis for calculating amounts in other cells. The amounts shall be established by the Estimator based on knowledge and information available at the time the estimate is developed.

Contingency % Cells = Percentage (%) shown is a **SAMPLE ONLY** and should only be used as a guide. The actual %ages used in these cells shall be set by the Estimator based on the assessed level of risk and uncertainty associated with each cost element at the time the estimate is developed.

Non-Data Entry Cells = Amounts calculated are **SAMPLES ONLY**. These cells contain formulas. The formulas should be used as a guide only. The calculated amounts for each cost element shall be reviewed, adjusted and established by the Estimator as necessary for each cost element based on their knowledge and information at the time the estimate is developed.

COST ELEMENT	BASE ESTIMATE	CONTINGENCY		TOTAL ESTIMATE	COMMENTS
		%	\$		
PROJECT MANAGEMENT	40,000	40%	16,000	56,000	3.5% of Total Project Estimate
PLANNING	6,362	40%	2,545	8,907	1% of Construction Base Estimate
DESIGN					
PRELIMINARY DESIGN	12,725	40%	5,090	17,815	2% of Construction Base Estimate
DETAILED DESIGN SERVICES	70,000	40%	28,000	98,000	See Assumptions Worksheet
DESIGN TOTAL	82,725	40%	33,090	115,815	
PROPERTY					
MARKET VALUE OF LAND	0	40%	0	0	
VARIABLE COSTS	0	40%	0	0	25% of Market Value
LESS: SURPLUS LAND RECOVERIES	0		0	0	Residual land sales from surplus property
PROPERTY TOTAL	0	#DIV/0!	0	0	
ENVIRONMENT					
ENVIRONMENTAL COMPENSATION	0	40%	0	0	
ENVIRONMENT TOTAL	0	#DIV/0!	0	0	
CONSTRUCTION					
ROAD CONSTRUCTION					
REMOVALS	30,000	40%	12,000	42,000	Allowance
PAVING	9,373	40%	3,749	13,123	Assumes 1 lane of 40m for WBL
GRADING	0	40%	0	0	
CURB AND GUTTER	26,245	40%	10,498	36,743	Assumes 50m of s/w on each approach
SIDEWALKS	36,087	40%	14,435	50,522	Assumes 50m of s/w on each approach
DRAINAGE	50,000	40%	20,000	70,000	Allowance
LANDSCAPING	50,000	40%	20,000	70,000	Allowance
URBAN TRAFFIC SIGNAL	352,787	40%	141,115	493,901	Per MOTI Upper Range
LIGHTING	31,752	40%	12,701	44,453	Per MOTI Upper Range
UTILITY RELOCATION	50,000	40%	20,000	70,000	Allowance
ROAD CONSTRUCTION SUB-TOTAL	636,244	40%	254,498	890,742	
STRUCTURAL CONSTRUCTION	0	40%	0	0	
CONSTRUCTION TOTAL	636,244	40%	254,498	890,742	
CONSTRUCTION SUPERVISION	60,000	40%	24,000	84,000	See Assumptions Worksheet
OTHER COSTS					
<INSERT ITEMS>	0	40%	0	0	describe each item in detail
OTHER COSTS TOTAL	0	#DIV/0!	0	0	
PAST COSTS (prior to <insert date>)	0	n/a	n/a	0	
MANAGEMENT RESERVE (if applicable)					maintained by CPB (5% of total estimate)
TOTAL	825,331	40%	330,133	1,155,464	

PROJECT COST ESTIMATE

Project No. 33033

Option 1 - Highway 99 / Garibaldi Way

Cost Element Worksheet

Notes:

Data Entry Cells = Amounts entered are **SAMPLES ONLY**. These cells are directly data entered and used as the basis for calculating amounts in other cells. The amounts shall be established by the Estimator based on knowledge and information available at the time the estimate is developed.

Contingency % Cells = Percentage (%) shown is a **SAMPLE ONLY** and should only be used as a guide. The actual %ages used in these cells shall be set by the Estimator based on the assessed level of risk and uncertainty associated with each cost element at the time the estimate is developed.

Non-Data Entry Cells = Amounts calculated are **SAMPLES ONLY**. These cells contain formulas. The formulas should be used as a guide only. The calculated amounts for each cost element shall be reviewed, adjusted and established by the Estimator as necessary for each cost element based on their knowledge and information at the time the estimate is developed.

COST ELEMENT	BASE ESTIMATE	CONTINGENCY		TOTAL ESTIMATE	COMMENTS
		%	\$		
PROJECT MANAGEMENT	270,000	40%	108,000	378,000	3.5% of Total Project Estimate
PLANNING	25,311	40%	10,124	35,435	1% of Construction Base Estimate
DESIGN					
PRELIMINARY DESIGN	50,622	40%	20,249	70,871	2% of Construction Base Estimate
DETAILED DESIGN SERVICES	280,000	40%	112,000	392,000	See Assumptions Worksheet
DESIGN TOTAL	330,622	40%	132,249	462,871	
PROPERTY					
MARKET VALUE OF LAND	1,925,623	40%	770,249	2,695,872	Assumes widening on GW & Hwy 99
VARIABLE COSTS	481,406	40%	192,562	673,968	25% of Market Value
LESS: SURPLUS LAND RECOVERIES	0		0	0	Residual land sales from surplus property
PROPERTY TOTAL	2,407,029	40%	962,812	3,369,841	
ENVIRONMENT					
ENVIRONMENTAL COMPENSATION	100,000	40%	40,000	140,000	Allowance
ENVIRONMENT TOTAL	100,000	40%	40,000	140,000	
CONSTRUCTION					
ROAD CONSTRUCTION					
REMOVALS	150,000	40%	60,000	210,000	Allowance
PAVING	257,765	40%	103,106	360,871	Assumes widening on each approach ~8 Lanes
GRADING	635,039	40%	254,016	889,055	Intersection regraded 11 lanes at 250m
CURB AND GUTTER	262,452	40%	104,981	367,432	Assumes 500m per approach
SIDEWALKS	541,307	40%	216,523	757,829	Assumes 500m s/w per approach
DRAINAGE	100,000	40%	40,000	140,000	Allowance
LANDSCAPING	100,000	40%	40,000	140,000	Allowance
URBAN TRAFFIC SIGNAL	352,787	40%	141,115	493,901	Per MOTI Upper Range
LIGHTING	31,752	40%	12,701	44,453	Per MOTI Upper Range
UTILITY RELOCATION	100,000	40%	40,000	140,000	Allowance
ROAD CONSTRUCTION SUB-TOTAL	2,531,101	40%	1,012,441	3,543,542	
STRUCTURAL CONSTRUCTION	0	40%	0	0	
CONSTRUCTION TOTAL	2,531,101	40%	1,012,441	3,543,542	
CONSTRUCTION SUPERVISION	140,000	40%	56,000	196,000	See Assumptions Worksheet
OTHER COSTS					
<INSERT ITEMS>	0	40%	0	0	describe each item in detail
OTHER COSTS TOTAL	0	#DIV/0!	0	0	
PAST COSTS (prior to <insert date>)	0	n/a	n/a	0	
MANAGEMENT RESERVE (if applicable)					maintained by CPB (5% of total estimate)
TOTAL	5,804,063	40%	2,321,625	8,125,689	

PROJECT COST ESTIMATE

Project No. 33033

Option 2A - Highway 99 / Garibaldi Way

Cost Element Worksheet

Notes:

Data Entry Cells = Amounts entered are **SAMPLES ONLY**. These cells are directly data entered and used as the basis for calculating amounts in other cells. The amounts shall be established by the Estimator based on knowledge and information available at the time the estimate is developed.

Contingency % Cells = Percentage (%) shown is a **SAMPLE ONLY** and should only be used as a guide. The actual %ages used in these cells shall be set by the Estimator based on the assessed level of risk and uncertainty associated with each cost element at the time the estimate is developed.

Non-Data Entry Cells = Amounts calculated are **SAMPLES ONLY**. These cells contain formulas. The formulas should be used as a guide only. The calculated amounts for each cost element shall be reviewed, adjusted and established by the Estimator as necessary for each cost element based on their knowledge and information at the time the estimate is developed.

COST ELEMENT	BASE ESTIMATE	CONTINGENCY		TOTAL ESTIMATE	COMMENTS
		%	\$		
PROJECT MANAGEMENT	180,000	40%	72,000	252,000	3.5% of Total Project Estimate
PLANNING	16,211	40%	6,484	22,695	1% of Construction Base Estimate
DESIGN					
PRELIMINARY DESIGN	32,422	40%	12,969	45,391	2% of Construction Base Estimate
DETAILED DESIGN SERVICES	180,000	40%	72,000	252,000	See Assumptions Worksheet
DESIGN TOTAL	212,422	40%	84,969	297,391	
PROPERTY					
MARKET VALUE OF LAND	1,284,319	40%	513,728	1,798,046	Assumes widening on GW
VARIABLE COSTS	321,080	40%	128,432	449,512	25% of Market Value
LESS: SURPLUS LAND RECOVERIES	0		0	0	Residual land sales from surplus property
PROPERTY TOTAL	1,605,399	40%	642,159	2,247,558	
ENVIRONMENT					
ENVIRONMENTAL COMPENSATION	100,000	40%	40,000	140,000	Allowance
ENVIRONMENT TOTAL	100,000	40%	40,000	140,000	
CONSTRUCTION					
ROAD CONSTRUCTION					
REMOVALS	100,000	40%	40,000	140,000	Allowance
PAVING	117,166	40%	46,866	164,032	Assumes widening on GW only
GRADING	317,520	40%	127,008	444,528	Assumes widening on GW only
CURB AND GUTTER	131,226	40%	52,490	183,716	Assumes 500m on GW approaches
SIDEWALKS	270,653	40%	108,261	378,915	Assumes 500m S/W on GW approaches
DRAINAGE	100,000	40%	40,000	140,000	Allowance
LANDSCAPING	100,000	40%	40,000	140,000	Allowance
URBAN TRAFFIC SIGNAL	352,787	40%	141,115	493,901	Per MOTI Upper Range
LIGHTING	31,752	40%	12,701	44,453	Per MOTI Upper Range
UTILITY RELOCATION	100,000	40%	40,000	140,000	Allowance
ROAD CONSTRUCTION SUB-TOTAL	1,621,103	40%	648,441	2,269,545	
STRUCTURAL CONSTRUCTION	0	40%	0	0	
CONSTRUCTION TOTAL	1,621,103	40%	648,441	2,269,545	
CONSTRUCTION SUPERVISION	110,000	40%	44,000	154,000	See Assumptions Worksheet
OTHER COSTS					
<INSERT ITEMS>	0	40%	0	0	describe each item in detail
OTHER COSTS TOTAL	0	#DIV/0!	0	0	
PAST COSTS (prior to <insert date>)	0	n/a	n/a	0	
MANAGEMENT RESERVE (if applicable)					maintained by CPB (5% of total estimate)
TOTAL	3,845,135	40%	1,538,054	5,383,189	

PROJECT COST ESTIMATE

Project No. 33033

Option 2B - Highway 99 / Garibaldi Way

Cost Element Worksheet

Notes:

Data Entry Cells = Amounts entered are **SAMPLES ONLY**. These cells are directly data entered and used as the basis for calculating amounts in other cells. The amounts shall be established by the Estimator based on knowledge and information available at the time the estimate is developed.

Contingency % Cells = Percentage (%) shown is a **SAMPLE ONLY** and should only be used as a guide. The actual %ages used in these cells shall be set by the Estimator based on the assessed level of risk and uncertainty associated with each cost element at the time the estimate is developed.

Non-Data Entry Cells = Amounts calculated are **SAMPLES ONLY**. These cells contain formulas. The formulas should be used as a guide only. The calculated amounts for each cost element shall be reviewed, adjusted and established by the Estimator as necessary for each cost element based on their knowledge and information at the time the estimate is developed.

COST ELEMENT	BASE ESTIMATE	CONTINGENCY		TOTAL ESTIMATE	COMMENTS
		%	\$		
PROJECT MANAGEMENT	170,000	40%	68,000	238,000	3.5% of Total Project Estimate
PLANNING	14,858	40%	5,943	20,801	1% of Construction Base Estimate
DESIGN					
PRELIMINARY DESIGN	29,716	40%	11,886	41,602	2% of Construction Base Estimate
DETAILED DESIGN SERVICES	170,000	40%	68,000	238,000	See Assumptions Worksheet
DESIGN TOTAL	199,716	40%	79,886	279,602	
PROPERTY					
MARKET VALUE OF LAND	1,284,319	40%	513,728	1,798,046	Assumes widening on Highway
VARIABLE COSTS	321,080	40%	128,432	449,512	25% of Market Value
LESS: SURPLUS LAND RECOVERIES	0		0	0	Residual land sales from surplus property
PROPERTY TOTAL	1,605,399	40%	642,159	2,247,558	
ENVIRONMENT					
ENVIRONMENTAL COMPENSATION	100,000	40%	40,000	140,000	Allowance
ENVIRONMENT TOTAL	100,000	40%	40,000	140,000	
CONSTRUCTION					
ROAD CONSTRUCTION					
REMOVALS	100,000	40%	40,000	140,000	Allowance
PAVING	117,166	40%	46,866	164,032	Assumes widening on highway only
GRADING	317,520	40%	127,008	444,528	Assumes widening on highway only
CURB AND GUTTER	131,226	40%	52,490	183,716	Assumes 500m on highway
SIDEWALKS	135,327	40%	54,131	189,457	Assumes 500m on highway approaches
DRAINAGE	100,000	40%	40,000	140,000	Allowance
LANDSCAPING	100,000	40%	40,000	140,000	Allowance
URBAN TRAFFIC SIGNAL	352,787	40%	141,115	493,901	Per MOTI Upper Range
LIGHTING	31,752	40%	12,701	44,453	Per MOTI Upper Range
UTILITY RELOCATION	100,000	40%	40,000	140,000	Allowance
ROAD CONSTRUCTION SUB-TOTAL	1,485,777	40%	594,311	2,080,087	
STRUCTURAL CONSTRUCTION	0	40%	0	0	
CONSTRUCTION TOTAL	1,485,777	40%	594,311	2,080,087	
CONSTRUCTION SUPERVISION	100,000	40%	40,000	140,000	See Assumptions Worksheet
OTHER COSTS					
<INSERT ITEMS>	0	40%	0	0	describe each item in detail
OTHER COSTS TOTAL	0	#DIV/0!	0	0	
PAST COSTS (prior to <insert date>)	0	n/a	n/a	0	
MANAGEMENT RESERVE (if applicable)					maintained by CPB (5% of total estimate)
TOTAL	3,675,749	40%	1,470,299	5,146,048	

PROJECT COST ESTIMATE

Project No. 33033

Option 1 - Highway 99 / Mamquam Road

Cost Element Worksheet

Notes:

Data Entry Cells = Amounts entered are **SAMPLES ONLY**. These cells are directly data entered and used as the basis for calculating amounts in other cells. The amounts shall be established by the Estimator based on knowledge and information available at the time the estimate is developed.

Contingency % Cells = Percentage (%) shown is a **SAMPLE ONLY** and should only be used as a guide. The actual %ages used in these cells shall be set by the Estimator based on the assessed level of risk and uncertainty associated with each cost element at the time the estimate is developed.

Non-Data Entry Cells = Amounts calculated are **SAMPLES ONLY**. These cells contain formulas. The formulas should be used as a guide only. The calculated amounts for each cost element shall be reviewed, adjusted and established by the Estimator as necessary for each cost element based on their knowledge and information at the time the estimate is developed.

COST ELEMENT	BASE ESTIMATE	CONTINGENCY		TOTAL ESTIMATE	COMMENTS
		%	\$		
PROJECT MANAGEMENT	140,000	40%	56,000	196,000	3.5% of Total Project Estimate
PLANNING	16,211	40%	6,484	22,695	1% of Construction Base Estimate
DESIGN					
PRELIMINARY DESIGN	32,422	40%	12,969	45,391	2% of Construction Base Estimate
DETAILED DESIGN SERVICES	180,000	40%	72,000	252,000	See Assumptions Worksheet
DESIGN TOTAL	212,422	40%	84,969	297,391	
PROPERTY					
MARKET VALUE OF LAND	641,304	40%	256,522	897,826	Widening MR on west side of hwy
VARIABLE COSTS	160,326	40%	64,130	224,457	25% of Market Value
LESS: SURPLUS LAND RECOVERIES	0		0	0	Residual land sales from surplus property
PROPERTY TOTAL	801,630	40%	320,652	1,122,283	
ENVIRONMENT					
ENVIRONMENTAL COMPENSATION	100,000	40%	40,000	140,000	Allowance
ENVIRONMENT TOTAL	100,000	40%	40,000	140,000	
CONSTRUCTION					
ROAD CONSTRUCTION					
REMOVALS	100,000	40%	40,000	140,000	Allowance
PAVING	117,166	40%	46,866	164,032	Assumes widening on MR
GRADING	317,520	40%	127,008	444,528	Assumes widening on MR
CURB AND GUTTER	131,226	40%	52,490	183,716	Assumes 500m on MR approaches
SIDEWALKS	270,653	40%	108,261	378,915	Assumes 500m S/W on MR approaches
DRAINAGE	100,000	40%	40,000	140,000	Allowance
LANDSCAPING	100,000	40%	40,000	140,000	Allowance
URBAN TRAFFIC SIGNAL	352,787	40%	141,115	493,901	Per MOTI Upper Range
LIGHTING	31,752	40%	12,701	44,453	Per MOTI Upper Range
UTILITY RELOCATION	100,000	40%	40,000	140,000	Allowance
ROAD CONSTRUCTION SUB-TOTAL	1,621,103	40%	648,441	2,269,545	
STRUCTURAL CONSTRUCTION	0	40%	0	0	
CONSTRUCTION TOTAL	1,621,103	40%	648,441	2,269,545	
CONSTRUCTION SUPERVISION	110,000	40%	44,000	154,000	See Assumptions Worksheet
OTHER COSTS					
<INSERT ITEMS>	0	40%	0	0	describe each item in detail
OTHER COSTS TOTAL	0	#DIV/0!	0	0	
PAST COSTS (prior to <insert date>)	0	n/a	n/a	0	
MANAGEMENT RESERVE (if applicable)					maintained by CPB (5% of total estimate)
TOTAL	3,001,367	40%	1,200,547	4,201,914	

PROJECT COST ESTIMATE

Project No. 33033

Option 2A - Highway 99 / Maquam Road

Cost Element Worksheet

Notes:

Data Entry Cells = Amounts entered are **SAMPLES ONLY**. These cells are directly data entered and used as the basis for calculating amounts in other cells. The amounts shall be established by the Estimator based on knowledge and information available at the time the estimate is developed.

Contingency % Cells = Percentage (%) shown is a **SAMPLE ONLY** and should only be used as a guide. The actual %ages used in these cells shall be set by the Estimator based on the assessed level of risk and uncertainty associated with each cost element at the time the estimate is developed.

Non-Data Entry Cells = Amounts calculated are **SAMPLES ONLY**. These cells contain formulas. The formulas should be used as a guide only. The calculated amounts for each cost element shall be reviewed, adjusted and established by the Estimator as necessary for each cost element based on their knowledge and information at the time the estimate is developed.

COST ELEMENT	BASE ESTIMATE	CONTINGENCY		TOTAL ESTIMATE	COMMENTS
		%	\$		
PROJECT MANAGEMENT	150,000	40%	60,000	210,000	3.5% of Total Project Estimate
PLANNING	17,239	40%	6,896	24,135	1% of Construction Base Estimate
DESIGN					
PRELIMINARY DESIGN	34,478	40%	13,791	48,270	2% of Construction Base Estimate
DETAILED DESIGN SERVICES	190,000	40%	76,000	266,000	See Assumptions Worksheet
DESIGN TOTAL	224,478	40%	89,791	314,270	
PROPERTY					
MARKET VALUE OF LAND	641,304	40%	256,522	897,826	Widening MR on west side of hwy
VARIABLE COSTS	160,326	40%	64,130	224,457	25% of Market Value
LESS: SURPLUS LAND RECOVERIES	0		0	0	Residual land sales from surplus property
PROPERTY TOTAL	801,630	40%	320,652	1,122,283	
ENVIRONMENT					
ENVIRONMENTAL COMPENSATION	100,000	40%	40,000	140,000	Allowance
ENVIRONMENT TOTAL	100,000	40%	40,000	140,000	
CONSTRUCTION					
ROAD CONSTRUCTION					
REMOVALS	100,000	40%	40,000	140,000	Allowance
PAVING	140,599	40%	56,240	196,839	Assumes widening on MR and hwy NB
GRADING	396,900	40%	158,760	555,659	Assumes widening on MR and hwy NB
CURB AND GUTTER	131,226	40%	52,490	183,716	Assumes 500m on MR approaches
SIDEWALKS	270,653	40%	108,261	378,915	Assumes 500m S/W on MR approaches
DRAINAGE	100,000	40%	40,000	140,000	Allowance
LANDSCAPING	100,000	40%	40,000	140,000	Allowance
URBAN TRAFFIC SIGNAL	352,787	40%	141,115	493,901	Per MOTI Upper Range
LIGHTING	31,752	40%	12,701	44,453	Per MOTI Upper Range
UTILITY RELOCATION	100,000	40%	40,000	140,000	Allowance
ROAD CONSTRUCTION SUB-TOTAL	1,723,917	40%	689,567	2,413,483	
STRUCTURAL CONSTRUCTION	0	40%	0	0	
CONSTRUCTION TOTAL	1,723,917	40%	689,567	2,413,483	
CONSTRUCTION SUPERVISION	110,000	40%	44,000	154,000	See Assumptions Worksheet
OTHER COSTS					
<INSERT ITEMS>	0	40%	0	0	describe each item in detail
OTHER COSTS TOTAL	0	#DIV/0!	0	0	
PAST COSTS (prior to <insert date>)	0	n/a	n/a	0	
MANAGEMENT RESERVE (if applicable)					maintained by CPB (5% of total estimate)
TOTAL	3,127,264	40%	1,250,906	4,378,170	

PROJECT COST ESTIMATE

Project No. 33033

Option 2B - Highway 99 / Mamquam Road

Cost Element Worksheet

Notes:

Data Entry Cells = Amounts entered are **SAMPLES ONLY**. These cells are directly data entered and used as the basis for calculating amounts in other cells. The amounts shall be established by the Estimator based on knowledge and information available at the time the estimate is developed.

Contingency % Cells = Percentage (%) shown is a **SAMPLE ONLY** and should only be used as a guide. The actual %ages used in these cells shall be set by the Estimator based on the assessed level of risk and uncertainty associated with each cost element at the time the estimate is developed.

Non-Data Entry Cells = Amounts calculated are **SAMPLES ONLY**. These cells contain formulas. The formulas should be used as a guide only. The calculated amounts for each cost element shall be reviewed, adjusted and established by the Estimator as necessary for each cost element based on their knowledge and information at the time the estimate is developed.

COST ELEMENT	BASE ESTIMATE	CONTINGENCY		TOTAL ESTIMATE	COMMENTS
		%	\$		
PROJECT MANAGEMENT	90,000	40%	36,000	126,000	3.5% of Total Project Estimate
PLANNING	14,858	40%	5,943	20,801	1% of Construction Base Estimate
DESIGN					
PRELIMINARY DESIGN	29,716	40%	11,886	41,602	2% of Construction Base Estimate
DETAILED DESIGN SERVICES	170,000	40%	68,000	238,000	See Assumptions Worksheet
DESIGN TOTAL	199,716	40%	79,886	279,602	
PROPERTY					
MARKET VALUE OF LAND	0	40%	0	0	
VARIABLE COSTS	0	40%	0	0	25% of Market Value
LESS: SURPLUS LAND RECOVERIES	0		0	0	Residual land sales from surplus property
PROPERTY TOTAL	0	#DIV/0!	0	0	
ENVIRONMENT					
ENVIRONMENTAL COMPENSATION	100,000	40%	40,000	140,000	Allowance
ENVIRONMENT TOTAL	100,000	40%	40,000	140,000	
CONSTRUCTION					
ROAD CONSTRUCTION					
REMOVALS	100,000	40%	40,000	140,000	Allowance
PAVING	117,166	40%	46,866	164,032	Assumes widening on highway only
GRADING	317,520	40%	127,008	444,528	Assumes widening on highway only
CURB AND GUTTER	131,226	40%	52,490	183,716	Assumes 500m on highway
SIDEWALKS	135,327	40%	54,131	189,457	Assumes 500m on highway approaches
DRAINAGE	100,000	40%	40,000	140,000	Allowance
LANDSCAPING	100,000	40%	40,000	140,000	Allowance
URBAN TRAFFIC SIGNAL	352,787	40%	141,115	493,901	Per MOTI Upper Range
LIGHTING	31,752	40%	12,701	44,453	Per MOTI Upper Range
UTILITY RELOCATION	100,000	40%	40,000	140,000	Allowance
ROAD CONSTRUCTION SUB-TOTAL	1,485,777	40%	594,311	2,080,087	
STRUCTURAL CONSTRUCTION	0	40%	0	0	
CONSTRUCTION TOTAL	1,485,777	40%	594,311	2,080,087	
CONSTRUCTION SUPERVISION	100,000	40%	40,000	140,000	See Assumptions Worksheet
OTHER COSTS					
<INSERT ITEMS>	0	40%	0	0	describe each item in detail
OTHER COSTS TOTAL	0	#DIV/0!	0	0	
PAST COSTS (prior to <insert date>)	0	n/a	n/a	0	
MANAGEMENT RESERVE (if applicable)					maintained by CPB (5% of total estimate)
TOTAL	1,990,350	40%	796,140	2,786,490	