PARSONS

BRITISH COLUMBIA

Ministry of Transportation and Infrastructure

Highway 1 – Malahat Segment Detour Route Planning

November 2019

Executive Summary

The Trans-Canada Highway is the main north-south corridor on Vancouver Island and serves as a critical route for commuting, moving goods, linking communities, and supporting a thriving tourism industry in the region. While long duration full highway closures are infrequent along the segment of the Malahat between Shawnigan Lake Road and West Shore Parkway, during the rare event of an emergency closure there are limited alternative route options for a detour to enable traffic to bypass the affected site. These options primarily consist of the following:

- The Pacific Marine Circle Route is a route which travels through Sooke, Port Renfrew, and Lake Cowichan returning to Highway 1 near Duncan; and
- The Mill Bay Ferry, which has a vehicle capacity of approximately 22 cars and 150 Passengers and crew.

The closures with long durations adversely affect users of Highway 1, as the alternative routings have travel times in the range of hours. Detouring to the Pacific Marine Circle Route would incur a typical travel time of approximately three and a half hours, while the Mill Bay Ferry would be dependent on the hourly ferry schedule and vehicle queue lengths, due to the limited ferry space available. These long detour times impact highway drivers seeking to make appointments, pick up children, reach home or work in a timely manner, or participate in tourism or recreational activities.

Historical DriveBC announcement data between the years of 2009 and 2018 was reviewed, and has shown that the segment of Highway 1 between the intersections of Shawinigan Lake Road and West Shore Parkway experienced approximately 40 incidents in which one, or both, directions of the highway are closed for any length of time greater than a half hour in duration. Most of these incidents were caused by vehicle collisions, vehicle incidents, or vehicle recovery operations, although there were some other incidents including fallen trees and hydro lines, or rock slides. Of these 40 incidents, 32 consisted of closures of both directions of travel, with 11 being longer than 2.5 hours in duration and seven longer than 4.0 hours. The longest duration of the 11 closures was approximately 21 hours in length, while the average duration was approximately 7.2 hours. Closures long enough to trigger the initiation of a detour deployment occur relatively infrequently, at approximately 1.1 incidents per year on average.

This study examined seven possible alternative Highway 1 Malahat segment emergency detour routes which could be implemented during long highway closures. The options included this following:

- Option 1A: Niagara Main
- Option 1B: Niagara Main in Watershed
- Option 2A: Far West Alignment
- Option 2B: Far West via Old Renfrew
- Option 3A: Sooke Main / Kapoor Main
- Option 3B: Sooke Main / Boneyard
- Option 4A: Old Highway #117 / Kapoor Main

These seven routes are shown in ***Figure ES.1,*** overleaf. These routes were screened and then compared against the existing base case Pacific Marine Circle Route detour that travels through Lake Cowichan and Port Renfrew. The existing base case Pacific Marine Circle Route is shown alongside the potential alternatives in ***Figure ES.2***. Full scale 11x17 sized versions of both graphics are available in ***Appendix D***.

The goal of the study is to assess the feasibility of a route that could make use of existing forestry resource roads, trails, and / or Greater Victoria Water Supply Area maintenance roads with limited investment and footprint changes, to allow drivers on Highway 1 to detour around Highway 1 efficiently via a shorter distance and travel time, in the event of a long duration highway closure.

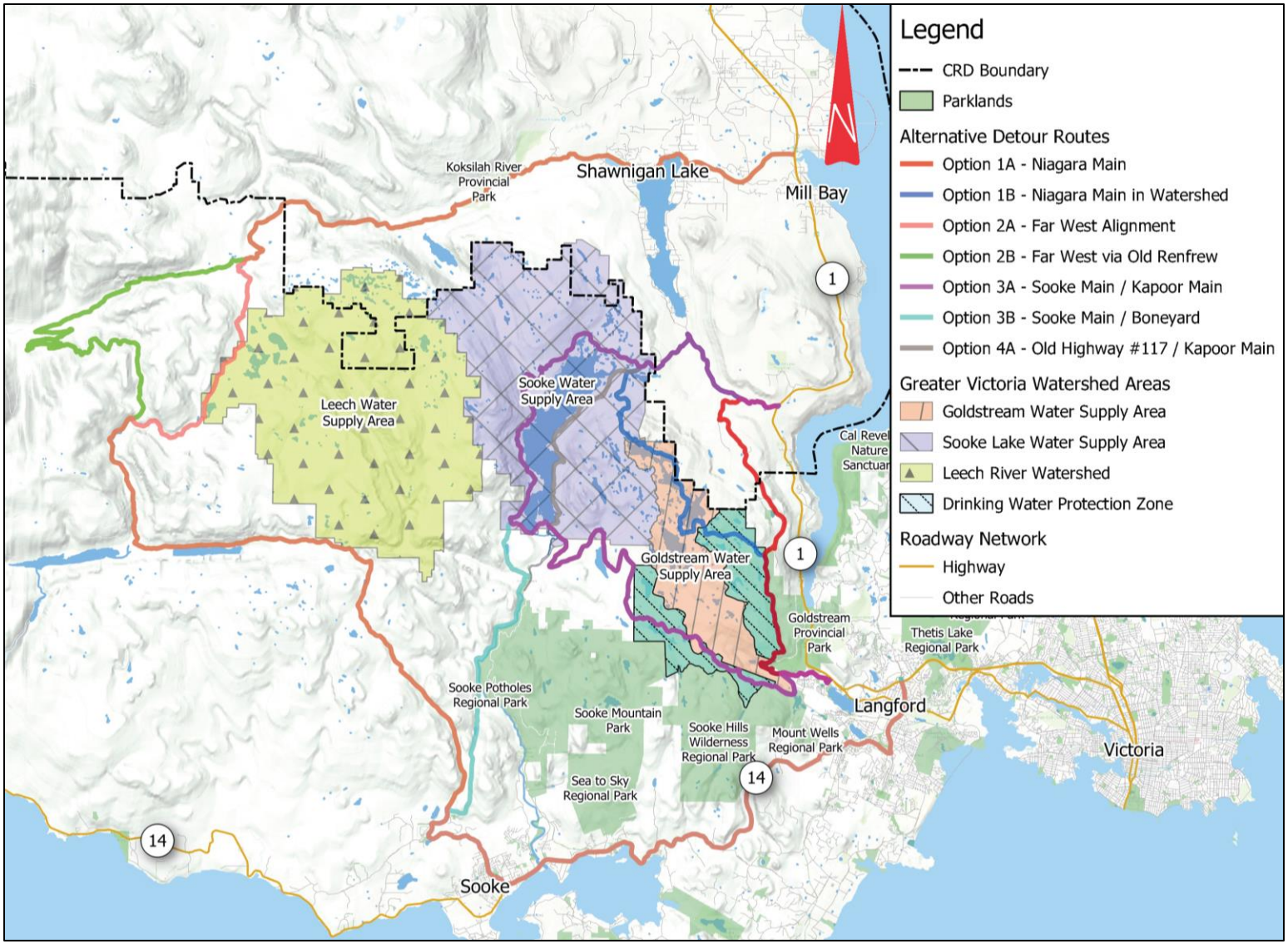

Figure ES.1: Potential Highway 1 Malahat Emergency Detours

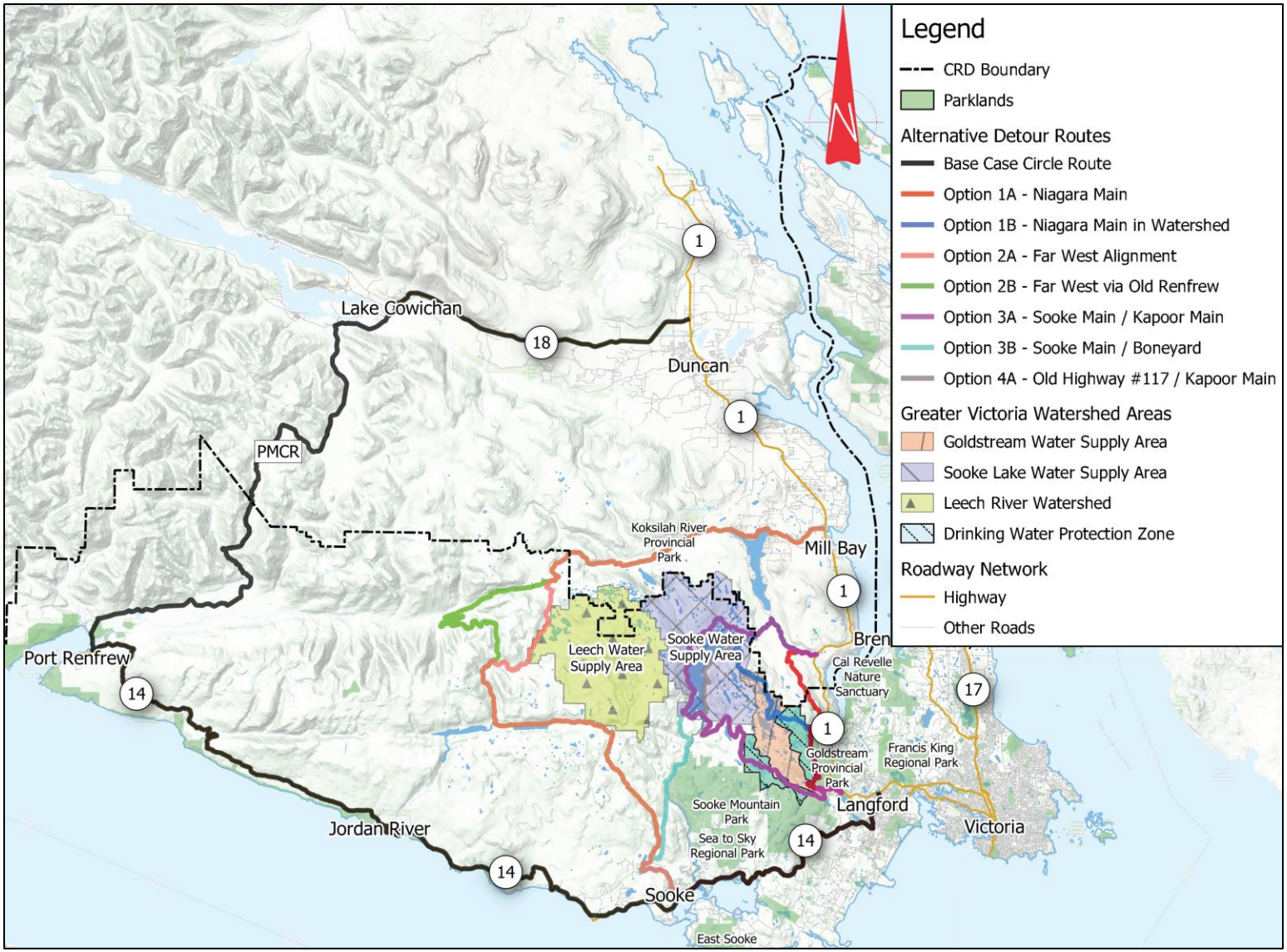

Figure ES.2: Existing and Potential Alternative Highway 1 Malahat Emergency Detours

Prior to submitting alternative emergency route options for more detailed evaluation, a screening process was conducted to reduce the set of options to a more manageable number which focussed the analysis requirements during the subsequent option evaluation process. By screening the options at this stage, only the most promising options are taken forward for detailed evaluation.

The intent of the option screening process is to identify short comings that may exist in one or more options previously generated. In identifying these short comings, some options can be eliminated from further consideration. Only the most feasible or practical short-listed options would be taken forward for a more detailed assessment using the Multiple Account Evaluation (MAE) framework.

As shown in ***Figure ES.3*** below, of the seven generated alternative route options, two options (Option 1A – Niagara Main and Option 2A – Far West Alignment) were retained following the screening and advanced for a detailed Multiple Account Evaluation assessment. Five options were screened out during the screening process primarily due to the potential for significant detrimental impacts to the drinking water supply of the Capital Regional District (CRD).

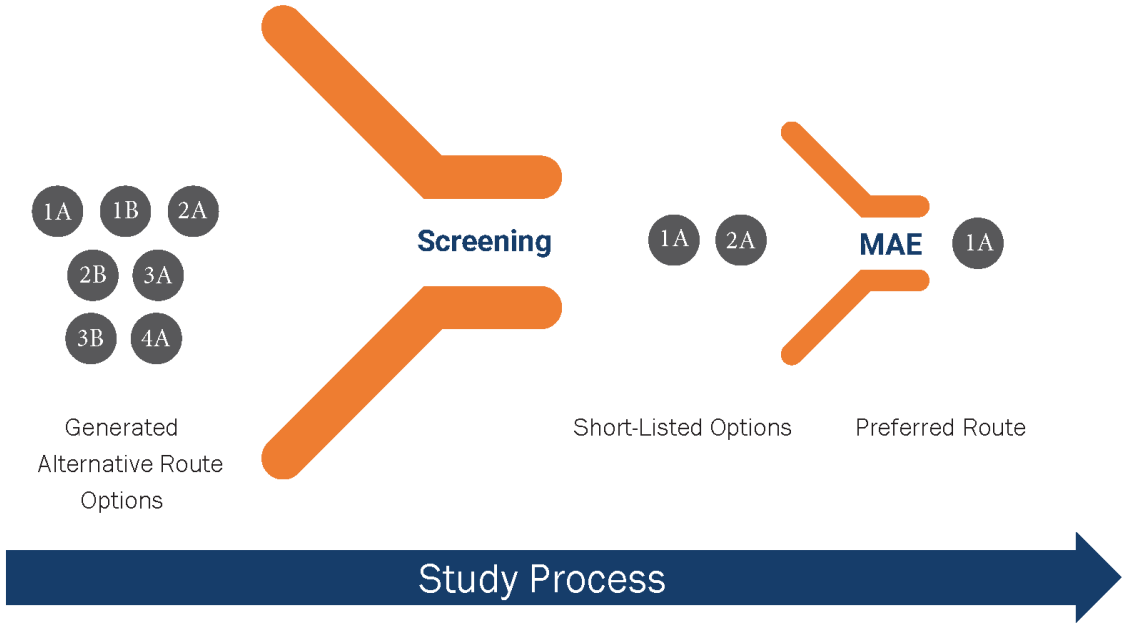

Figure ES.3: Screening and MAE Process

The MAE discerned Option 1A – Niagara Main as the preferred route for an emergency detour route for the Malahat Highway. This option has a lower capital cost of the two alternative emergency detour route options and greater travel time savings of all the routes, including the Base Case. This option also has a limited footprint and thus has significantly fewer interactions with aquatic features and does not enter the water catchment area of the CRD's water supply. However, there are three primary drawbacks of this option. One drawback being that the option bisects and severs the Sooke Hills Regional Park and Great Trail alignment along the Niagara Main road, which would result in impacts to fauna and flora in the park, and the requirement to relocate a section of the Great Trail, all of which would be difficult to entirely mitigate. Environmental compensation will likely be required to address unmitigated impacts. The second drawback is that the alignment passes in close proximity to the CRD Japan Gulch Disinfection Facility compound, potentially bisecting it. The facility would require security revisions / upgrades to continue the protection of the facility from the emergency detour roadway, as well as operational procedure adjustments to maintain public safety in relation to separation of the public from facility areas that require the loading, storage, and

injection of chemical treatments including ammonia and chlorine. It is envisioned that certain operational procedures in the handling of water treatment chemicals may be unmitigable in that an emergency detour activation could not occur simultaneously with scheduled chemical storage delivery processes, or a chemical release emergency situation. The last drawback would be the increase in wildfire risks that come from vehicles travelling alongside the water protection buffer zone during the activation of the emergency detour.

The following subsections of the Executive Summary provide a summary of the findings from the screening and multiple account evaluation of the options.

Screening Summary

Noting the characteristics of the options being considered and the environment in which the options pass through, the following screening criteria were utilized:

- Environmental (Species at Risk, Protected Areas, Designated Sensitive Habitat, Aquatic Habitat and Registered Archaeological and Historical Sites);
- Socio-Community (Property Impacts, Community Disruption, and Water Resource Impacts);
- Engineering (Option Length, Bridges, Design Criteria Compliance, Alignment Considerations and Geotechnical); and,
- Capital Cost (Relative Capital Cost).

A summary of the screening criteria evaluations for each option is shown in ***Table ES.1*** overleaf. At the bottom of the table the outcome of the screening process is given along with the rationale behind the decision.

Table ES.1: Screening Summary and Outcome

CATEGORY	CRITERIA	OPTIONS						
		OPTION 1A	OPTION 1B	OPTION 2A	OPTION 2B	OPTION 3A	OPTION 3B	OPTION 4A
		NIAGARA MAIN	NIAGARA MAIN IN WATERSHED	FAR WEST ALIGNMENT	FAR WEST VIA OLD RENFREW	SOOKE MAIN / KAPOOR MAIN	SOOKE MAIN / BONEYARD	OLD HIGHWAY / KAPOOR MAIN
Environmental	Species at Risk Impacts	Potential impacts to: • 9 Wildlife Species; • 5 Critical Habit Parcels; • 1 Plant / Fungus Species; • 2 Ecosystems.	Potential impacts to: • 9 Wildlife Species; • 6 Critical Habit Parcels; • 2 Plant / Fungus Species; • 2 Ecosystems.	Potential impacts to: • 10 Wildlife Species; • 21 Critical Habit Parcels; • 12 Plant / Fungus Species; • 3 Ecosystems.	Potential impacts to: • 9 Wildlife Species; • 20 Critical Habit Parcels; • 12 Plant / Fungus Species; • 3 Ecosystems.	Potential impacts to: • 9 Wildlife Species; • 7 Critical Habit Parcels; • 2 Plant / Fungus Species; • 2 Ecosystems.	Potential impacts to: • 9 Wildlife Species; • 15 Critical Habit Parcels; • 8 Plant / Fungus Species; • 2 Ecosystems at Risk.	Potential impacts to: • 8 Wildlife Species; • 5 Critical Habit Parcels; • 2 Plant / Fungus Species; • 2 Ecosystems.
	Protected Areas Impacts	• 1 Provincial Park; • 1 Regional Park.	• 1 Provincial Park; • 1 Regional Park.	• 1 Provincial Park; • 4 Regional Parks.	• 1 Provincial Park; • 4 Regional Parks.	• 1 Provincial Park; • 1 Regional Park.	• 6 Regional Parks.	• 1 Provincial Park; • 1 Regional Park.
	Designated Sensitive Habitat Impacts	No anticipated impacts.	No anticipated impacts.	Potential impacts to 1 Old Growth Management Area.	Potential impacts to 1 Old Growth Management Area.	No anticipated impacts.	No anticipated impacts.	No anticipated impacts.
	Stream, Lake, Marine / Shoreline, and Wetland Aquatic Habitat Features Impacts	Potential interactions: • 29 Stream; • 1 Lake / Shoreline; • 6 Wetland.	Potential interactions: • 47 Stream; • 2 Lake / Shoreline; • 33 Wetland.	Potential interactions: • 307 Stream; • 18 Lake / Shoreline; • 10 Wetland.	Potential interactions: • 330 Stream; • 18 Lake / Shoreline; • 8 Wetland.	Potential interactions: • 69 Stream; • 7 Lake / Shoreline; • 33 Wetland.	Potential interactions: • 157 Stream; • 11 Lake / Shoreline; • 27 Wetland.	Potential interactions: • 51 Stream; • 5 Lake / Shoreline; • 14 Wetland.
	Registered Archaeological and Historical Sites Impacts	Insufficient data to determine potential impacts.	Insufficient data to determine potential impacts.	Potential impacts to: • 12 Archaeological sites; • 2 Historical sites.	Potential impacts to: • 12 Archaeological sites; • 2 Historical sites.	Insufficient data to determine potential impacts.	Insufficient data to determine potential impacts.	Insufficient data to determine potential impacts.
Socio-Community	Property Impacts	Potential impacts to the Sooke Hills Wilderness Regional Park. Moderate impacts when connecting to Goldstream Heights Drive.	Potential impacts to the Sooke Hills Wilderness Regional Park, however, overall mild impacts anticipated.	Severe impacts to Mosaic Forest Management properties.	Severe impacts to Mosaic Forest Management properties.	Mild potential impacts to the Sooke Hills Wilderness Regional Park.	Severe impacts to Mosaic Forest Management properties.	Mild potential impacts to the Sooke Hills Wilderness Regional Park.
	Community Disruption	Potential impacts to the Goldstream Heights rural residential area and Goldstream neighbourhood in Langford.	Potential impacts to the Shawnigan Station and Goldstream residential neighbourhoods.	Potential impacts to the Shawnigan Lake area, and Shawnigan Station residential neighbourhood and Municipality of Sooke. The route could also act as an emergency detour for incidents on Highway 14.	Potential impacts to the Shawnigan Lake area, Shawnigan Station residential neighbourhood and Municipality of Sooke. The route could also act as an emergency detour for incidents on Highway 14.	Potential impacts to the Shawnigan Station and Goldstream residential neighbourhoods.	Potential impacts to the Shawnigan Station and the Municipality of Sooke. The route could also act as a emergency detour for incidents on Highway 14.	Potential impacts to the Shawnigan Station and Goldstream residential neighbourhoods.
	Water Resource Impacts	Located directly on the edge of the Drinking Water Protection Zone, likely no impacts to drinking water supply, but would increase wildfire risks. Would also require security upgrades to the Japan Gulch Disinfection Facility.	Located directly on the edge of the Drinking Water Protection Zone, passes through the Goldstream and Sooke Water Supply Areas and directly adjacent to Lubbe Lake and Butchart Lake Reservoirs and would increase wildfire risks. Would require security upgrades to the Japan Gulch Disinfection Facility.	Passes by an edge of the Leech River Watershed and overtop of one stream that connects downstream to the Leech River. Impacts to potential future drinking water supply could be mitigated.	No anticipated water resource impacts.	Passes through the Sooke and Goldstream Water Supply Areas as well as the Drinking Water Protection Zone. Is adjacent to the Sooke Reservoir with a minimum distance of 30 metres separation. Would require security upgrades to the Japan Gulch Disinfection Facility.	Passes through the Sooke Water Supply Area and is located adjacent to the Sooke Reservoir with a minimum distance of 30 metres separation.	Passes through the Sooke and Goldstream Water Supply Areas as well as the Drinking Water Protection Zone. Is adjacent to the Sooke Reservoir with a minimum distance of 15-20 metres separation. Would require security upgrades to the Japan Gulch Disinfection Facility.

CATEGORY	CRITERIA	OPTIONS						
		OPTION 1A	OPTION 1B	OPTION 2A	OPTION 2B	OPTION 3A	OPTION 3B	OPTION 4A
		NIAGARA MAIN	NIAGARA MAIN IN WATERSHED	FAR WEST ALIGNMENT	FAR WEST VIA OLD RENFREW	SOOKE MAIN / KAPOOR MAIN	SOOKE MAIN / BONEYARD	OLD HIGHWAY / KAPOOR MAIN
Engineering	Option Length	20.3 km total 8.2 km non-public roadway	33.9 km total 24.3 km non-public roadway	103.6 km total 57.6 km non-public roadway	116.7 km total 70.5 km non-public roadway	49.7 km total 39.8 km non-public roadway	71.0 km total 32.2 km non-public roadway	42.9 km total 33.0 km non-public roadway
	Bridges	2 short bridges likely requiring construction / replacement / upgrading.	3 short bridges likely requiring replacement / upgrading.	12 short bridges and 4 medium sized bridges likely requiring replacement / upgrading.	12 short bridges and 3 medium sized bridges likely requiring replacement / upgrading.	6 short bridges likely requiring replacement / upgrading.	5 short bridges, 2 medium bridges, and 1 long bridge likely requiring replacement / upgrading.	2 short bridges likely requiring replacement / upgrading.
	Design Criteria Compliance	Relatively flat terrain, limited lateral constraints, steep section near the southern end.	Steep section near southern end and within Goldstream Water Supply Area where switchbacks are used. Some laterally constrained sections.	Some laterally constrained sections less than 200 metres long. Sections of steep grades are typically short.	Several laterally constrained sections on Old Renfrew Road and Williams Main where steep grade and switchbacks are utilized.	Some minor areas of lateral constraints, however majority of route is on more open terrain.	Severely laterally constrained on the Boneyard Main where rock canyon faces on one side and a very steep slope into the Sooke River.	Some laterally constrained sections on Leechtown Road and Kapoor Main.
	Alignment Considerations	Primarily straight with consistent, if steep, grading.	Sections within the Goldstream Water Supply area feature variable grading and frequent back to back curves with some tight turning radii.	Typically, straighter consistently graded sections of road, although some sections of West Jordan Main feature higher frequencies of curves.	Section of the route on Old Renfrew Road and Williams Main feature frequent switchbacks with tight hairpin turns.	Frequent horizontal curves on Kapoor Main and some sections of Sooke Main. Sooke Main has variable grading. Kapoor Main has some tight turning radii.	Frequent horizontal curves on Kapoor Main and some sections of Sooke Main. Sooke Main and Boneyard Main feature variable grading.	Frequent horizontal curves on Kapoor Main and some sections of Leechtown Road, both of which have some tight turning radii. Leechtown Road is quite variable with grading.
	Geotechnical	Few or non-existent geotechnical or geohazard constraints, although a review may be necessary due to an adjacent FortisBC gas line.	Some geotechnical or geohazard constraints of limited complexity required to be assessed and managed, and a review may be necessary due to an adjacent FortisBC gas line.	Some geotechnical or geohazard constraints of limited complexity required to be assessed and managed.	Some geotechnical or geohazard constraints of limited complexity required to be assessed and managed.	Some geotechnical or geohazard constraints of limited complexity required to be assessed and managed.	Geotechnical and geohazard constraints are complex and difficult to overcome.	Some geotechnical or geohazard constraints of limited complexity required to be assessed and managed.
Capital Cost	Relative Capital Cost	$$	$$$	$$$$	$$$$$	$$$	$$$$$	$$$
	Screening Outcome	**Retained**	**Screened Out**	**Retained**	**Screened Out**	**Screened Out**	**Screened Out**	**Screened Out**
	Rationale	This option was retained for subsequent evaluation as it is the shortest detour route with potentially little required infrastructure and likely minimal direct impacts to drinking water supply.	This option was screened out from further consideration due to the proximity of the route to open water bodies within the Goldstream Water Supply area which could have significant detrimental impacts to the drinking water supply. Additionally, there would be more constrained and steeper roadway sections and geotechnical constraints in comparison with Option 1A.	This option was retained for subsequent evaluation as the route features few significant engineering challenges, mitigatable impacts to drinking water supply, and could be made into a public roadway. Additionally, is one of the three routes that would also act as an emergency detour route for Highway 14.	This option was screened out from further consideration due to the limited incremental utility the route would achieve in comparison to Option 2A.	This option was screened out from further consideration as the proximity of the route to the Sooke Lake Reservoir could have significant detrimental impacts to the drinking water supply.	This option was screened out from further consideration as the extreme lateral constraint of the route near the Boneyard Main gate would make widening of the route along the Sooke River prohibitively expensive for a short segment.	This option was screened out from further consideration as the extreme proximity of the route to the Sooke Lake Reservoir could have significant detrimental impacts to the drinking water supply.

Multiple Account Evaluation Summary

A more detailed option evaluation process involved the application of a comprehensive evaluation framework for the two retained emergency detour route options. In order to compare and contrast the relative merits and drawbacks of each option against a base case (Circle Route), a set of high-level evaluation criteria was developed based on the Multiple Account Evaluation methodology typically used for Ministry of Transportation and Infrastructure planning studies. For this study, the following accounts and criteria were applied:

- Customer Service (Traffic Mobility and Travel Time Savings);
- Socio-Community (Property Impacts, Noise and Visual Impacts, Water Resource Impacts, and Community Disruption);
- Environmental (Terrestrial Impacts, Aquatic Impacts, and Archaeological / Historical Impacts); and
- Financial (Capital Cost, Property Cost, Maintenance Costs, Salvage Value, Benefit / Cost Ratio, and Net Present Value).

As shown in ***Figure ES.4***, the Economic Development Account was not utilized for this study. As the accounts have not been assigned specific weightings, each account is in essence weighted equally.

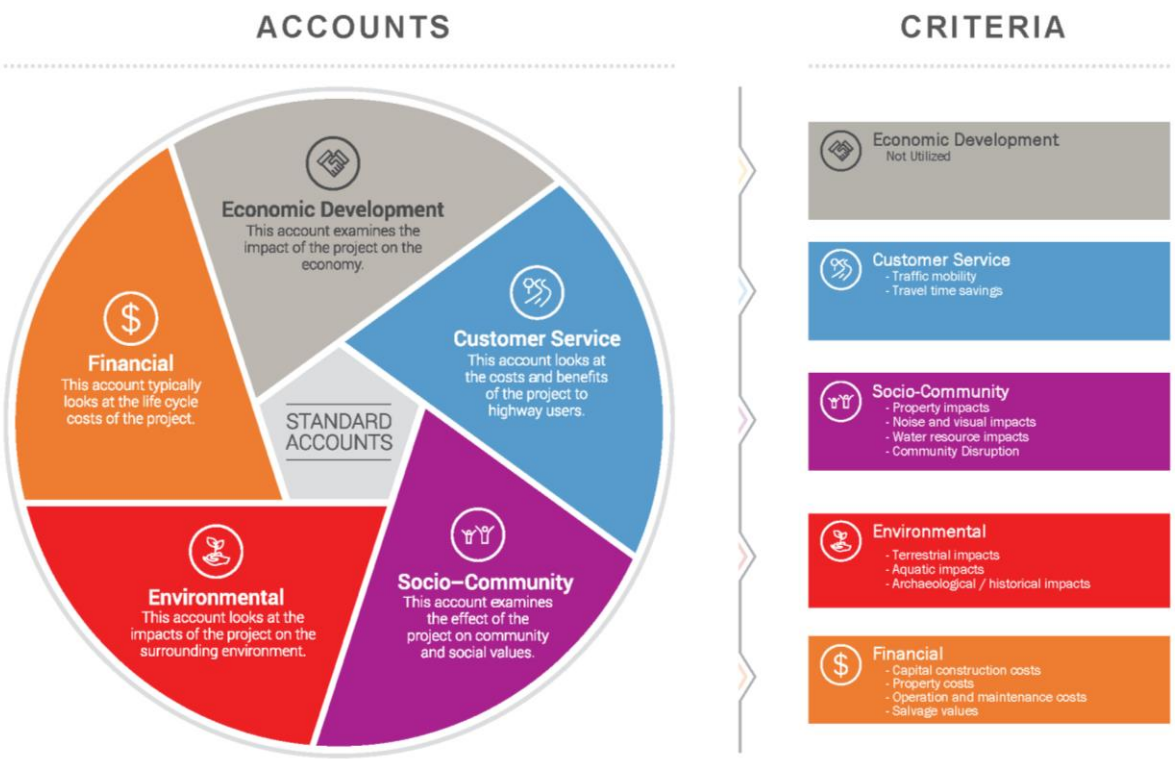

Figure ES.4: Multiple Account Evaluation – Accounts and Criteria

The table overleaf, ***Table ES.2***, provides a summary of the evaluation assessments for each criterion and provides an outcome for the evaluation.

Table ES.2: Multiple Account Evaluation Summary and Outcome

ACCOUNT	CRITERIA	UNITS	OPTIONS		
			BASE CASE	OPTION 1A	OPTION 2A
			CIRCLE ROUTE (DO NOTHING)	NIAGARA MAIN	FAR WEST ALIGNMENT
Customer Service	Traffic Mobility	Travel Time (hrs)	~ 4.0 hrs Hwy 1 incidents ~ 3.5 hrs Hwy 14 incidents	~ 0.6 hrs for Hwy 1 incidents N/A for Hwy 14 incidents	~ 2.3 for Hwy 1 incidents ~ 2 hrs for Hwy 14 incidents
	Travel Time Savings	$M (2019 PV)	N/A	$ 7.6	$ 3.8
Socio-Community	Property Impacts	Property Area (ha)	N/A	5.0 hectares total, 0.0 hectares of Mosaic Forest Management	255.8 hectares total, 250.7 hectares of Mosaic Forest Management
	Noise and Visual Impacts	Qualitative / # of Residents	1,150 residents within 50 m of lower volume roadways.	~250 residents within 50 m of lower volume roadways. Significantly Better ●	~450 residents within 50 m of lower volume roadways. Significantly Better ●
	Water Resource Impacts	Qualitative	Water supply areas that the base case passes through are either groundwater supplied, or upstream of the route, therefore negligible impacts are anticipated from usage of the base case.	Located directly on the edge of the Drinking Water Protection Zone and the southeasternmost portion of the Goldwater Supply Area. Does not enter the water catchment area, but does pass through the Japan Gulch Disinfection Facility compound. Somewhat Worse ◔	Passes by an edge of the Leech River Watershed and overtop of one stream that connects downstream to the Leech River, however mitigation measures could be taken and have been included in the cost estimate. Somewhat Worse ◔
	Community Disruption	Qualitative / # of Residents	~50 residents near collector and local roads ~11,950 residents near arterial roads	~950 residents near collector and local roads ~50 residents near arterial roads The number of residents that would be disturbed by increased traffic on local and collector roadways would significantly increase relative to the base case, however, the number of residents near arterial roadways would decrease. Mitigations via traffic controls are possible. Significantly Worse ○	~1,250 residents near collector and local roads ~8,400 residents near arterial roads The number of residents that would be disturbed by increased traffic on local and collector roadways would significantly increase relative to the base case, and those near arterial roadways would only slightly decrease. Mitigations via traffic controls are possible. Significantly Worse ○

ACCOUNT	CRITERIA	UNITS	OPTIONS		
			BASE CASE	OPTION 1A	OPTION 2A
			CIRCLE ROUTE (DO NOTHING)	NIAGARA MAIN	FAR WEST ALIGNMENT
Environmental	Terrestrial Impacts	Qualitative	78 At-risk species nearby, Crosses 2 Provincial Parks, 1 National Park, and 5 Regional Parks Crosses 6 legal OGMAs and 1 WMA	17 At-risk species nearby Crosses 1 Provincial and 1 Regional Park Crosses no OGMAs or WMAs Has significantly fewer terrestrial impacts and results in detouring vehicles passing through far fewer instances of at risk species than the base case. As Option 1A bisects the Sooke Hills Regional Park there are anticipated to be some impacts to fauna and flora in the park that would be difficult to entirely mitigate. Significantly Better ●	48 At-risk species nearby Crosses 1 Provincial Park and 4 Regional Parks Crosses one non-legal OGMA Would result in detouring vehicles passing fewer instances of at risk species. Due to the length of Option 2A, the provincial environmental assessment process would likely be triggered. The existing federal environmental assessment process may be triggered (CEAA, 2012), but not the new federal *Impact Assessment Act* (IAA). Somewhat Better ◕
	Aquatic Impacts	Qualitative	442 interactions with water courses and waterbodies	36 interactions with water courses and waterbodies The route has significantly fewer interactions with aquatic features, and would therefore have fewer interactions between detouring vehicles and water bodies. It should be noted that these would be new impacts to fish bearing features. Significantly Better ●	335 interactions with water courses and waterbodies The route length would likely trigger the provincial environmental assessment process and would result in disturbances of fish bearing habitats that may be mitigatable. It is anticipated that stream crossing structures currently creating water quality or fish passage issues would be replaced with clear span or open bottom structures. Somewhat Better ◕
	Archaeological / Historical Impacts	Qualitative	There are 17 registered archaeological sites within 100 metres of the Pacific Marine Circle Route.	Although no registered archaeological sites or historic places intersect with the option, there is considered to be a high likelihood of impacts to unregistered sites. Significantly Better ●	There are 12 registered archaeological sites and 2 historic places within 100 metres of the route, although none intersect. There is considered to be a high likelihood of impacts to unregistered sites. Somewhat Better ◕

ACCOUNT	CRITERIA	UNITS	OPTIONS		
			BASE CASE	OPTION 1A	OPTION 2A
			CIRCLE ROUTE (DO NOTHING)	NIAGARA MAIN	FAR WEST ALIGNMENT
Financial	Capital Cost	$M (2019 PV)	N/A	$ 30.0	$ 175.0
	Property Cost	$M (2019 PV)	N/A	$ 0.5	$ 6.9
	Maintenance Costs	$M (2019 PV)	N/A	$ 0.6	$ 6.2
	Salvage Value	$M (2019 PV)	N/A	$ 1.4	$ 9.5
	B/C Ratio	Ratio	N/A	0.26	0.02
	NPV	$M (2019 PV)	N/A	- $ 22.1	- $ 174.8
Evaluation Outcome			**Possible (Status Quo)**	**Preferred**	**Possible**
Rationale			Although the base case involves a very long detour for vehicles travelling between Victoria and areas north of the Shawnigan Lake Road intersection, the route already exists and would have no net impacts to water resources or the environment. Additionally, the average number of incidents a year, in which the route would be required, is quite low, with an anticipated 1.1 incidents a year.	This option has a lower capital cost and greater travel time savings of the two alternative emergency detour route options. This option also has significantly fewer interactions with aquatic features and does not enter the water catchment area of the CRD's water supply area, although it would pass in close proximity to and may bisect the CRD Japan Gulch Disinfection Facility compound. One significant drawback of this option is that it crosses the Sooke Hills Regional Park which would result in impacts to fauna and flora in the park that would be difficult to entirely mitigate. Environmental compensation will likely be required to address unmitigated impacts.	Although not identified as the preferred route option, this option is still possible. There are significant travel time savings for this option when compared to the base case, particularly as this option also has the benefit of acting as a detour to Highway 14 closures. This option passes by an edge of the Leech River Watershed and overtop of one stream that connects downstream to the Leech River, however mitigation measures could be taken. Drawbacks of this option are the high cost and the significantly increased number of residents that would be disturbed by increased traffic on local and collector roadways relative to the base case, during a Highway 1 detour deployment.

Table of Contents

1. Introduction

The Highway 1 Malahat Segment Detour Route Planning study ("the study") is focused on determining the feasibility of a potential emergency detour route for the Malahat segment of Highway 1 between the intersections of Shawnigan Lake Road and West Shore Parkway. The study is being undertaken by Parsons at the request of the BC Ministry of Transportation and Infrastructure ("MoTI").

The goal of the study is to assess the feasibility of a route that, with limited capital investment and the smallest footprint, could make use of existing forestry resource roads, trails, and / or Greater Victoria Water Supply Area maintenance roads to allow drivers on Highway 1 to detour around Highway 1 efficiently via a shorter distance and travel time, in the event of a highway closure. Although there is an existing detour route, the Pacific Marine Circle Route which uses Highway 18 and Highway 14, these new routes would be closer to the incident location and could provide greater utility and travel time savings.

This report consists of five sections which cover the following topics:

- Section 2: Problem Definition
    - Defines the issues this study is attempting to mitigate.
- Section 3: Emergency Route Option Development
    - Summarizes the criteria used to develop the routes as well as the seven identified options.
- Section 4: Option Screening
    - Details and summarizes the outcome of a high-level screening used to reduce the number of options to a manageable size.
- Section 5: Option Evaluation
    - Outlines and summarizes the outcome of the criteria used to evaluate the options relative to one another as well as the base case.
- Section 6: Conclusions
    - Summarizes the feasibility of the potential options for an emergency detour route for the Highway 1 Malahat segment.

2. Problem Definition

The Trans-Canada Highway is the main north-south corridor on Vancouver Island and serves as a critical route for commuting, moving goods, linking communities, and supporting a thriving tourism industry in the region. While long duration full highway closures are infrequent along the approximately 12.8 km segment of the Malahat between Shawnigan Lake Road and West Shore Parkway, during the rare event of an emergency closure there are limited alternative route options for a detour to enable traffic to bypass the affected site. These options consist primarily of:

- The Pacific Marine Circle Route which travels through Sooke, Port Renfrew, and Lake Cowichan returning to Highway 1 near Duncan; and
- The Mill Bay Ferry, which has a vehicle capacity of approximately 22 cars and 150 Passengers and crew.

The closures with long durations adversely affect users of Highway 1, as the alternative routings have travel times in the range of hours. Detouring to the Pacific Marine Circle Route would incur a typical travel time of approximately three and a half hours and would have a detour set up time of about two to three hours. The Mill Bay Ferry does not have a set up time, but the travel time is dependent on the hourly ferry schedule and vehicle queue lengths due to the limited ferry space available. These detour times impact highway drivers seeking to make appointments, pick up children, reach home or work in a timely manner, or participate in tourism or recreational activities.

2.1 Highway 1 Closure Incidents

The average 2018 annual traffic volumes for this segment of Highway 1 are summarized below in ***Table 2.1***, with volumes being binned into four-hour periods. The volumes show that long duration closures that occur in the midday would have a larger impact to travellers than those closures that occur during the night, due to the general daily traffic volume fluctuations.

Table 2.1: Highway 1 Average Annual Traffic Volumes

AVERAGE VOLUME	HOUR IN DAY TIME PERIOD BIN						DAILY AVERAGE VOLUME
	0 – 3	4 – 7	8 – 11	12 – 15	16 – 19	20 – 23	
All Days	357	2,859	6,008	7,114	6,368	2,032	24,739
Weekdays	326	3,546	5,989	6,783	6,406	1,890	24,939
Weekends	439	1,103	6,056	7,962	6,271	2,394	24,225
Midweek (Tue, Wed, Thu)	320	3,727	6,000	6,511	6,280	1,830	24,668
Mon	315	3,231	5,694	6,671	5,924	1,649	23,484
Tue	309	3,746	5,945	6,455	6,191	1,762	24,408
Wed	317	3,726	5,919	6,420	6,217	1,809	24,408
Thu	333	3,708	6,135	6,658	6,433	1,919	25,186
Fri	353	3,322	6,259	7,713	7,274	2,318	27,238
Sat	439	1,300	6,482	7,768	6,177	2,464	24,630
Sun	439	899	5,613	8,164	6,369	2,322	23,804

Historical DriveBC announcement data between the years of 2009 and 2018 was reviewed, and has shown that the segment of Highway 1 between the intersections of Shawinigan Lake Road and West Shore Parkway experienced approximately 40 incidents in which one, or both, directions of the highway are closed for any length of time greater than a half hour in duration. Most of these incidents were caused by vehicle collisions, vehicle incidents, or vehicle recovery operations, although there were some other incidents including fallen trees and hydro lines, or rock slides.

Of these 40 incidents, 32 consisted of closures of both directions of travel, with 11 being longer than 2.5 hours in duration and seven longer than 4.0 hours. The longest duration of the 11 closures was approximately 21 hours in length, while the average duration was approximately 7.2 hours. Closures long enough to trigger the initiation of a detour deployment occur relatively infrequently, at approximately 1.1 incidents per year on average. The location of these incidents along the Highway 1 route is shown in ***Figure 2.1*** below. The figure also summarizes the year by year incident totals, and shows recent corridor improvements that which consisted of median barrier implementation.

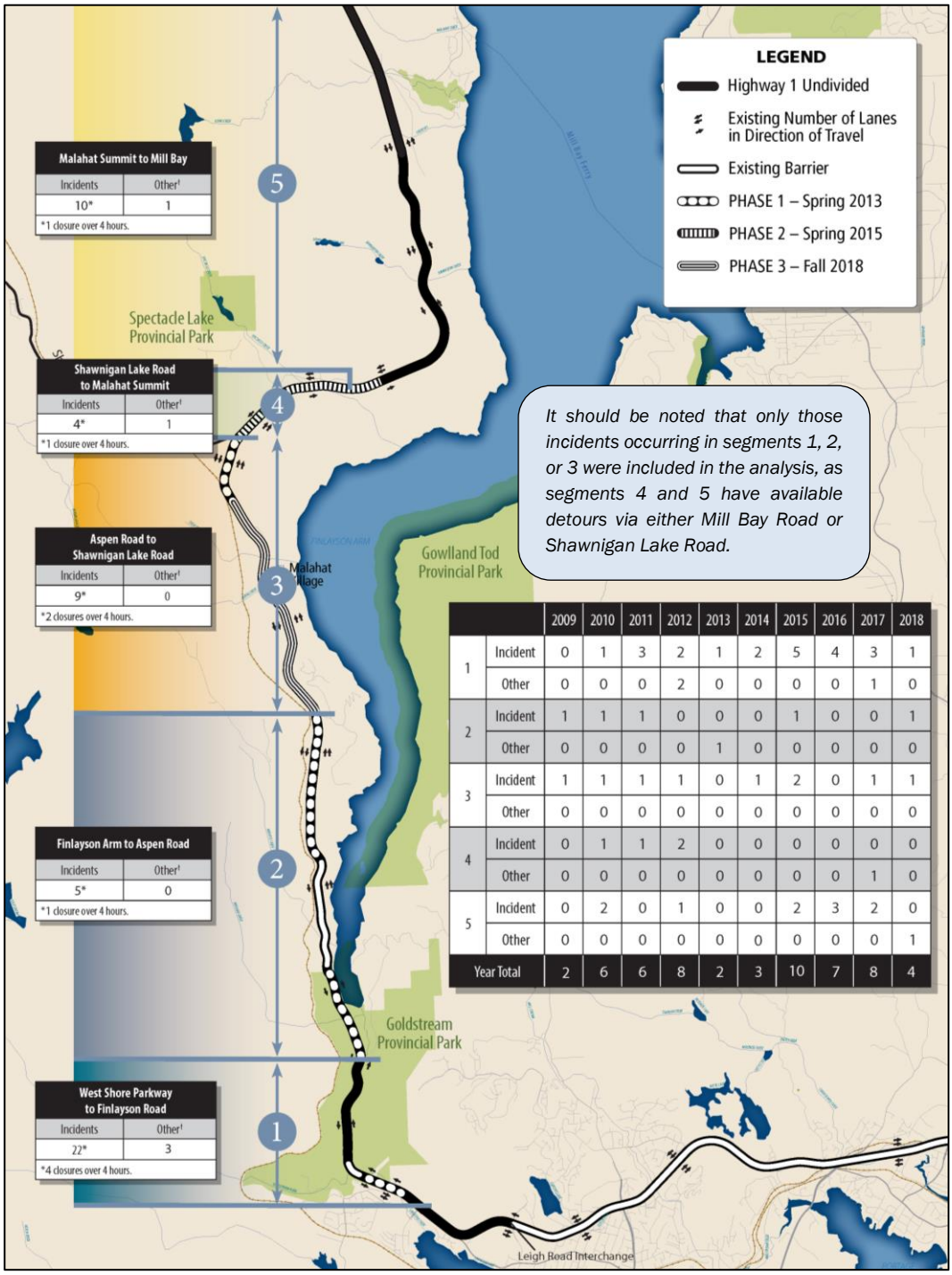

Figure 2.1: Highway 1 Incident Locations during the Years of 2009 to 2018

2.2 Agencies of Concern

Within the study area there are two primary agencies of concern. The first agency is the Ministry of Transportation and Infrastructure (MoTI), while the second agency is the Capital Regional District (CRD).

The Ministry of Transportation and Infrastructure's role is to "plan transportation networks, provide transportation services and infrastructure, develop and implement transportation policies, and administer the related acts, regulations, and federal-provincial properties"[1]. The priorities of MoTI include "improving vital rural and urban infrastructure, investing in public transit, cycling infrastructure and other green modes of transportation, reducing transportation related GHG emissions, and strengthening the economy through the movement of people and goods"[1]. MoTI has jurisdiction over Highway 1 and is the agency that plans and coordinates the implementation of detour routes during highway closures.

The Capital Regional District is a regional government that makes regional-level decisions on various issues for the southern tip of Vancouver Island. The responsibilities of the CRD include water supply and wastewater treatment, overseeing regional parks, housing, 911 operators, and recreational facilities. Their mission statement is to "work together to serve the public good and build a vibrant, livable, and sustainable region through an effective, efficient, and open organization". The CRD has been included as an agency of concern as some of the alternative route options could pass through the Victoria Water Supply Area, in which the CRD has jurisdiction over. The Victoria Water Supply Area is used as the supply for water treatment and distribution to various communities on the south coast of Vancouver Island, such as Victoria and Langford, and supplies drinking water to over 370,000 people. In relation to drinking water supply the CRD is committed to providing "high quality, safe drinking water" from an "adequate, long-term [drinking water] supply" via a "reliable and efficient water transmission system"[2].

Both of these agencies, MoTI and CRD, are cooperating on this study to investigate potential solutions to the issues discussed previously in this section.

[1] Ministry of Transportation and Infrastructure, "2017/18 Annual Service Plan Report", Victoria BC, 2018
[2] Capital Regional District, "Regional Water Supply 2017 Strategic Plan", Victoria BC, 2017

3. Emergency Route Option Feasibility Development

This section summarizes the emergency routes that were identified as potential alternative options to the existing Pacific Marine Circle Route base case. The routes were identified by determining potential roadway connections between the two ends of the Highway 1 Malahat segment using existing resource and maintenance roads or short connections between those existing roads.

This section includes two subsections, the first outlines the high-level attributes that were desired when determining potential emergency detour routes, while the second summarizes the seven identified alternative route options.

3.1 Preferred High-Level Features for Private Roadways

Private roadways, including forest service roads, trails, resource roads, and water supply maintenance roads, were considered to be potentially viable for inclusion in an emergency detour route provided they met a few key desired attributes:

- The roadway should require little to no extra effort to activate or reactivate to a driveable state, which could include such activities as clearing vegetation, replacing culverts, installing bridges, or regrading roadway surfaces. Those routes that are currently traversable by vehicle are the most preferable;
- The roadway should connect to the next roadway link in the route, or have a limited amount of required greenfield alignment to reach the next roadway link, i.e. less than a kilometre;
- Primary roadways are preferable to secondary or tertiary class roadways, as these would tend to be more frequently maintained and are likely to be built to a higher standard;
- Flatter terrain and straighter roadway alignments are preferable to alignments that are steeper or curvier; and
- The starting and ending roadway links should connect to the public roadway network in some form.

3.2 Emergency Route Option Generation

Seven possible alternative Malahat Highway emergency detour routes have been generated for consideration. The approximate lengths of each route is summarized below in ***Table 3.1***. These routes are shown in ***Figure 3.1,*** overleaf. These routes would be compared against the existing base case detour route that travels through Lake Cowichan and Port Renfrew. The existing base case route is shown alongside the potential alternatives in ***Figure 3.2,*** overleaf. Full scale 11x17 sized versions of both graphics are available in ***Appendix D.***

Table 3.1: Approximate Lengths of the Detour Route Options

OPTION	LENGTH ON HIGHWAY 1 (KM)	LENGTH ON OTHER PUBLIC ROADS (KM)[1]	LENGTH OF NEW ROADWAYS (KM)	LENGTH ON PRIVATE ROADS (KM)	ADDITIONAL LENGTH FROM SHAWNIGAN LAKE (KM)[2]	OVERALL LENGTH – HWY 18 (KM)[1]	OVERALL LENGTH – SHAWNIGAN LAKE (KM)[3]
Base Case	0.0	183.4	0.0	0.0	37.1	183.4	220.5
1A	39.5	12.1	0.6	7.6	0.0	59.8	59.8
1B	39.5	9.6	0.0	24.3	0.0	73.4	73.4
2A	22.8	51.9	0.0	51.7	5.0	126.4	131.4
2B	22.8	51.9	0.0	64.8	5.0	139.5	144.5
3A	39.5	9.9	0.0	39.8	0.0	89.2	89.2
3B	36.1	38.8	0.0	32.2	0.0	107.1	107.1
4A	39.5	9.9	0.0	33.0	0.0	82.4	82.4

[1] Measured as the shortest distance from the intersection of Highway 1 with Highway 18 to the interchange of Highway 1 with Highway 14

[2] Measured as the net distance from the Highway 1 / Shawnigan Lake Road intersection to the nearest point on the detour route.

[3] Measured as the distance from the intersection of Highway 1 with Highway 18 to the interchange of Highway 1 with Highway 14 if southbound vehicles were to turn back at the Highway 1 / Shawnigan Lake Road intersection instead of the earliest turn off-point.

The existing and potential alternative detour routes are described in the subsections below from the point of leaving the Highway 1 to the point of re-entering the Malahat Highway 1 from the perspective of travelling in the southbound direction.

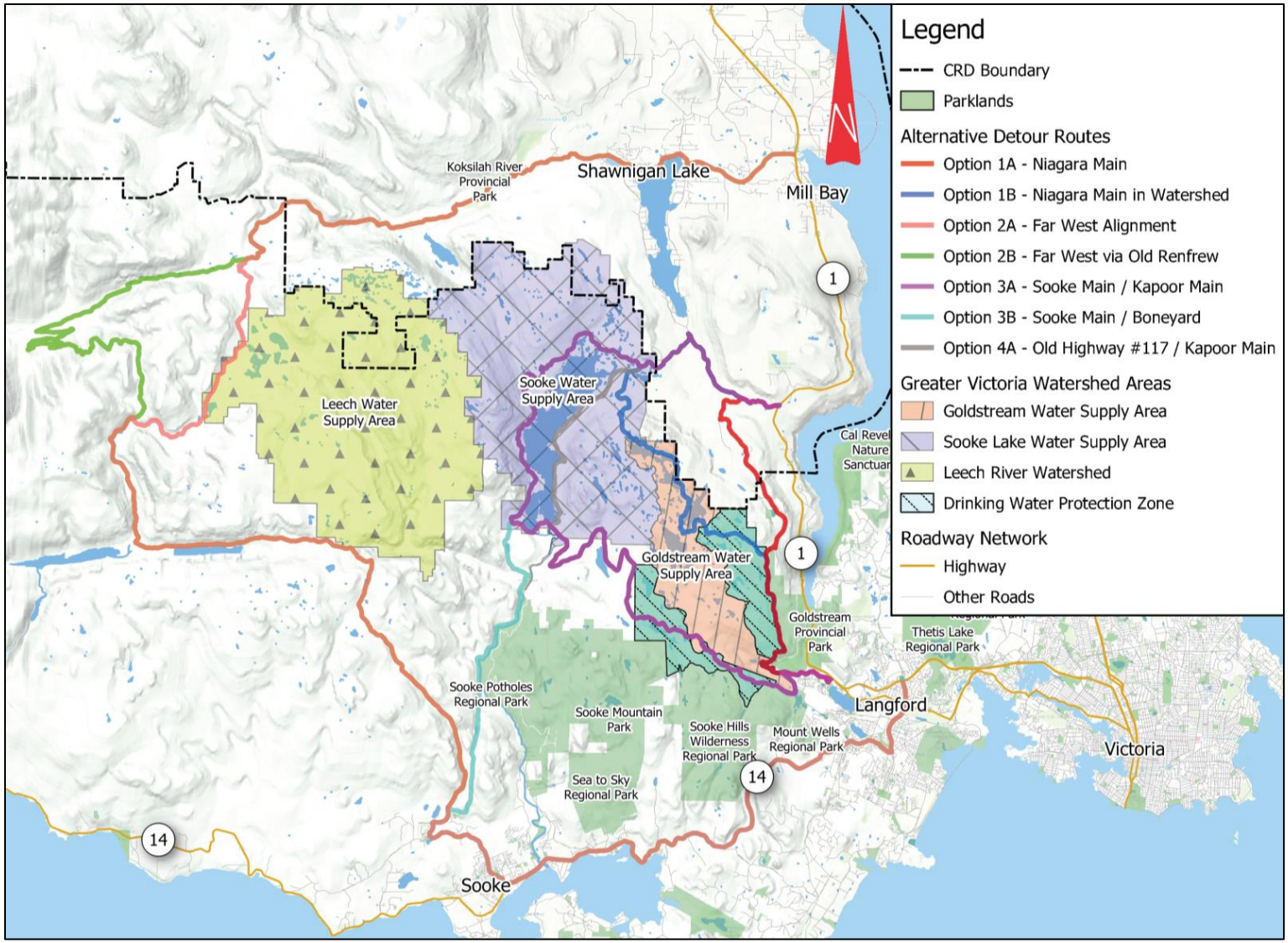

Figure 3.1: Potential Highway 1 Malahat Emergency Detours

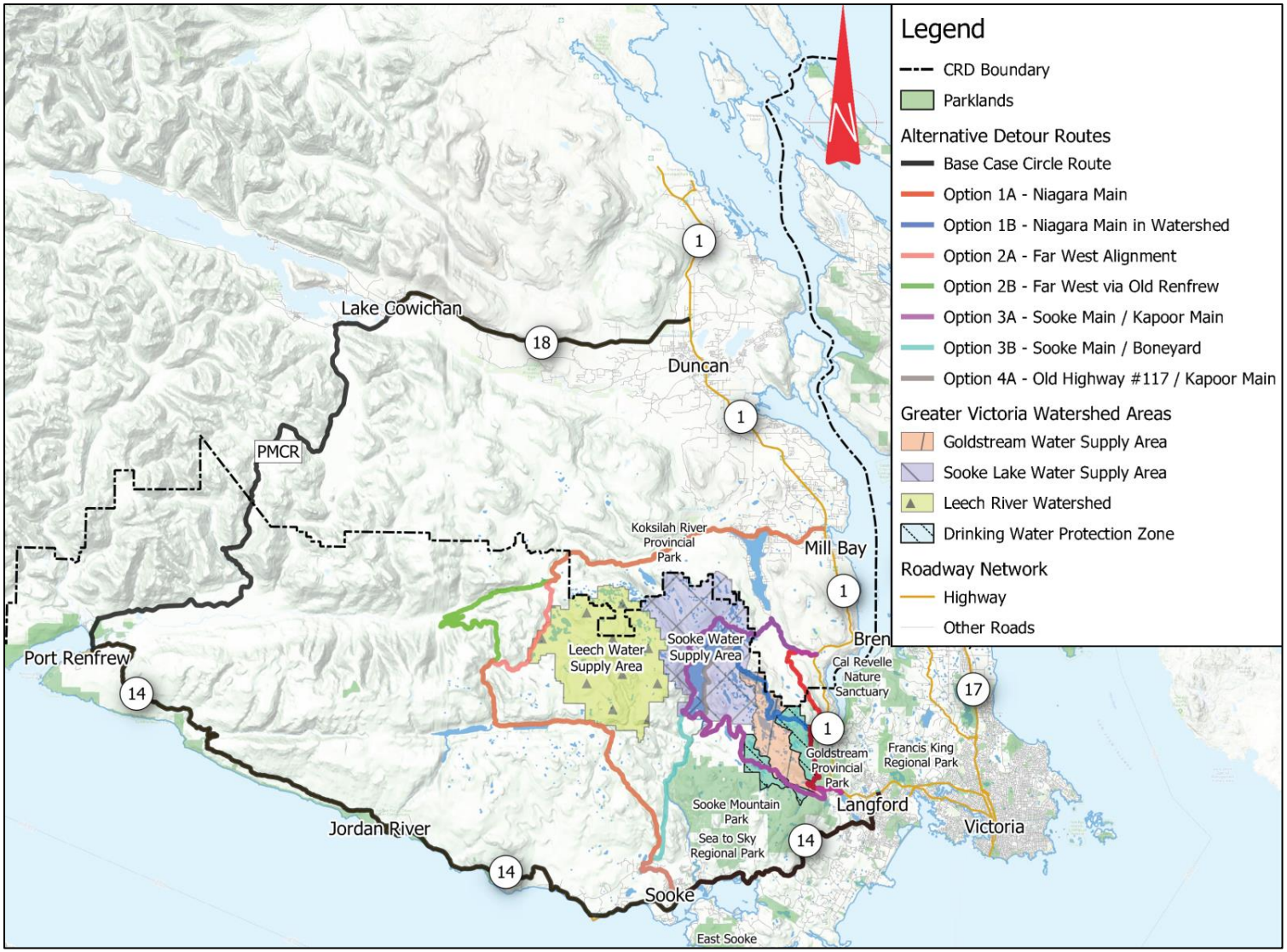

Figure 3.2: Existing and Potential Alternative Highway 1 Malahat Emergency Detours

3.2.1 Base Case – Pacific Marine Circle Route

The Base Case consists of the Pacific Marine Circle Route that uses Highway 18 and Highway 14, passing through Lake Cowichan and Port Renfrew southwards through to Sooke. The route and applicable steps are shown in ***Figure 3.3*** below. The route for drivers north of Duncan that are aware of the closure and who would use the Pacific Marine Circle Route begin at Duncan and exit Highway 1 travelling west on Highway 18 and then:

A. Turning left onto Cowichan Lake Road;

B. Turning left onto Pacific Marine Road to travel southwards to Port Renfrew;

C. Entering Port Renfrew and turning left onto Deering Road;

D. Turning left onto Highway 14;

E. Travelling eastwards on Highway 14 through Sooke and into the City of Langford;

F. Turning left onto Veterans Memorial Parkway; and

G. Re-entering Highway 1.

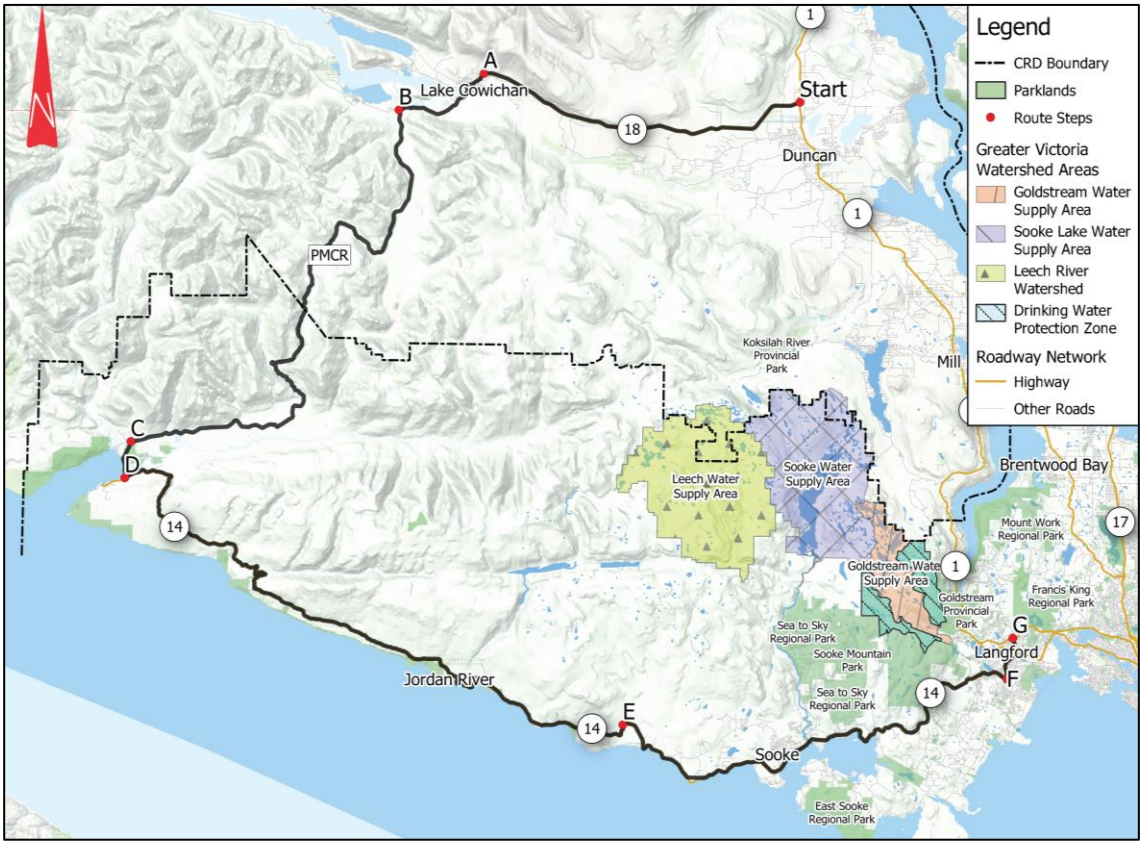

Figure 3.3: Existing Base Case Highway 1 Malahat Emergency Detour

3.2.2 Option 1A – Niagara Main

The route and applicable steps for this option are shown in ***Figure 3.4*** below. This option does not enter any water supply areas, but does border the Drinking Water Protection Zone. The Niagara Main route option exits the Malahat Highway 1 travelling west on Shawnigan Lake Road, and then:

A. Turning left onto Stebbings Road;

B. Turning left onto Goldstream Heights Drive;

C. Leaving Goldstream Drive to the right on a to be constructed new road which would enter Sooke Hills Wildness Park and connect to the Niagara Main;

D. Travelling south on the Niagara Main until the junction with Sooke Lake Road;

E. Turning left onto Sooke Lake Road, near the Capital Regional District Japan Gulch Disinfection Facility compound;

F. Travelling on Sooke Lake Road until reaching Amy Road;

G. Turning right onto Amy Road;

H. Turning left onto West Shore Parkway; and

I. Re-entering Highway 1.

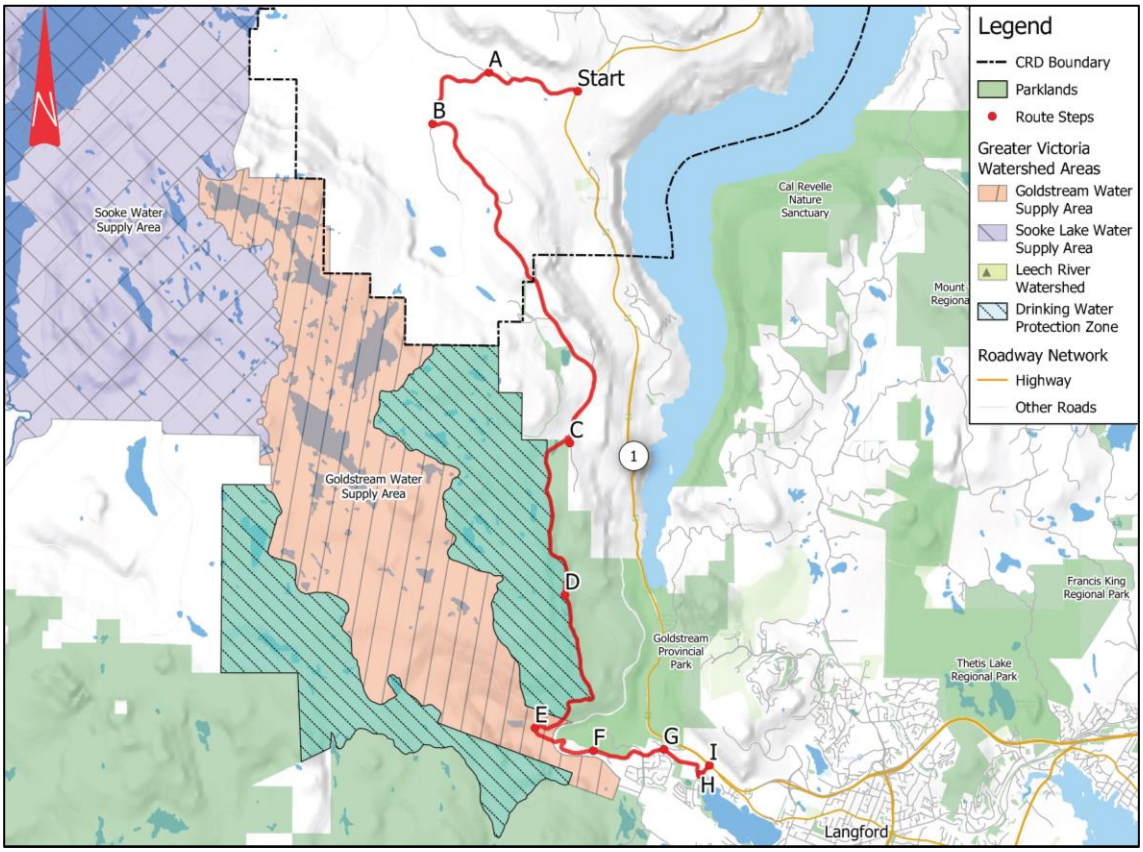

Figure 3.4: Option 1A Alternative Highway 1 Malahat Emergency Detour

3.2.3 Option 1B – Niagara Main in Watershed

The route and applicable steps for this option are shown in ***Figure 3.5*** below. Unlike Option 1A, Option 1B enters the Sooke Water Supply Area and Goldstream Water Supply Area and borders the Drinking Water Protection Zone. The Niagara Main in Watershed route exits the Malahat Highway 1 travelling west on Shawnigan Lake Road, and then:

A. Turning left onto Sooke Lake Road and entering the Sooke Lake Water Supply Area at the Sooke Entrance Gate;

B. Turning left onto Leechtown Road;

C. Turning left onto Niagara Main before entering the Goldstream Water Supply Area to the south;

D. While travelling south on Niagara Main the route passes close to Butchart Lake Reservoir and Lubbe Lake Reservoir;

E. Travelling east and then south on the Niagara Main until the junction with Sooke Lake Road near the Capital Regional District Japan Gulch Disinfection Facility compound;

F. Turning left onto Sooke Lake Road;

G. Travelling on Sooke Lake Road until reaching Amy Road;

H. Turning right onto Amy Road;

I. Turning left onto West Shore Parkway; and

J. Re-entering Highway 1.

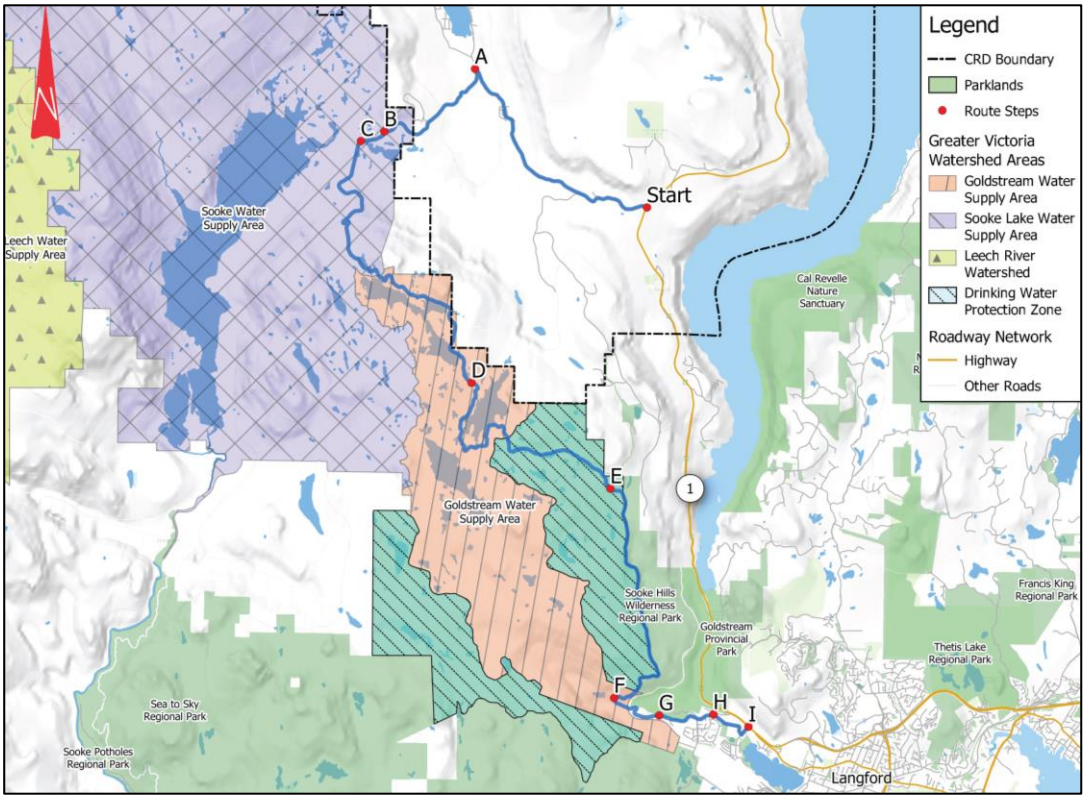

Figure 3.5: Option 1B Alternative Highway 1 Malahat Emergency Detour

3.2.4 Option 2A – Far West Alignment

The route and applicable steps for this option are shown in ***Figure 3.6*** below. The Far West Alignment route option exits the Malahat Highway 1 travelling west on Shawnigan Lake – Mill Bay Road, and then:

A. Travels west until reaching and turning left onto Renfrew Road;

B. Continuing to travel west until reaching the Kapoor Mainline and entering existing private Mosaic Forest Management lands on active logging roads (TimberWest lands);

C. Turning left onto West Jordan Main;

D. While travelling south on West Jordan Main the route passes just within the (extreme) northwest edge of the Leech River Watershed;

E. Turning left onto Jordan Mainline Road;

F. Turning left onto Butler Main;

G. Continuing east and then south on Butler Main until turning left onto Butler Road (exiting Mosaic Forest Management lands) just northwest of Sooke;

H. Turning left onto Otter Point Road;

I. Turning left onto Highway 14 (Sooke Road);

J. Continuing eastbound through Sooke until reaching Veterans Memorial Parkway;

K. Turning left onto Veterans Memorial Parkway; and

L. Re-entering Highway 1.

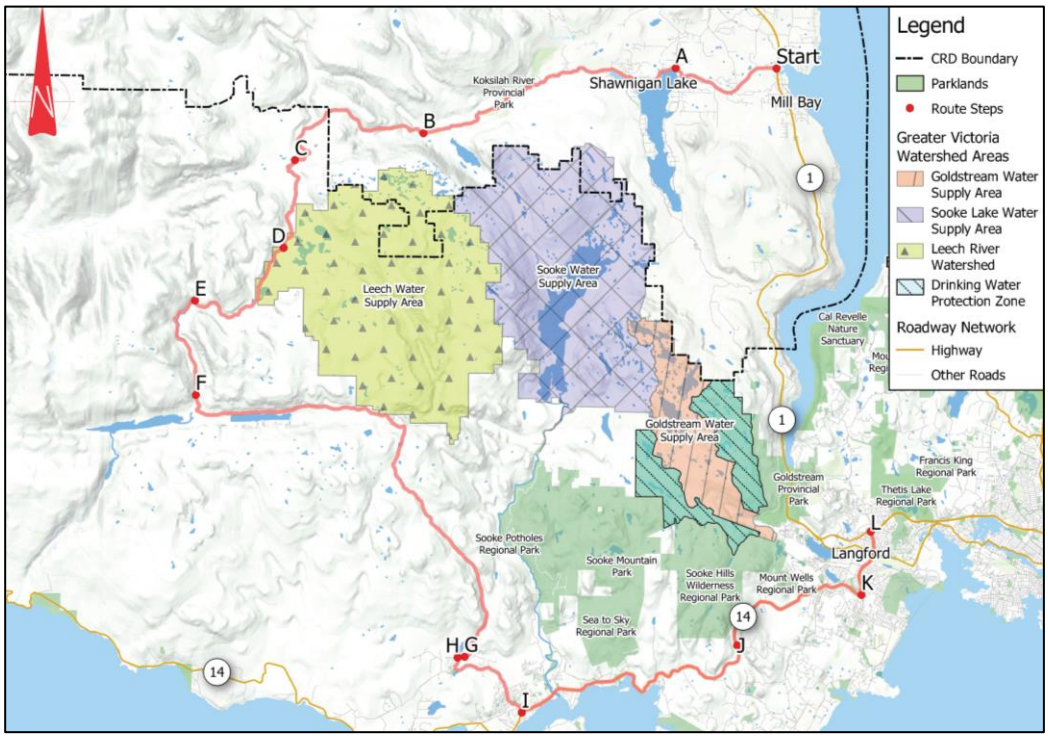

Figure 3.6: Option 2A Alternative Highway 1 Malahat Emergency Detour

3.2.5 Option 2B – Far West via Old Renfrew

The route and applicable steps for this option are shown in ***Figure 3.7*** below. The Far West Alignment via Old Renfrew route option exits the Malahat Highway 1 travelling west on Shawnigan Lake – Mill Bay Road, and then:

A. Travels west until reaching and turning left onto Renfrew Road;

B. Continuing to travel west until reaching the Kapoor Mainline and entering existing private Mosaic Forest Management lands on active logging roads (TimberWest lands);

C. Continues westbound onto the Old Port Renfrew Road and through a series of switchbacks;

D. Turning left onto the Williams Creek Main;

E. Turning right onto Jordan Mainline Road;

F. Turning left onto Butler Main;

G. Continuing east and then south on Butler Main until turning left onto Butler Road (exiting Mosaic Forest Management lands) just northwest of Sooke;

H. Turning left onto Otter Point Road;

I. Turning left onto Highway 14 (Sooke Road);

J. Continuing eastbound through Sooke until reaching Veterans Memorial Parkway;

K. Turning left onto Veterans Memorial Parkway; and

L. Re-entering Highway 1.

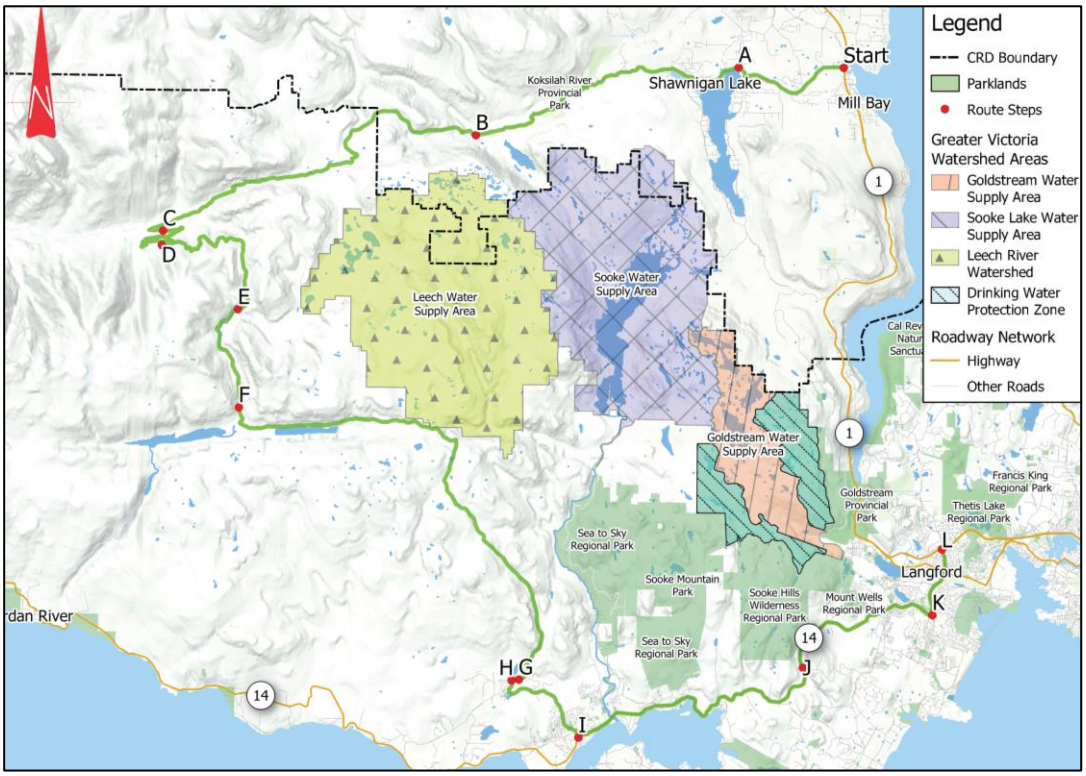

Figure 3.7: Option 2B Alternative Highway 1 Malahat Emergency Detour

3.2.6 Option 3A – Sooke Main / Kapoor Main

The route and applicable steps for this option are shown in ***Figure 3.8*** below. The Sooke Main / Kapoor Main route exits the Malahat Highway 1 travelling west on Shawnigan Lake Road, and then:

A. Turning left onto Sooke Lake Road, entering the Sooke Lake Water Supply Area at the Sooke Entrance Gate;

B. Continues westwards on the roadway, which becomes the Sooke Main before turning southwards along the west side of the Sooke Lake Reservoir. The route then travels on top of the causeway of the southernmost dam at the south end of the Sooke Lake reservoir before intersecting with the Kapoor Main;

C. Turning right onto the Kapoor Main and travelling southeast to Sooke Lake Road;

D. Turning right onto Sooke Lake Road near the Capital Regional District Japan Gulch Disinfection Facility compound;

E. Travelling on Sooke Lake Road until reaching Amy Road;

F. Turning right onto Amy Road;

G. Turning left onto West Shore Parkway; and

H. Re-entering Highway 1.

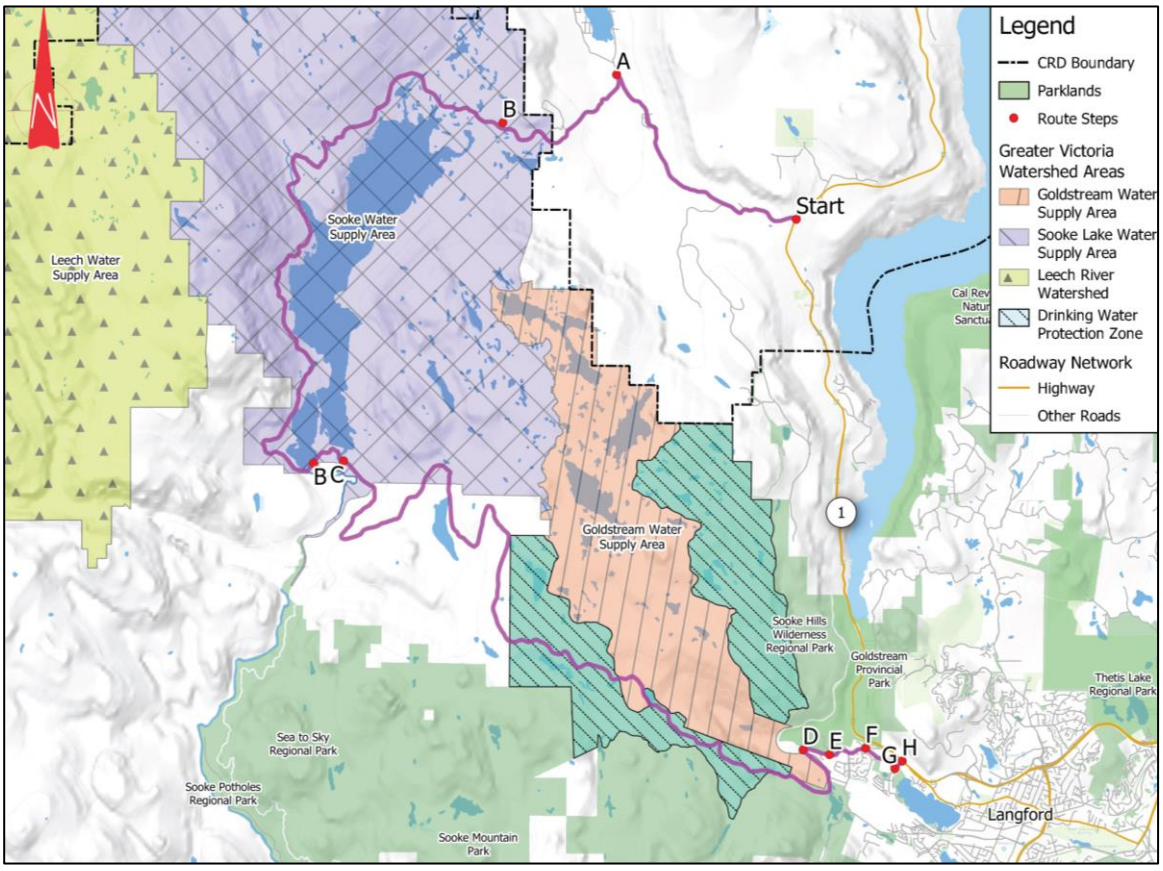

Figure 3.8: Option 3A Alternative Highway 1 Malahat Emergency Detour

3.2.7 Option 3B – Sooke Main / Boneyard

The route and applicable steps for this option are shown in ***Figure 3.9*** below. The Sooke Main / Boneyard route exits the Malahat Highway 1 travelling west on Shawnigan Lake Road, and then:

A. Turning left onto Sooke Lake Road, entering the Sooke Lake Water Supply Area at the Sooke Entrance Gate;

B. Continues westwards on the roadway, which becomes the Sooke Main before turning southwards along the west side of the Sooke Lake Reservoir until reaching the MacDonald Main;

C. Turning right onto MacDonald Main and travelling southwards to exit the watershed and enter Mosaic Forest Management lands (TimberWest lands) at the MacDonald Main Gate;

D. Turning left onto Boneyard Main and travelling south through Boneyard Gate until reaching Butler Main;

E. Turning left onto Butler Main;

F. Continuing south on Butler Main until turning left onto Butler Road (exiting Mosaic Forest Management lands) just northwest of Sooke;

G. Turning left onto Otter Point Road;

H. Turning Left onto Sooke Road (Hwy 14);

I. Continuing eastbound through Sooke until reaching Veterans Memorial Parkway;

J. Turning left onto Veterans Memorial Parkway; and

K. Re-entering Highway 1.

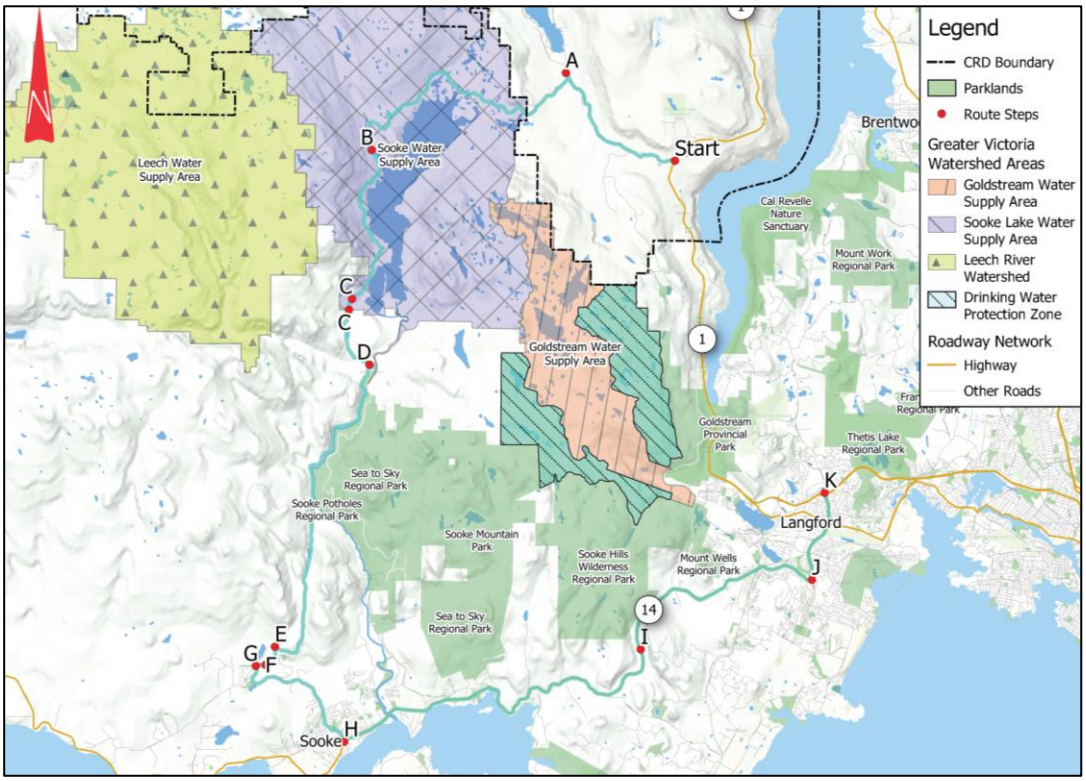

Figure 3.9: Option 3B Alternative Highway 1 Malahat Emergency Detour

3.2.8 Option 4A – Old Highway #117 / Kapoor Main

The route and applicable steps for this option are shown in ***Figure 3.10*** below. The Old Highway #117 / Kapoor Main route exits the Malahat Highway 1 travelling west on Shawnigan Lake Road, and then:

A. Turning left onto Sooke Lake Road and entering the Sooke Lake Water Supply Area at the Sooke Entrance Gate;

B. Turning left onto Leechtown Road the route passes near the Sooke Lake Reservoir on the east side of the reservoir until intersecting with the Kapoor Main;

C. Turning left onto the Kapoor Main and travelling southeast to Sooke Lake Road;

D. Turning right onto Sooke Lake Road near the Capital Regional District Japan Gulch Disinfection Facility compound;

E. Travelling on Sooke Lake Road until reaching Amy Road;

F. Turning right onto Amy Road;

G. Turning left onto West Shore Parkway; and

H. Re-entering Highway 1.

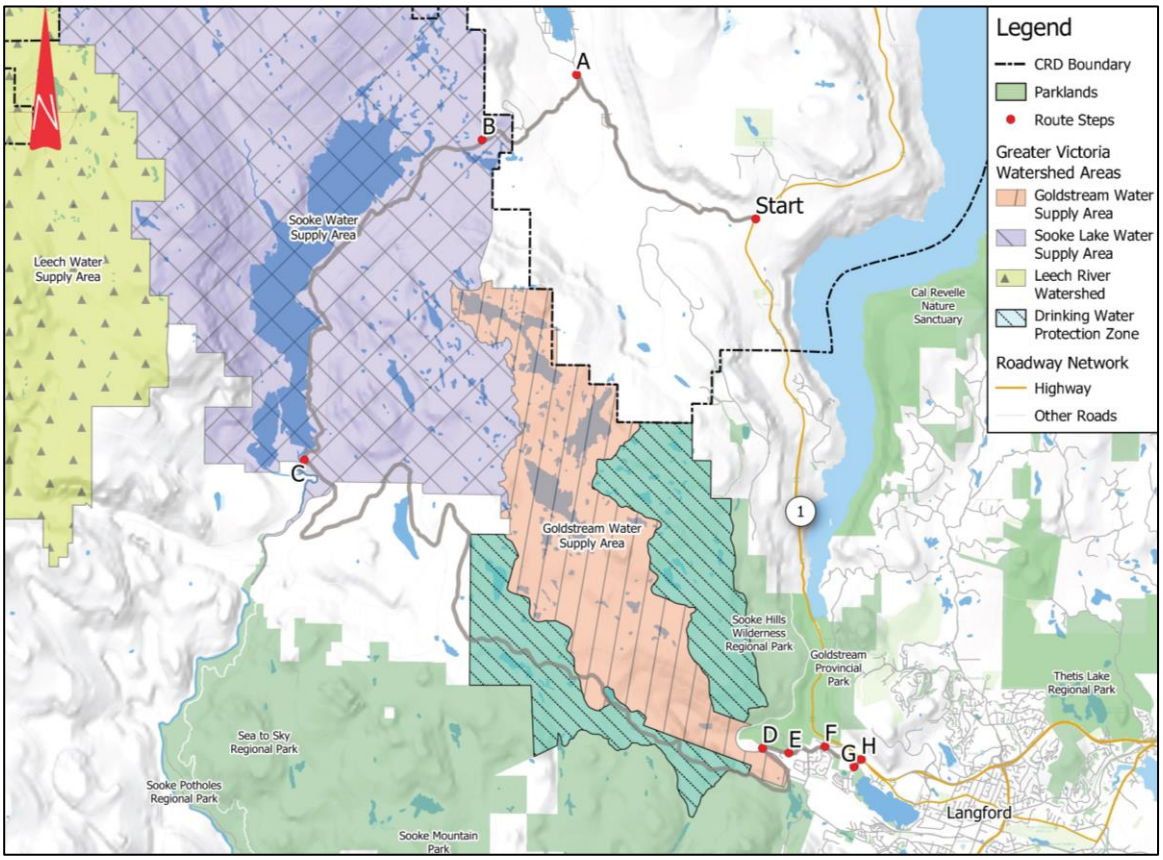

Figure 3.10: Option 4A Alternative Highway 1 Malahat Emergency Detour

4. Option Screening

This section outlines the option screening for the Malahat Emergency Detour Route Planning Study. Subsection 4.1 summarizes the design criteria that was used in determining the suitability of existing private roadways for use as part of an emergency detour route. Subsection 4.2 summarizes the criteria that will be used to screen the initial options list down to no more than three options, while Subsection 4.3 summarizes the screening of the initial options. Subsection 4.4 provides a summary of the screening assessment.

4.1 Design Criteria

Prescriptive standard design criteria for an emergency detour route does not exist. As an emergency detour, the route would experience no or very little traffic most of the time, and perhaps a considerable amount of traffic when the detour is implemented. Generally, the first step in developing design criteria for a road is to designate a road classification which is predicated on traffic usage and the mobility or access function of the road. To seek guidance in developing design criteria for the emergency route, two reference documents were consulted:

- BC MoTI, BC Supplement to the TAC Geometric Design Guide, Chapter 500, Low-Volume Roads; and
- TAC, Geometric Design Guide for Canadian Roads, Draft Chapter 11, Special Roads.

Referencing the BC Supplement, a Low-Volume Road (LVR), Category A – for rural road system and roads to and within isolated communities, appears the most appropriate classification for the emergency detour road. This reference further states that if there are periods of high use but the periods of high use are short but numerous (for example, two or three consecutive days for no more than twelve times a year), an economic analysis may be required to determine whether to use the LVR or other higher standards. During the period from 2009 to 2018, there were eleven major emergency closures of the Malahat Highway with an average duration of about seven hours, due to incidents on the highway. This usage of the emergency detour route is consistent with an LVR, Category A.

Referencing the TAC Special Roads Chapter, a road classification of Access Roads (RSA), for roads that provide access to farms, residences, businesses or other abutting properties, as well as access to and within isolated communities, appears to be the most appropriate classification. Although design speeds can be between 50 and 80 km/h for this class of road, for mountainous or rolling terrain with horizontal and vertical constraints, lower design speeds are recommended.

It should be noted that these design criteria represent prescriptive features of an ultimate build out state and are not necessarily required in all segments of the route during opening day. If there are budgetary or scheduling constraints the construction can be staged such that only the most essential improvements are undertaken for opening day. Some segments may remain below in terms of standard horizontal or vertical radii, have Single Lane Alternating Traffic patterns at bridges or pinch points, etc. all of which can be upgraded in later stages. However, it should be recognized that if there is staging in this manner there could be requirements for additional traffic management personnel to be present at these locations.

A summary of the design criteria for select road elements from these two references and the proposed design criteria for the emergency detour route is shown in ***Table 4.1***, overleaf.

Table 4.1: Proposed Design Criteria for the Emergency Detour Route

ITEM	BC MOTI SUPPLEMENT TO TAC GDG	TAC DRAFT GDG CHAPTER 11 SPECIAL ROADS	PROPOSED PROJECT CRITERIA
Design Classification	LVR – Cat. A	RSA – Access Road	LVR – Cat. A
Posted Speed	40 to 70 km/h	NA	50 km/h w/ curve warning signs and reduced speed zones to a minimum of 30 km/h
Design Speed	40 to 70 km/h	30 to 50 km/h Rolling Terrain	50 km/h (with some reduced curve warnings at 30 km/h)
Basic Lanes	2	2	2
Minimum Radius (50 km/h)	90 m	90 m	90 m
Equiv. Min.....Sag "K" Factor.....Crest	12 11	12 11	12 11
Maximum Grade	14 %	10 to 14 %	14 %
Basic Crossfall	2 %	2 to 4 %	2 %
Maximum Super-elevation	6 %	8 %	6 %
Minimum S.S.D. (50km/h)	65 m with corrections for grade	65 m with corrections for grade	65 m with corrections for grade
Lane Width	3.5 m	3.1 m	3.2 m
Shoulder Width Outside	0.5 m gravel	0.5 m	0.3 m gravel
Clear Zone	2 m utility offset only 2:1 Fill Slope	NA	2 m utility offset only 2:1 Fill Slope or Roadside Barrier
Catchment Width in Rock Cuts	0.6 m	NA	0.6 m
Level of Service	NA	NA	NA
Design Vehicle	I-BUS	Varies	I-BUS*

* Note: An I-BUS design vehicle will be used as the design vehicle to ensure that acceptable turning radii and pavement areas are used that would allow an I-BUS to remain within the theoretical lane lines. Vehicles up to a WB-20 design vehicle would also be allowed to use the route, however, these vehicles may result in vehicle tracking passing overtop of the theoretical location of the lane lines when performing certain tighter radius turns.

4.1.1 Detour Operational Considerations

It should be noted that in addition to the design criteria listed above, there would be additional considerations that would need to be addressed in later stages of design. These primarily relate to what level of service the detour is looking to achieve and how the detour route would operate. These details would have a cyclical relationship with the design criteria, as the criteria affect what is possible to achieve, and the needs require certain levels of design to be achieved. The details that would require further review should any option be pursued in the future include the following:

- The exact duration of a highway closure that would trigger the opening and operation of the detour.
- The seasonal / weather operational constraints of the detour and the degree of maintenance required for operation (i.e. in terms of snow ploughing and roadway surface condition).
- The exact traffic control deployments that would be necessary for the operation of the detour including:
    - Temporary detour signage that would need to be placed;
    - Traffic control personnel needed for areas of complex geometry or traffic patterns;
    - The need for pilot vehicles for larger commercial vehicles.
- Whether heavier vehicles including overload, oversized, commercial trucks, RV's etc. would be allowed to use the detour either at all or only in specific time periods. If these vehicles are not allowed to use the detour, or are postponed until specific hours to use the detour, it would need to be determined where these vehicles would be staged or whether they would be turned around to wait elsewhere.
- The potential for the inclusion of Single Lane Alternating Traffic (SLAT) at pinch point locations such as bridges or rock outcrops and if utilized, whether these sections of roadway would require traffic flaggers or be navigable via self-guided signage.

4.2 Option Screening Framework

Prior to submitting alternative emergency route options for more detailed evaluation, a screening process was conducted to reduce the set of options to a more manageable number which will focus the analysis requirements during the subsequent option evaluation process. By screening the options at this stage, only the most promising options were taken forward for detailed evaluation. This section describes the option screening process in terms of the screening criteria.

The intent of the option screening process is to identify short comings that may exist in one or more options previously generated. In identifying these short comings, some options can be eliminated from further consideration. Only the most feasible or practical short-listed options would be taken forward for a more detailed assessment using the Multiple Account Evaluation (MAE) framework. The screening process would be applied to emergency route options with the goal of short listing no more than three options.

The option screening is also the start of the option evaluation process, so some of the information generated in the screening assessment will be carried forward, where appropriate, in the more detailed option evaluation process. Noting the characteristics of the options being considered and the environment in which the options pass through, the following screening criteria are proposed:

- Environmental;
- Socio-Community;
- Engineering; and,
- Financial.

4.2.1 Environmental

The environmental screening assessment of the seven alternative detour route options, consist of a high-level consideration of an option's potential effects on environmental features that support biodiversity and sustainable ecosystems. The environmental screening is be based upon a desk top assessment using available documentation and cursory visual observations that were made during a driving tour along the 2-wheel drive vehicle accessible portions of the various routes.

At the screening level, the following environmental features were considered:

- Species at risk (individual observation records and federally-designated Critical Habitat parcels);
- Stream and wetland aquatic habitat features;
- Parks or conservation areas;
- Old Growth Management Areas (OGMAs);
- Wildlife Management Areas (WMAs); and
- Recorded archaeological sites.

It should be noted that due to the high-level nature of the environmental review, a very conservative approach has been taken in considering possible environmental impacts. If a project were to come to fruition, there steps could be taken to mitigate the impacts.

4.2.2 Socio-Community

The socio-community screening assessment includes consideration of an option's impact on the community from a built form, planning, and land use perspective. This assessment will be based on high-level desk top investigations using local land use maps, previous studies, and feedback from stakeholders, such as Mosaic Forest Management and the Capital Regional District.

Considerations include:

- Potential for property acquisition;
- Community disruption (i.e. detour traffic on local roads acts as a barrier); and
- Water resource impacts.

4.2.3 Engineering

The engineering criteria will perform a high-level assessment of each option for constructability, complexity and quality of an inferred conceptual design for the topography and environment. Projects with less complex infrastructure and construction requirements will have lower risk and generally lower costs along with reduced construction impacts on road users and adjacent properties. Conversely, complex projects often have higher risks and generally higher costs along with potentially higher impacts to road users and adjacent properties. The quality of the inferred conceptual design will affect the user experience and required operating / maintenance efforts.

Engineering considerations relate to construction magnitude, complexity and risks, and include:

- Overall option length.
- Number / size of bridge structures.
- Likely compliance with selected design criteria. Potential for lateral constraints, steep graded sections, and severe cross slope areas.
- Alignment considerations:
    - Abrupt changes in alignment;
    - Consistency with existing topography; and
    - Vertical profile elevation variability.
- Geotechnical concerns:
    - Evidence of unstable terrain.
    - Significant rock cut requirements.
    - Existing roads with over-steepened embankments.

4.2.4 Capital Cost

The costs criteria will assess the order of magnitude for costs for the implementation of the route option, with considerations to the design and construction of road upgrades, structures, and culverts.

4.3 Option Screening Assessment

4.3.1 Environmental

The results of the Option Screening Assessment for the five environmental criteria considered are described below. Summary information on the criteria considered are shown on ***Figure 4.1***, overleaf.

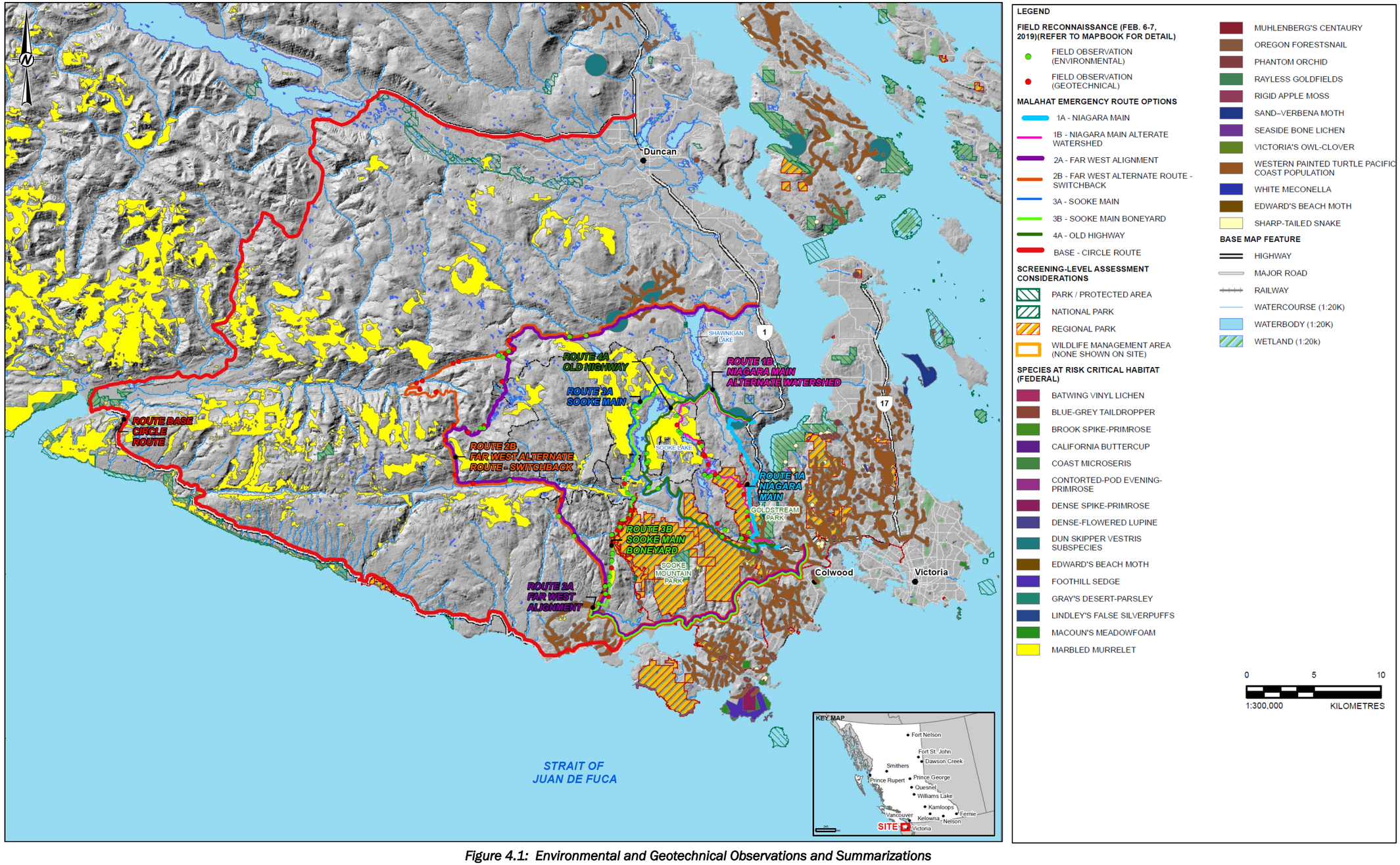

Figure 4.1: Environmental and Geotechnical Observations and Summarizations

SPECIES AT RISK

For the purpose of conducting a high-level screening evaluation of the relative effects of the seven options on species at risk, spatial interaction with wildlife species at risk observation records, federally designated critical habitat parcels, plant / fungus species at risk and ecosystems at risk observation records were considered. Screening evaluation of species of concern potentially affected by each option was conducted by tallying the number of records located within a 100-metre buffer of the centre line of the routes (higher sum inferred to have higher potential for effects on species at risk).

A summary and rank ordering of the number of species or ecosystems at risk within a 100-metre buffer of the centre line of each of these routes is provided in *Table 4.2*.

Table 4.2: Number of Species at Risk Observation Records and Critical Habitat Parcels Crossed or within 100 metres of Option Alignment

OPTION ALIGNMENT	WILDLIFE SPECIES AT RISK	CRITICAL HABITAT PARCELS	PLANT / FUNGUS SPECIES AT RISK	ECOSYSTEMS AT RISK	SUM (ORDERED LEAST TO MOST DESIRABLE)
2A – Far West Alignment	10 records total: non-sensitive (9) 1 sensitive (species unknown)	21 parcels	12 records	3 records	46 (~0.9 per km of private road)
2B – Far West via Old Renfrew	9 records total: Non-sensitive (8) 1 sensitive (species unknown)	20 parcels	12 records	3 records	44 (~0.7 per km of private road)
3B – Sooke Main / Boneyard	9 records total: Non-sensitive (8) 1 sensitive (species unknown)	15 parcels	8 records	2 records	34 (~1.1 per km of private road)
3A – Sooke Main / Kapoor Main	9 records total: Non-sensitive (8) 1 sensitive (species unknown)	7 parcels	2 records	2 records	20 (~0.8 per km of private road)
1B – Niagara Main in Watershed	9 records total: non-sensitive (8) 1 sensitive (species unknown)	6 parcels	2 records	2 records	19 (~0.8 per km of private road)
1A – Niagara Main	9 records total: non-sensitive (8) 1 sensitive (species unknown)	5 parcels	1 record	2 records	17 (~2.1 per km of private road)
4A – Old Highway / Kapoor Main	8 records total: Non-sensitive (7) 1 sensitive (species unknown)	5 parcels	2 records	2 records	17 (~0.5 per km of private road)

It is important to emphasize the total route length has great bearing on this screening criterion. Longer routes have greater probability of intersecting a species at risk observation record or habitat parcel. The results here are also limited by a number of factors: observation records for species and ecosystems at risk are patchy and data coverage is a direct result of the amount and intensity of survey effort and accessibility of an area for survey effort (more survey effort provides more observation records). The coverage of observation records and survey effort intensity is not consistent across this broad study area, so there are inherent limitations in the inferences that can be made

from this type of screening desktop data assessment. A lack of observation records does not mean there are no species at risk in a given location.

For this criterion, Option 2A (Far West Alignment) is longest and least desirable in terms of absolute numbers, having the most wildlife, plant/fungus species at risk observation records and the highest number of critical habitat parcels in proximity to the alignment. Option 1A (Niagara Main) and Option 4A (Old Highway / Kapoor Main) are the most desirable based on this criterion, having the lowest number of all species at risk record types in proximity to the alignment.

DESIGNATED SENSITIVE HABITAT FEATURES: OLD GROWTH MANAGEMENT AREAS (OGMAS) AND WILDLIFE MANAGEMENT AREAS (WMAS)

As a high-level screening evaluation of the relative effects of the seven options on sensitive habitat features (OGMAs and WMAs), a tally of the number of these designated areas intersected by the route options was considered. Screening evaluation of sensitive habitat features potentially affected by each option was conducted by tallying the number of designated areas within a 100-metre buffer of the centre line of the routes (higher sum inferred to have higher potential for effects on sensitive habitat features). A summary and rank ordering of the number of designated sensitive habitat features within a 100-metre buffer of the centre line of each of these routes is provided in *Table 4.3*.

Table 4.3: Number of Designated Sensitive Habitat Features (including OGMAs, WMAs) Crossed or within 100 metres of Option Alignment

OPTION ALIGNMENT	OGMAS	WMAS	SUM (ORDERED LEAST TO MOST DESIRABLE)
2A – Far West Alignment	1 (non-legal)	none	1
2B – Far West via Old Renfrew	1 (non-legal)	none	1
1A – Niagara Main	none	none	0
1B – Niagara Main in Watershed	none	none	0
3A – Sooke Main / Kapoor Main	none	none	0
3B – Sooke Main / Boneyard	none	none	0
4A – Old Highway / Kapoor Main	none	none	0

It is important to emphasize the limitation of the discontinuous nature of spatial data used for this screening criterion. The designated features considered in this evaluation (OGMAs and WMAs) are only designated within provincial crown land areas not under other protected status, with OGMAs only designated within areas under previous or active timber harvest licenses (i.e., for this study area, within the crown lands subject to timber harvest by TimberWest). There are no OGMAs or WMAs designated within the CRD's watershed management boundary or within provincial parks, conservation areas or regional parks, so any route alignments within these protected areas will not have these sensitive habitat features designated. It is important to point out the lack of designated sensitive habitat areas in proximity to routes within the CRD's watershed management area boundary or protected areas does not mean there are no sensitive habitats; on the contrary, the protection of these areas from development makes the likelihood of actual sensitive habitat features being present much higher. It is just not captured by datasets that can be used in this screening assessment.

For this criterion, the Far West routes are least desirable, having one designated sensitive habitat features in proximity to the alignments. Options 1A, 1B, 3A, 3B and 4A are most desirable, having no sensitive habitat features in proximity to the alignments.

PROTECTED AREAS (PROVINCIAL PARKS, CONSERVATION AREAS AND REGIONAL PARKS)

As a high-level screening evaluation of the relative effects of the seven options on protected areas (Provincial Parks, Conservation Areas, and Regional Parks), a tally of the number of these areas intersected by the route options was considered. Although mapping of Community and Municipal Parks was available, these types of parks were excluded from this evaluation as they are typically not in a natural state and used primarily for recreation or other human use (i.e., not presently in a protected, natural state). Screening evaluation of protected areas potentially affected by each option was conducted by tallying the number of designated areas within a 100-metre buffer of the centre line of the routes (higher sum inferred to have higher potential for effects on designated areas). A summary and rank ordering of the number of protected areas within a 100-metre buffer of the centre line of each of these routes is provided in *Table 4.4*.

Table 4.4: Number of Protected Areas (Provincial Parks, Conservation Areas, and Regional Parks)

OPTION ALIGNMENT	PROVINCIAL PARKS	CONSERVATION AREAS	REGIONAL PARKS	SUM (ORDERED LEAST TO MOST DESIRABLE)
3B – Sooke Main / Boneyard	none	none	6 Parks: Ayum Creek Regional Park Reserve; Galloping Goose Regional Trail; Kapoor Regional Park; Sea to Sea Regional Park; Sooke Hills Wilderness Regional Park; and Sooke Potholes Regional Park.	6
2A – Far West Alignment	1 Park: Koksilah River Park A*	none	4 Parks: Ayum Creek Regional Park Reserve; Galloping Goose Regional Trail; Sea to Sea Regional Park; and Sooke Hills Wilderness Regional Park.	5
2B – Far West via Old Renfrew	1 Park: Koksilah River Park A*	none	4 Parks: Ayum Creek Regional Park Reserve; Galloping Goose Regional Trail; Sea to Sea Regional Park; and Sooke Hills Wilderness Regional Park.	5
1A – Niagara Main	1 Park: Goldstream Park A	none	1 Park: Sooke Hills Wilderness Regional Park*	2
1B – Niagara Main in Watershed	1 Park: Goldstream Park A	none	1 Park: Sooke Hills Wilderness Regional Park*	2
3A – Sooke Main / Kapoor Main	1 Park: Goldstream Park A	none	1 Park: Sooke Hills Wilderness Regional Park*	2
4A – Old Highway / Kapoor Main	1 Park: Goldstream Park A	none	1 Park: Sooke Hills Wilderness Regional Park*	2

* Option would result in new bisection of parkland with a publicly accessible roadway

For this criterion, Option 3B Sooke Main / Boneyard is least desirable based strictly on the number of parks potentially affected, having the most park or protected areas in proximity to the alignments (6 protected areas). Although the count of parks affected provides a high-level indication of level of potential effects, the more important

measure is the degree to which a new roadway would affect the current conditions, i.e., a new road segment or upgraded road segment adjacent to a protected area has lower impact than a new or upgraded road right of way that bisects a previously undisturbed natural area. In this context, Options 1A, 1B, 3A, and 4A would have a higher degree of anticipated impacts as the route alignments bisect the Sooke Hills Wilderness Park. Options 2A and 2B also bisect the Koksilah River Park A, but to a much lesser degree. Furthermore, Options 1A and 1B also affect a section of the Great Trail alignment within the Sooke Hills Wilderness Park, which runs along the Niagara Main.

STREAM, LAKE, MARINE / SHORELINE, AND WETLAND AQUATIC HABITAT FEATURES

As a high-level screening evaluation of the relative effects of the seven options on aquatic habitat and water quality, a tally of the number of these aquatic habitat features intersected by the route options was considered. Screening evaluation of aquatic habitat potentially affected by each option was conducted by tallying the number of mapped aquatic habitat features (primarily at 1:20,000 scale, from provincial datasets) within a 100-metre buffer of the centre line of the routes (higher sum inferred to have higher potential for effects on aquatic habitat and water quality). Although interactions do not necessarily equate to impacts in all cases, there is a higher likelihood of an option having aquatic impacts given higher numbers of interactions with bodies of water.

A summary and rank ordering of the number of mapped aquatic habitat features within a 100-metre buffer of the centre line of each of these routes is provided in ***Table 4.5***.

Table 4.5: Number of Interactions with Streams, Lakes, Marine / Shoreline and Wetlands: Crossed or within 100 metres of Option Alignment

OPTION ALIGNMENT	STREAMS	LAKES OR MARINE / SHORELINE	WETLANDS[3]	SUM (ORDERED LEAST TO MOST DESIRABLE)
2B – Far West via Old Renfrew	330 total interactions (some features with more than 1 intersection with 100 m route buffer): • 29 major watercourse with the Jordan River and Koksilah River as known fish bearing rivers; • 145 definite streams with known fish bearing streams, Bear Creek, Bilston Creek, DeMamiel Creek, Jordan River, Koksilah River, and Shawnigan Creek; • 152 indefinite streams; • 2 intermittent streams – Bilston Creek known as fish bearing; and • 2 ditches.	18 total interactions (some features with more than 1 intersection with 100 m route buffer): • 15 waterbodies; • 2 manmade waterbodies – Bear Creek Reservoir; and • 1 marine/shoreline.	8 total: • 5 marshes • 2 swamps • 1 (1:2,500 scale CRD mapped)	356

[3] Note: wetlands were mapped at large scale (1:2,500) within CRD Greater Victoria Water Supply Area boundaries only, therefore, the counts of wetlands being compared between options outside of, or inside of the Water Supply Area boundary where more detailed wetland mapping was undertaken, should not be considered a primary factor in this assessment, it is considered here only because it is a high-level assessment for initial screening purposes.

OPTION ALIGNMENT	STREAMS	LAKES OR MARINE / SHORELINE	WETLANDS[3]	SUM (ORDERED LEAST TO MOST DESIRABLE)
2A – Far West Alignment	307 total interactions (some features with more than 1 intersection with 100 m route buffer): • 30 major watercourses with the Jordan River, Koksilah River, and Sooke River as known fish bearing watercourses; • 145 definite streams with known fish bearing streams – Bear Creek, Bilston Creek, DeMamiel Creek, Jordan River, Koksilah River, and Shawnigan Creek; • 128 indefinite streams; • 2 intermittent stream– Bilston Creek confirmed as fish bearing; • 2 ditches	18 total interactions (some features with more than 1 intersection with 100 m route buffer): • 15 waterbodies; • 2 manmade waterbodies – Bear Creek Reservoir; and • 1 marine/shoreline.	10 total: • 6 marshes • 2 swamps • 2 (1:2,500 scale CRD mapped)	335
3B – Sooke Main / Boneyard	157 total interactions (some features with more than 1 intersection with 100 m route buffer): • 18 major watercourses – with Golledge Creek and Sooke River known as fish bearing; • 66 definite streams with the following known fish bearing streams, Bilston Creek, DeMamiel Creek, Golledge Creek, Macdonald Creek, and Sooke River; • 69 indefinite streams – Macdonald Creek known as fish bearing; • 2 intermittent streams – Bilston Creek known as fish bearing; and • 2 ditches.	11 total interactions (some features with more than 1 intersection with 100 m route buffer): • 8 waterbodies; • 2 manmade waterbodies; and • 1 marine/shoreline.	27 total: • 3 marshes • 3 swamp • 21 (1:2,500 scale CRD mapped)	195
3A – Sooke Main / Kapoor Main	69 total interactions (some features with more than 1 intersection with 100 m route buffer): • 29 definite streams – Goldstream River being fish bearing; • 37 indefinite streams; and • 3 ditches.	7 total interactions (some features with more than 1 intersection with 100 m route buffer): • 5 waterbodies; and • 2 manmade waterbodies.	33 total: • 4 marshes • 1 swamp • 28 (1:2,500 scale CRD mapped)	109

OPTION ALIGNMENT	STREAMS	LAKES OR MARINE / SHORELINE	WETLANDS[3]	SUM (ORDERED LEAST TO MOST DESIRABLE)
1B – Niagara Main in Watershed	47 total interactions (some features with more than 1 intersection with 100 m route buffer): • 26 definite streams – Goldstream River being fish bearing; • 18 indefinite streams; and • 3 ditches.	• 2 waterbodies	33 total: • 7 marshes • 1 swamp • 25 (1:2,500 scale CRD mapped)	82
4A – Old Highway / Kapoor Main	51 total interactions (some features with more than 1 intersection with 100 m route buffer): • 18 definite streams – Council Creek and Goldstream River being fish bearing; • 30 indefinite streams; and • 3 ditches.	5 total interactions (some features with more than 1 intersection with 100 m route buffer): • 4 waterbodies; and • 1 manmade waterbody.	14 total: • 3 marshes • 1 swamp • 10 (1:2,500 scale CRD mapped)	70
1A – Niagara Main	29 total interactions (some features with more than 1 intersection with 100 m route buffer): • 16 definite streams – with Goldstream River being fish bearing; • 10 indefinite streams; and • 3 ditches.	• 1 waterbody	6 total: • 5 (1:2,500 scale CRD mapped) • 1 marsh	36

It is important to emphasize the total route length has great bearing on this screening criterion. Longer routes have greater probability of intersecting more aquatic habitat features.

For this criterion, the two Far West options (2A and 2B) are the least desirable, having the most aquatic habitat features crossed or in proximity to the alignments (356 and 335, respectively). Option 1A (Niagara Main) is the most desirable, having by far the lowest number of aquatic habitat features crossed or in proximity to the alignment (36).

The existing industrial resource logging roads or CRD maintenance roads are already in operation over these alignments on a regular basis. Therefore, the relevance of considering aquatic habitat within 100 metres is related to the increased risk of water quality impairment, potential requirement for new or upgraded watercourse crossing structures along the existing routes, and environmental permitting (greater with fish presence, greatest with salmonid presence).

REGISTERED ARCHAEOLOGICAL AND HISTORICAL SITES

As a high-level review of archaeological impacts of the emergency detour route options, a scan of recorded archaeological sites was conducted. The number of previously identified and registered heritage sites crossed or within 100 metres of the option alignments are shown in ***Table 4.6***.

Table 4.6: Number of Previously Identified and Registered Heritage Sites Crossed or within 100 metres of Option Alignment

OPTION ALIGNMENT	ARCHAEOLOGICAL SITE	HISTORICAL SITE – FORMALLY RECOGNIZED	HISTORICAL SITE -UNPROTECTED NOT RECOGNIZED
1A – Niagara Main	0	0	0
1B – Niagara Main in Watershed	0	0	0
2A – Far West Alignment	12	2	0
2B – Far West via Old Renfrew	12	2	0
3A – Sooke Main / Kapoor Main	0	0	0
3B – Sooke Main / Boneyard	11	2	0
4A – Old Highway / Kapoor Main	0	0	0

The absence or limited number of registered archaeological and heritage sites within the Option Alignments are a likely indicator of data gaps (i.e. lack of previous studies) and not a lack of archaeological resources present within the Option Alignments.

4.3.2 Socio-Community

The results of the Option Screening Assessment for the three socio-community criteria considered are described in the subsections below.

PROPERTY IMPACTS

The primary source of property impacts would be the acquisition of new land to construct new roadway connections, and the acquisition of existing road right-of-ways. It is assumed that the Capital Regional District would retain control over any roadways within the Greater Victoria Water Supply Area and the Drinking Water Protection Area and would thusly not result in property impacts. However, those roadways within Mosaic Forest Management Lands are assumed to result in property impacts. To this end, the anticipated property impacts are listed below in T*able 4.7*.

Table 4.7: Anticipated Property Impacts of Alternative Detour Routes

OPTION	ANTICIPATED IMPACTS	QUALITATIVE IMPACT
1A	Impacts to properties near Goldstream Heights Drive, to provide roadway connection between the roadway and Niagara Main.	Moderate
1B	No significant impacts anticipated as route would remain on public roadways or CRD roads.	Mild
2A	Impacts to Mosaic Forest Management properties for all of the route except the beginning and end.	Severe
2B	Impacts to Mosaic Forest Management properties for all of the route except the beginning and end.	Severe
3A	No significant impacts anticipated as route would remain on public roadways or CRD roads.	Mild
3B	Impacts to Mosaic Forest Management properties in relation to Boneyard Main and the southern tip of Butler Main.	Moderate
4A	No significant impacts anticipated as route would remain on public roadways or CRD roads.	Mild

COMMUNITY DISRUPTION

When an emergency detour route has been implemented due to an incident requiring a road closure along the Malahat Highway, the volume of traffic on the detour travelling through existing urban or suburban areas will temporarily act as a barrier, making crossing the route difficult for local residents and potentially disrupting community connectivity temporarily while the detour is in operation. To assess the potential for temporary community disruption by the emergency detour route options, the length of existing public roads along each route was determined. As Arterial class roads are designed with limited crossing opportunities, only the Collector and Local road classes were considered for potential community disruption concerns. The existing public roads for each emergency detour route option by road classification are shown in ***Table 4.8***.

Table 4.8: Roadway Classification Lengths

OPTION	ROADWAY CLASSIFICATION LENGTHS (KM)				
	ARTERIAL	COLLECTOR	LOCAL ROAD	TOTAL	TOTAL TEMPORARY CROSSING BARRIER
1A	1.7	1.7	9.1	12.5	10.8
1B	5.7	1.7	2.9	10.3	4.6
2A	39.2*	10.0	4.0	53.2	14.0
2B	39.2*	10.0	4.0	53.2	14.0
3A	5.7	1.7	2.9	10.3	4.6
3B	34.8*	4.7	2.9	42.4	7.6
4A	5.7	1.7	2.9	10.3	4.6

* Note: Highway 14 is classified as an arterial roadway.

Option 1A – Niagara Main

The southern segments of Option 1A route travel through the Goldstream neighbourhood in Langford. This neighbourhood is a suburban residential area with some local commercial businesses and potentially could experience severe issues during the detour implementation. Also, the northern segments of Option 1A travel through the rural area of Goldstream Heights. This is a rural residential development area of very low density with large acre lots sparsely positioned along the route with very little need for crossing interactions. Although the length of this route through existing areas is relatively long the areas of potential community disruption are relatively small.

Option 1B – Niagara Main in Watershed

The northern segments of the detour route would pass through the Shawnigan Station which is a small single family home residential neighbourhood, of about 100 houses, straddling Shawnigan Lake Road south of Shawnigan Lake. The southern segments of Option 1B route travel through the Goldstream neighbourhood in Langford. This neighbourhood is a suburban residential area with some local commercial businesses and potentially could experience severe issues during the detour implementation.

Option 2A – Far West Alignment

The northern segments of the detour route would pass through the Shawnigan Lake Village area at the north end of Shawnigan Lake. Also, should traffic be directed onto the emergency detour at the Shawnigan Lake Road / Highway 1 intersection, the detour would pass through the Shawnigan Station which is a small single family home residential neighbourhood, of about 100 houses, straddling Shawnigan Lake Road south of Shawnigan Lake. The south segment of the detour would pass through a residential community including city parks and commercial lands within the Municipality of Sooke on Otter Point Road.

It should be noted that this detour route could also act as an emergency detour for incidents that occur on Highway 14 between Gillespie Road and Drennan Street in Sooke, which would reduce the community disruption of Sooke and the surrounding area, that occurs during those Highway 14 closures.

Option 2B – Far West via Old Renfrew

The northern segments of the detour route would pass through the Shawnigan Lake Village area at the north end of Shawnigan Lake. Also, should traffic be directed onto the emergency detour at the Shawnigan Lake Road / Highway 1 intersection, the detour would pass through the Shawnigan Station which is a small single family home residential neighbourhood, of about 100 houses, straddling Shawnigan Lake Road south of Shawnigan Lake. The south segment of the detour would pass through a residential community including city parks and commercial lands within the Municipality of Sooke on Otter Point Road.

It should be noted that this detour route could also act as an emergency detour for incidents that occur on Highway 14 between Gillespie Road and Drennan Street in Sooke, which would reduce the community disruption of Sooke and the surrounding area, that occurs during those Highway 14 closures.

Option 3A – Sooke Main / Kapoor Main

The northern segments of the detour route would pass through the Shawnigan Station which is a small single family home residential neighbourhood, of about 100 houses, straddling Shawnigan Lake Road south of Shawnigan Lake. The southern segments of Option 3A route travel through the Goldstream neighbourhood in Langford. This neighbourhood is a suburban residential area with some local commercial businesses and potentially could experience severe issues during the detour implementation.

Option 3B – Sooke Main / Boneyard

The northern segments of the detour route would pass through the Shawnigan Station which is a small single family home residential neighbourhood, of about 100 houses, straddling Shawnigan Lake Road south of Shawnigan Lake. The south segment of the detour would pass through a residential community including city parks and commercial lands within the Municipality of Sooke on Otter Point Road.

It should be noted that this detour route could also act as an emergency detour for incidents that occur on Highway 14 between Gillespie Road and Drennan Street in Sooke, which would reduce the community disruption of Sooke and the surrounding area, that occurs during those Highway 14 closures.

Option 4A – Old Highway / Kapoor Main

The northern segments of the detour route would pass through the Shawnigan Station which is a small single family home residential neighbourhood, of about 100 houses, straddling Shawnigan Lake Road south of Shawnigan Lake. The southern segments of Option 4A route travel through the Goldstream neighbourhood in Langford. This neighbourhood is a suburban residential area with some local commercial businesses and potentially could experience severe issues during the detour implementation.

WATER RESOURCES

The primary use for water resources in the project area is for drinking water supply for the Greater Victoria Water Service Area. It is supplied by three watershed areas including the Goldstream Water Supply Area, the Sooke Lake Water Supply Area, and the Leech River Watershed, which combined make up the Greater Victoria Water Supply Area. The first two watershed areas are currently in use for supplying the Japan Gulch Disinfection Facility with water, and the Sooke Lake Water Supply Area also supplies the Sooke River Road Disinfection Facility. The Leech River Watershed area is currently not used for drinking water supply, however there is a tunnel connection to the Sooke Lake Reservoir that would provide capacity for future growth in the region. Altogether, there are twelve municipalities that source their water from the Greater Victoria Water Supply Area.

Important features in the watersheds include the Goldstream River, the Goldstream Lake Reservoir, the Lubbe Lake Reservoir, the Butchart Lake Reservoir, the Sooke Lake Reservoir, the Deception Reservoir, and the Leech River. As these features all connect to the disinfection facilities downstream, they are considered to be highly sensitive to potential contamination. In addition to the three watersheds, there is also a buffer zone surrounding the southwestern portion of the Goldstream Water Supply Area, which prevents public access and development near to the watershed. Additionally, the buffer zone also helps to mitigate the risks of wildfire within the watershed, with monitoring for fire watch including regular aerial monitoring and 24/7 on call fire response crews and equipment. These features can be seen in ***Figure 4.2***, overleaf. A full scale 11x17 version is available in ***Appendix D***.

It should be noted that impacts to water resources can sometimes be mitigated through greenfield construction, watercourse rerouting, or implementation of infrastructure such as oil water storm drain separators, however this would increase the cost for implementation. Additionally, mitigation of wildfire risks within the watershed during an emergency detour route activation would need to be considered, and in extreme fire danger rating periods of the year, mitigations may not be feasible to facilitate an effective detour deployment simultaneously.

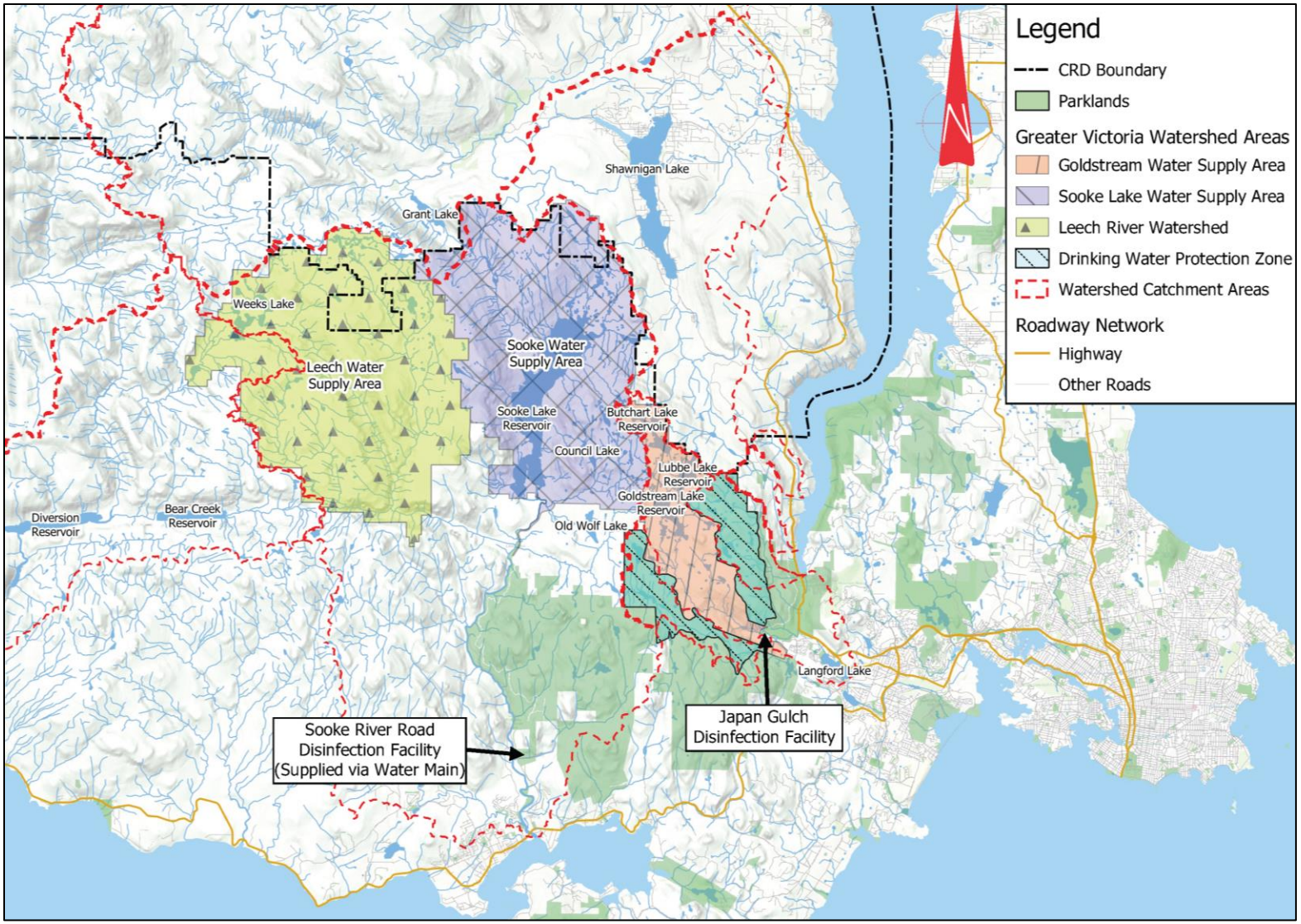

Figure 4.2: Capital Regional District Water Supply Areas Catchment Areas and Water Resource Features

Option 1A – Niagara Main

The Option 1A route travels through the Goldstream Water Supply Area near the southeasternmost tip of the area, for a total distance of approximately one kilometre, close by the Japan Gulch Disinfection Facility. However, the route never passes closer than 350 metres from the outermost boundary of the watershed, and the route is located on the downstream side. After passing through the Goldstream Water Supply Area, the route follows the boundary of the Drinking Water Protection Area for a distance of approximately 5.3 kilometres. As the route is located downstream of the watersheds, the potential for impacts to the watershed and the drinking water supply is considered to be minimal. However, there would be a significant increase in wildfire risk, which is the biggest threat in the water supply area. Additionally, as the route passes in close proximity to the Japan Gulch Disinfection Facility, there would need to be security mitigations / upgrades to ensure the separation of the public from restricted areas of the compound, in order to keep the public a safe distance away from the disinfection chemicals and processes.

Option 1B – Niagara Main in Watershed

The southernmost portion of the Option 1B route follows the same route as Option 1A, however there are additional impacts on the northern portion. From north to south, the route travels through the Sooke Lake Water Supply Area, the Goldstream Water Supply Area, and the Drinking Water Protection area. The route travels within the Sooke Lake Water Supply Area for approximately 5.8 kilometres and the Goldstream Water Supply Area for approximately 7.5 kilometres. While inside the water supply areas, the route passes overtop of several streams and creeks that connect to the Sooke Lake Reservoir and passes within 10 to 15 metres of both the Lubbe Lake Reservoir and the Butchart Lake Reservoir. Finally, before connecting to the same route as Option 1A, Option 1B would travel approximately 3.3 kilometres within the Drinking Water Projection Area. The route would also impact the Japan Gulch Disinfection facility, similar to Option 1A.

Due to the proximity to these reservoirs, which can be seen in ***Figure 4.3*** below, as well as the Japan Gulch Disinfection Facility, the potential for impacts to water resources within the Greater Victoria Water Supply Area if this route is implemented is considered to be very significant.

Figure 4.3: Proximity of Route 1B to Lubbe Lake (Image taken from Inside Vehicle on Route 1B; Lake located beyond trees)

Option 2A – Far West Alignment

Option 2A would pass through a small corner of the designated CRD Leech River Water Supply Area for a total of approximately 4.1 kilometres. However, the route would only include approximately one kilometre in which the route would be within the actual watershed catchment area for the Leech River, with the rest of the distance within the watershed being located downstream. To this end, there is a single mapped watercourse that feeds directly into the Leech River which is anticipated to have the potential for the introduction of contaminants from the route, although it should be noted that some of the watercourse is located outside of the designated Leech River Water Supply Area, meaning that moving the road outside the area may not mitigate the effects. As there is only one mapped watercourse that is an issue, the potential for impacts to the water resources of the Leech River and considered to be mitigatable through other infrastructure.

Option 2B – Far West via Old Renfrew

Option 2B does not pass through any portion of the Greater Victoria Water Supply Area, and thus there a would not be the potential for impacts to water resources.

Option 3A – Sooke Main / Kapoor Main

Option 3A travels through a significant section of the Sooke Lake Water Supply Area as well as through portions of the Goldstream Water Supply Area and the Drinking Water Protection Area. The total distance in which Option 3A travels through the Sooke Lake Water Supply Area is approximately 19.8 kilometres, passing overtop of several watercourses that intersect with either the Sooke Lake Reservoir or the Deception Reservoir. The route alignment bounds the northern, western, and southern edges of the Sooke Lake Reservoir, as well as the western and southern edges of the Deception Reservoir, passing within 40 metres of Sooke Lake and within 30 metres of Deception Reservoir. When adjacent to the southern edge of the Deception Reservoir, the route travels on top of the reservoir dam causeway as shown in ***Figure 4.4*** below. Due to the proximity of the route to the lake, there is considered to be a very significant potential risk of deleterious substances being introduced to the drinking water supply. Redirecting the route away from this dam may be possible, but would result in greenfield construction and another structure to cross the outflow channel. In addition to the reservoir, the route also passes in close proximity to the Japan Gulch Disinfection Facility, which would require security mitigations / upgrades to ensure the separation of the public from restricted areas of the compound.

Figure 4.4: Causeway of Deception Reservoir Dam

In addition to the portion through the Sooke Lake Water Supply Area, Option 3A passes through the Goldstream Water Supply Area for a length of approximately 1.7 kilometres and through the Drinking Water Protection Area for a length of approximately 6.2 kilometres. However, neither of these have issues as significant as those described above for the Sooke Lake Reservoir.

Option 3B – Sooke Main / Boneyard

Option 3B follows a similar route to Option 3A for the most part, but would only be located within the Sooke Lake Water Supply area for a distance of approximately 15.9 kilometres. The route would also not travel over any dam causeway, but would pass within 40 metres of the Sooke Lake Reservoir, and like Option 3A, on several bridges that pass overtop of watercourses that feed the lake. An example of one of these bridges is shown in ***Figure 4.5***.

Figure 4.5: Bridge Structure Overtop of Watercourse that Feeds Sooke Lake Reservoir

Option 4A – Old Highway / Kapoor Main

Option 4A passes through the Sooke Lake Water Supply Area for a distance of approximately 12.9 kilometres. The alignment of the route crosses several watercourses that intersect with the Sooke Lake Reservoir and comes to within a proximity of less than 15 metres from the lake itself. The point at which the route is closest to the lake is shown in ***Figure 4.6*** overleaf. Due to the proximity of the route to the lake, there is considered to be a very significant potential risk of deleterious substances being introduced to the drinking water supply. Additionally, as the route would pass in close proximity to the Japan Gulch Disinfection Facility, there would need to be security mitigations / upgrades to ensure the separation of the public from restricted areas of the compound.

Figure 4.6: Proximity of Leechtown Road to Sooke Lake Reservoir

As Option 4A uses the same exit route as Option 3A, the route also passes through the Goldstream Water Supply Area and the Drinking Water Protection Area at lengths of 1.7 and 6.2 kilometres, respectively.

4.3.3 Engineering

The results of the Option Screening Assessment for the four engineering criteria considered are described in the subsections below.

OPTION LENGTH

The length of the alternative detour routes assist in understanding the potential costs and benefits a route is likely to have. Shorter routes with shorter distances off of existing public roadway will typically have lower capital costs, depending on the general typography. Additionally, routes that are shorter can be expected to have higher travel time savings and can be expected to draw more detour traffic. The lengths of each alternative detour route are shown in ***Table 4.9*** overleaf.

Table 4.9: Lengths of Alternative Detour Routes

TRAVEL SEGMENT	APPROXIMATE OPTION LENGTHS (KM)						
	1A	1B	2A	2B	3A	3B	4A
Non-Hwy 1 Detour Length	20.3	33.9	103.6	116.7	49.7	71.0	49.2
Non-Public Roadway Detour Length	8.2	24.3	57.6	70.5	39.8	32.2	33.0
Additional travel distance on Hwy 1 from Hwy 18 intersection to Shawnigan Lake Rd	36.1	36.1	22.8	22.8	36.1	36.1	36.1
Additional travel distance on Hwy 1 from the end of the detour route to Hwy 1 / Hwy 14 interchange	3.4	3.4	0.0	0.0	3.4	0.0	3.4
Additional travel distance from Shawnigan Lake Rd turnaround point to the detour route	0.0	0.0	5.0	5.0	0.0	0.0	0.0
Total Travel Distance from Hwy 1 / Hwy 18 Intersection to Hwy 1 / Hwy 14 Interchange Via Detour	**59.8**	**73.4**	**126.4**	**139.5**	**89.2**	**107.1**	**88.7**
Total Travel Distance from Hwy 1 / Shawnigan Lake Rd Intersection to Hwy 1 / Hwy 14 Interchange Via Detour	**23.7**	**37.3**	**131.4**	**144.5**	**53.1**	**71.0**	**52.6**

From the table above it can be seen that the shortest route between the seven alternative route options is Option 1A, as this option is located the closest to Highway 1. Option 1A is also the route that uses the least non-existing public roadways in its detour length. Conversely, the longest route is Option 2B, followed closely by Option 2A, both of which circle around the Capital Regional District Protected Watershed areas to the west.

BRIDGE STRUCTURES

Bridge structures on the routes are typically shorter structures with single lane cross sections. Those located within the Capital Regional District Greater Victoria Water Supply Area tend to be more permanent structures with steel girders and concrete bridge decks. Those within Mosaic Forest Management lands tend to be more temporary steel span structures with thinner bridge decks, consisting of a variety of materials including wood, concrete, or metal plates. The number of structures a route has is important to note, as these can significantly increase costs, schedules, and environmental impacts if requiring replacement on opening day or in the future. Those structures that can be utilized but have a limited cross section may pose as capacity constraints where alternating single lane operations may need to take place. Summaries of the observed bridge structures are shown for each route in *Table 4.10* through to *Table 4.16*.

Table 4.10: Bridges on Option 1A

ROADWAY	APPARENT LENGTH	APPARENT WIDTH	REPLACEMENT REQUIRED?
Niagara Main	Short	1 lane	Opening Day
New bridge at Fortis easement	Short	N/A	Opening Day

Table 4.11: Bridges on Option 1B

ROADWAY	APPARENT LENGTH	APPARENT WIDTH	REPLACEMENT REQUIRED?
Niagara Main	Short	1 lane	Opening Day
Niagara Main	Short	1.5 – 2 lanes	Likely
Niagara Main	Short	1 Lane	Yes

Table 4.12: Bridges on Option 2A

ROADWAY	APPARENT LENGTH	APPARENT WIDTH	REPLACEMENT REQUIRED?
Renfrew Road	Short	1 Lane	Future Widening as Needed
Kapoor Mainline	Short	1.5 – 2 Lanes	Future Widening as Needed
Kapoor Mainline	Short	1 Lane	Opening Day
Kapoor Mainline	Short	1 Lane	Opening Day
Kapoor Mainline	Short	1 Lane	Opening Day
West Jordan Main	Short	1 Lane	Future Widening as Needed
West Jordan Main	Medium	1 Lane	Future Widening as Needed
Jordan Main Road	Medium	1 Lane	Future Widening as Needed
Jordan Main Road	Short	1 Lane	Future Widening as Needed
Jordan Main Road	Medium	1.5 – 2 Lanes	Opening Day
Butler Main	Short	1 Lane	Opening Day
Butler Main	Short	1 Lane	Opening Day
Butler Main	Short	1 Lane	Opening Day
Butler Main	Short	1 Lane	Opening Day
Butler Main	Short	1 Lane	Opening Day
Butler Main	Medium	1 Lane	Future Widening as Needed

Table 4.13: Bridges on Option 2B

ROADWAY	APPARENT LENGTH	APPARENT WIDTH	REPLACEMENT REQUIRED?
Renfrew Road	Short	1 Lane	Future Widening as Needed
Kapoor Mainline	Short	1.5 – 2 Lanes	Future Widening as Needed
Kapoor Mainline	Short	1 Lane	Opening Day
Kapoor Mainline	Short	1 Lane	Opening Day
Kapoor Mainline	Short	1 Lane	Opening Day
Old Renfrew Road	Short	1 Lane	Opening Day
Jordan Main Road	Medium	1 Lane	Future Widening as Needed
Jordan Main Road	Short	1 Lane	Future Widening as Needed
Jordan Main Road	Medium	1.5 – 2 Lanes	Opening Day
Butler Main	Short	1 Lane	Opening Day
Butler Main	Short	1 Lane	Opening Day
Butler Main	Short	1 Lane	Opening Day
Butler Main	Short	1 Lane	Opening Day
Butler Main	Short	1 Lane	Opening Day
Butler Main	Medium	1 Lane	Future Widening as Needed

Table 4.14: Bridges on Option 3A

ROADWAY	APPARENT LENGTH	APPARENT WIDTH	REPLACEMENT REQUIRED?
Sooke Main	Short	1.5 – 2 Lanes	Future Widening as Needed
Sooke Main	Short	1.5 – 2 Lanes	Future Widening as Needed
Sooke Main	Short	2 Lanes	Likely Not Required
Sooke Main	Short	1.5 – 2 Lanes	Future Widening as Needed
Sooke Main	Short	1 Lane	Future Widening as Needed
Sooke Main	Short	1.5 – 2 Lanes	Future Widening as Needed
Kapoor Main	Short	1.5 – 2 Lanes	Future Widening as Needed

Table 4.15: Bridges on Option 3B

ROADWAY	APPARENT LENGTH	APPARENT WIDTH	REPLACEMENT REQUIRED?
Sooke Main	Short	1.5 – 2 Lanes	Future Widening as Needed
Sooke Main	Short	1.5 – 2 Lanes	Future Widening as Needed
Sooke Main	Short	2 Lanes	Likely Not Required
Sooke Main	Short	1.5 – 2 Lanes	Future Widening as Needed
Boneyard Main	Long	1 Lane	Opening Day
Boneyard Main	Medium	1 Lane	Opening Day
Butler Main	Medium	1 Lane	Future Widening as Needed

Table 4.16: Bridges on Option 4A

ROADWAY	APPARENT LENGTH	APPARENT WIDTH	REPLACEMENT REQUIRED?
Leechtown Road	Short	1 Lane	Future Widening as Needed
Kapoor Main	Short	1.5 – 2 Lanes	Future Widening as Needed

From the tables above, it can be seen that the shorter routes tend to have fewer structures, with the two longest routes, Options 2A and 2B, have the most identified structures. As these two routes are within Mosaic Forest Management Lands, and the bridges tend to be more temporary structures, there would likely be higher costs associated implementing these routes as emergency detours. As noted above however, some of the bridges do not necessarily need to be replaced for opening day with wider cross sections, provided that adequate barriers are implemented. These bridges would result in single lane alternating traffic conditions, and would act as pinch points.

DESIGN CRITERIA COMPLIANCE

The following section outlines how well the alternative routes will be able to achieve the design criteria noted in Section 3.1.

Option 1A – Niagara Main

The route of Option 1A typically features approximately 1.5 to 2 lane roadway widths, necessitating limited amounts of roadway widening. Typically, the central and northern sections of the route have flatter terrain and a wider cross section. The southern section of the route has a steep grade with steep embankments. Although the cross section

is wide enough for vehicles to pass one another, they would need to slow down to do so safely. As such the southern section would require some widening, which may have some minor impacts to the side slope, particularly where there is a minor laterally constrained section with a rock outcrop. Some typical cross section examples are shown in ***Figure 4.7*** through to ***Figure 4.10***.

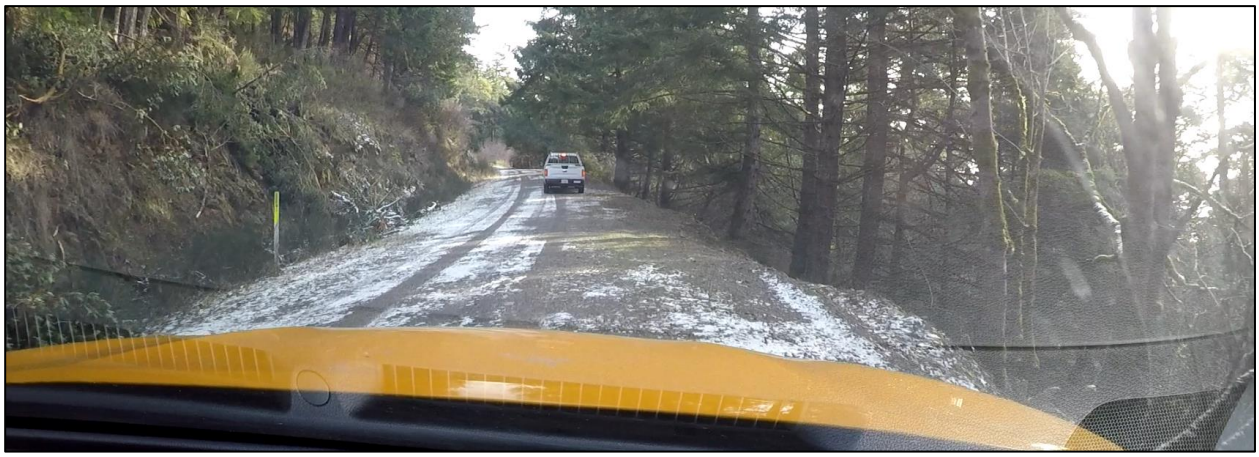

Figure 4.7: Typical Example of Cross Section with Steep Slopes at the Niagara Main South End

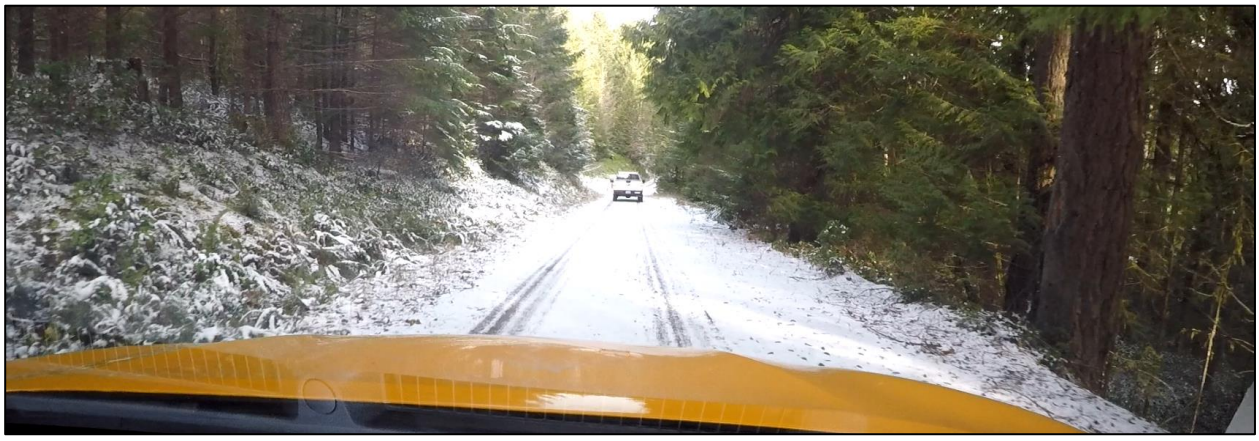

Figure 4.8: Typical Example of Cross Section with Moderate Slopes at the Centre of Niagara Main

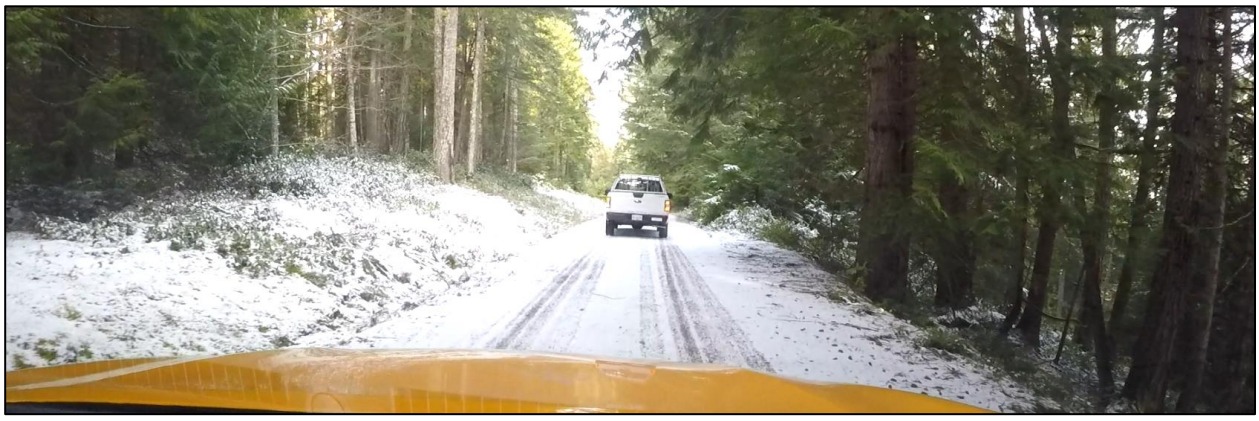

Figure 4.9: Typical Example of Cross Section with Relatively Flat Slopes at the Centre of Niagara Main

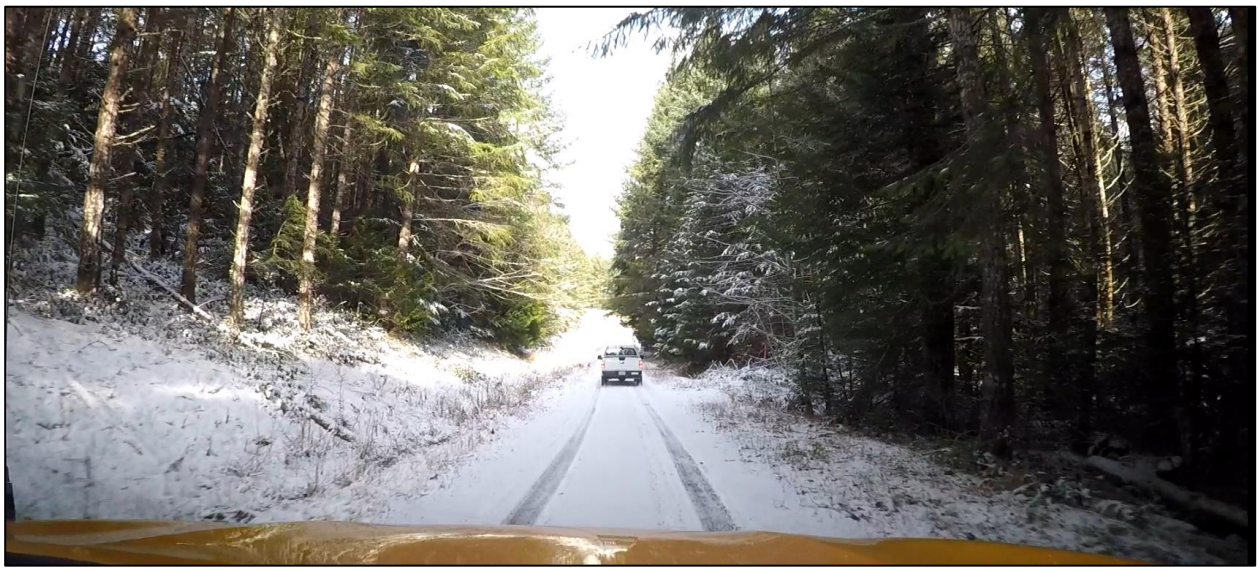

Figure 4.10: Typical Example of Cross Section with Moderate Slopes at the Niagara Main North End

Option 1B – Niagara Main in Watershed

Option 1B follows the same route as Option 1A for a large proportion of its length and has the same issues as discussed above. However, the route also experiences more lateral constraints along its length and features an area of steep grades in which switchbacks are used. An example of a lateral constraint at Butchart Lake Reservoir is shown in ***Figure 4.11*** below. Other more typical cross sections on this route are shown in ***Figure 4.12*** and ***Figure 4.13***. Additionally, as Option 1A and 1B share part of their routing, ***Figures 4.7*** to ***4.10*** are also applicable to Option 1B.

Figure 4.11: Lateral Constraint near Butchart Lake Reservoir

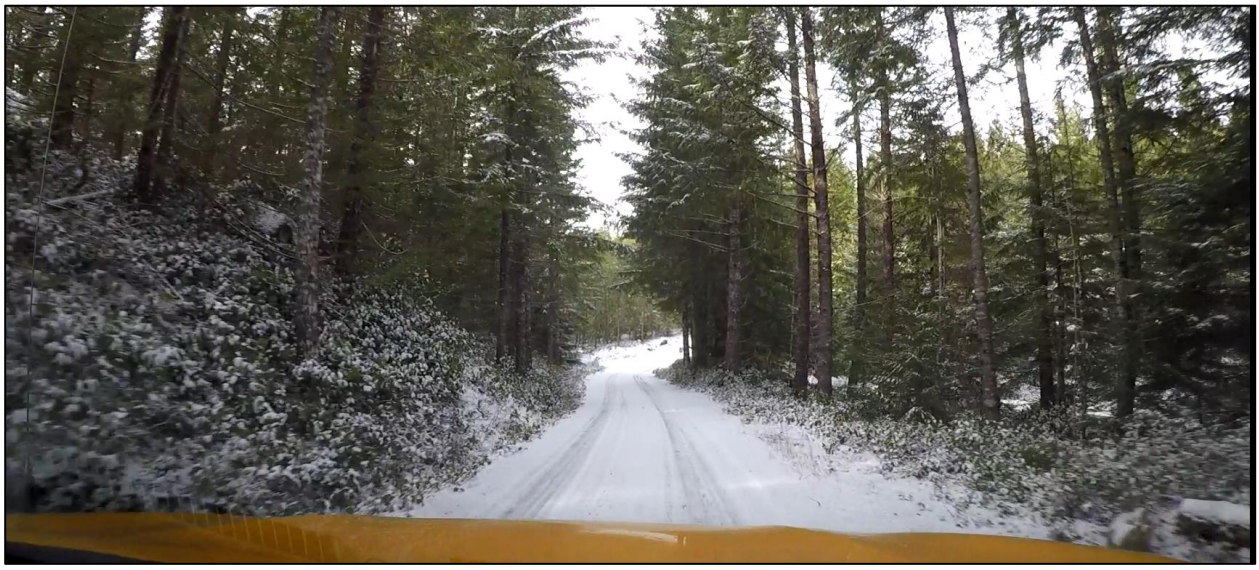

Figure 4.12: Example of Cross Section with Moderate Slopes on Niagara Main inside Watershed

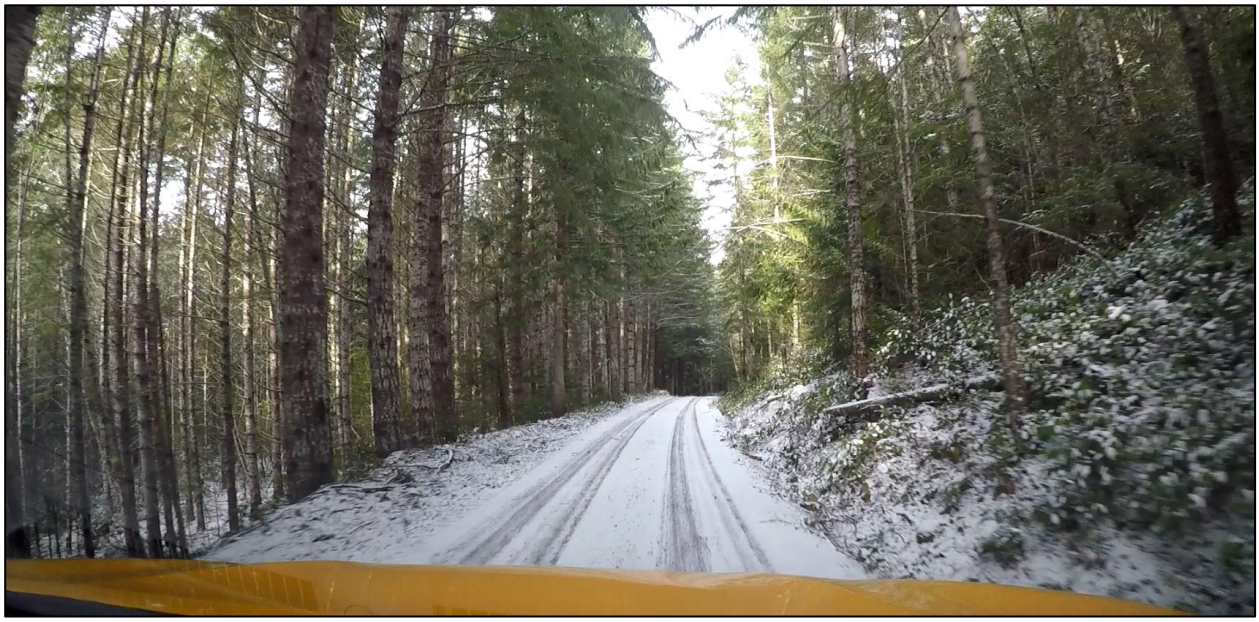

Figure 4.13: Example of Cross Section around Switchback Area of Niagara Main inside Watershed

Option 2A – Far West Alignment

Option 2A has several laterally constrained sections that are located between watercourses and natural slopes. However, these sections are fairly short relative to the overall length of the detour route, being less than 200 metres long. The majority of the route however, is typically on flatter sections of terrain, which would be more easily able to widen to a two-lane cross section. Although there are some sections with steep grades, these tend to be shorter sections. Example photos of these terrain types are shown in ***Figures 4.14*** to ***4.17.***

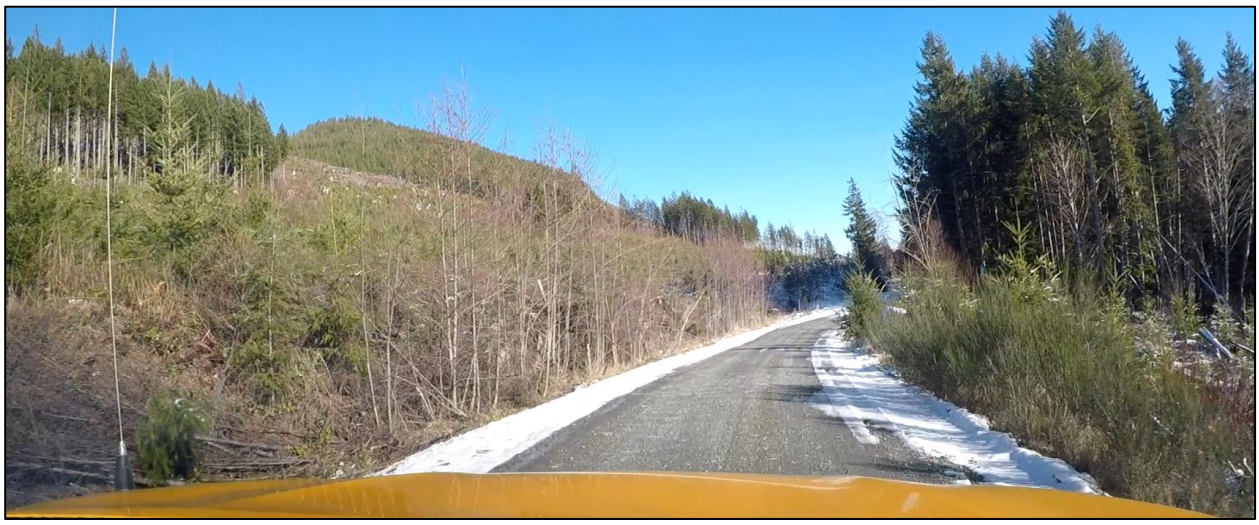

Figure 4.14: Typical Option 2A Cross Section – Flat Slopes, Butler Main

Figure 4.15: Typical Option 2A Cross Section – Moderate Slopes, Butler Main

Figure 4.16: Typical Option 2A Cross Section – Moderate Slopes, West Jordan Main

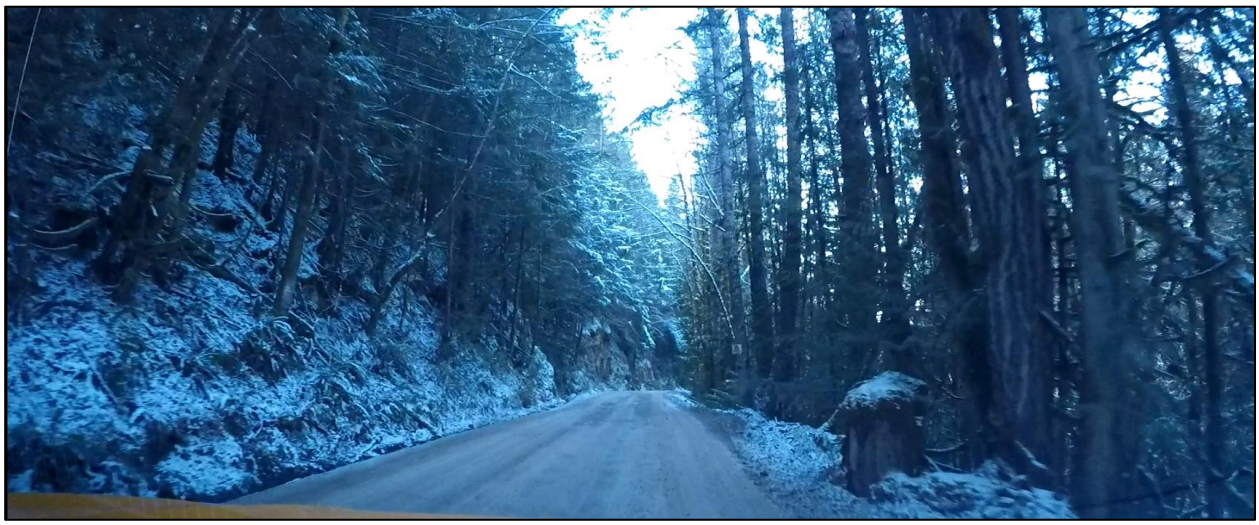

Figure 4.17: Typical Option 2A Cross Section – Steep Slopes, Renfrew Road

Option 2B – Far West via Old Renfrew

Option 2B has at least six laterally constrained sections of roadways that are bounded by rock outcrops and steep embankment slopes. Two examples of these constrained sections are shown in ***Figure 4.18***, through to ***Figure 4.21*** overleaf. The route also features lengthy sections on Williams Main and Old Renfrew Road with steeper grades, where the use of switchbacks is a necessity.

Figure 4.18: Williams Main Pinch Point at between Cliff-face and Steep Slope

Figure 4.19: Williams Main Pinch Point Downslope View

Figure 4.20: Old Renfrew Road Pinch Point between Steep Slope and Cliff-face

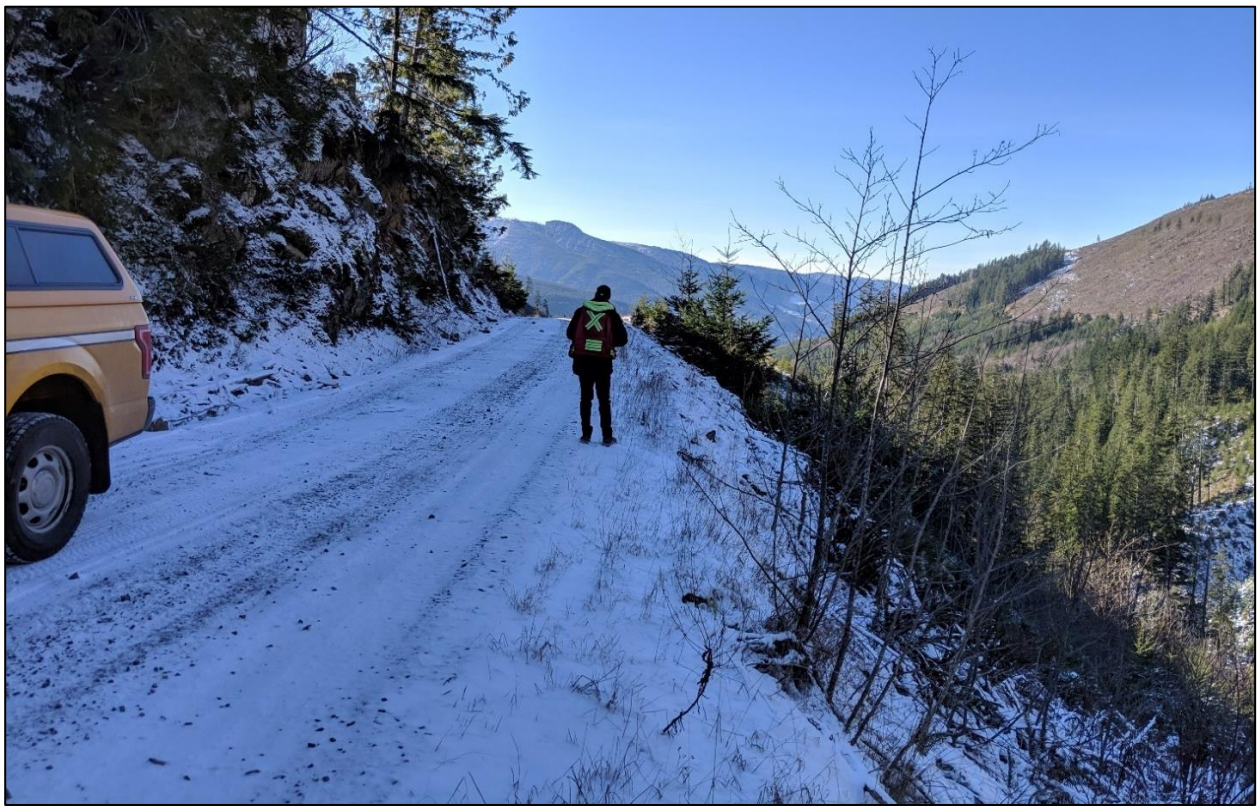

Figure 4.21: Old Renfrew Road Pinch Point between Steep Slope and Cliff-face

Option 3A – Sooke Main / Kapoor Main

Option 3A features some minor areas of lateral constraints, however they are typically smaller in length. The route has some minor slopes on either side that would need to be addressed, however the overall impact required to create a two-lane cross section is considered minimal for the most part. An example of the typical existing cross section are shown in ***Figures 4.22*** to ***4.24*** below.

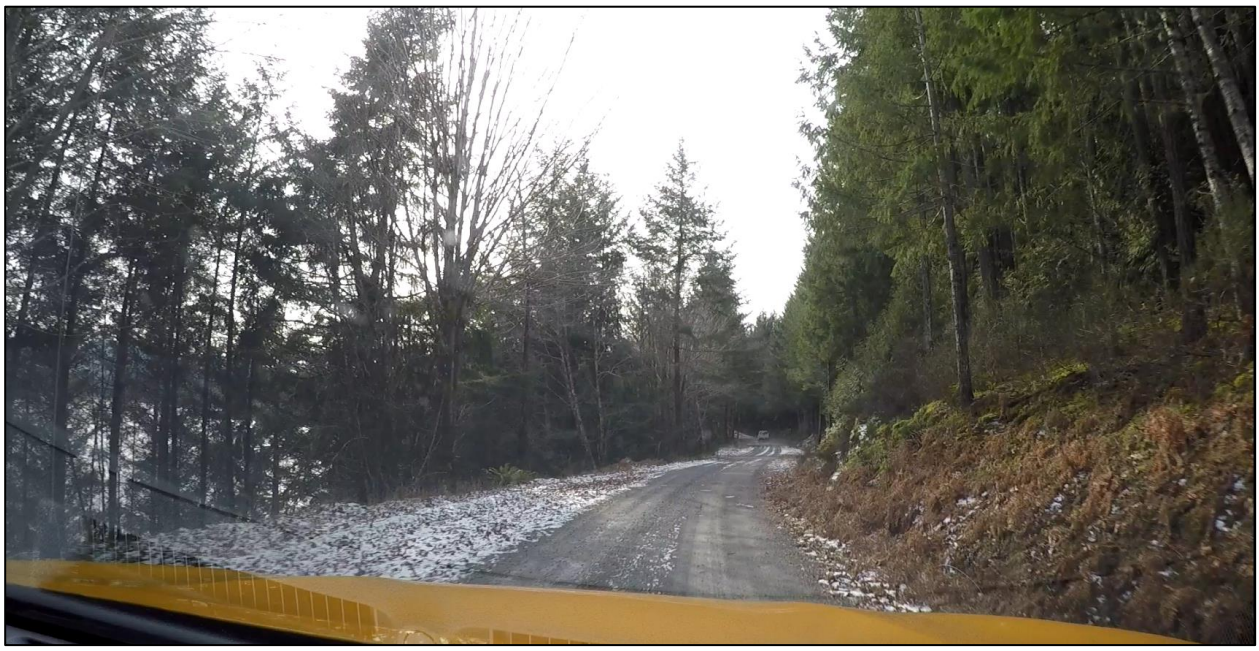

Figure 4.22: Typical Option 3A Cross Section – Sooke Main

Figure 4.23: Typical Option 3A Cross Section – Sooke Main

Figure 4.24: Typical Option 3A Cross Section – Kapoor Main

Option 3B – Sooke Main / Boneyard

The route of Option 3B travels along the Boneyard Main, which is situated alongside the Sooke River. This roadway poses significant challenges to achieving a two-lane cross section due to the significant number of pinch points along its length. The roadway is often squeezed between the Sooke River to the east and rock cliff-faces to the west as can be seen in ***Figure 4.25*** and ***Figure 4.26*** below. Other typical cross sections for the route on Boneyard Main are shown in ***Figure 4.27*** and ***Figure 4.28.*** The segments on Sooke Main are the same as shown in Option 3A.

Figure 4.25: Boneyard Main Pinch Point between Sooke River and Cliff-face

Figure 4.26: Boneyard Main Pinch Point at Boneyard Gate between Sooke River and Cliff-face

Figure 4.27: Typical Option 3B Cross Section – Boneyard Main Easy Terrain

Figure 4.28: Typical Option 3A Cross Section – Boneyard Main Rough Terrain

Option 4A – Old Highway / Kapoor Main

The Option 4A alignment travels along Leechtown Road, which is located adjacent to the Sooke Lake Reservoir. In some locations, the road experiences pinch points when passing between rock cliff-faces on the east and steep slopes down to Sooke Lake to the west. The most severe pinch point is shown in ***Figure 4.29*** below. Other typical cross section examples are shown in ***Figures 4.30*** and ***4.31.***

Figure 4.29: Leechtown Road Pinch Point between Sooke Lake Reservoir and Cliff-face

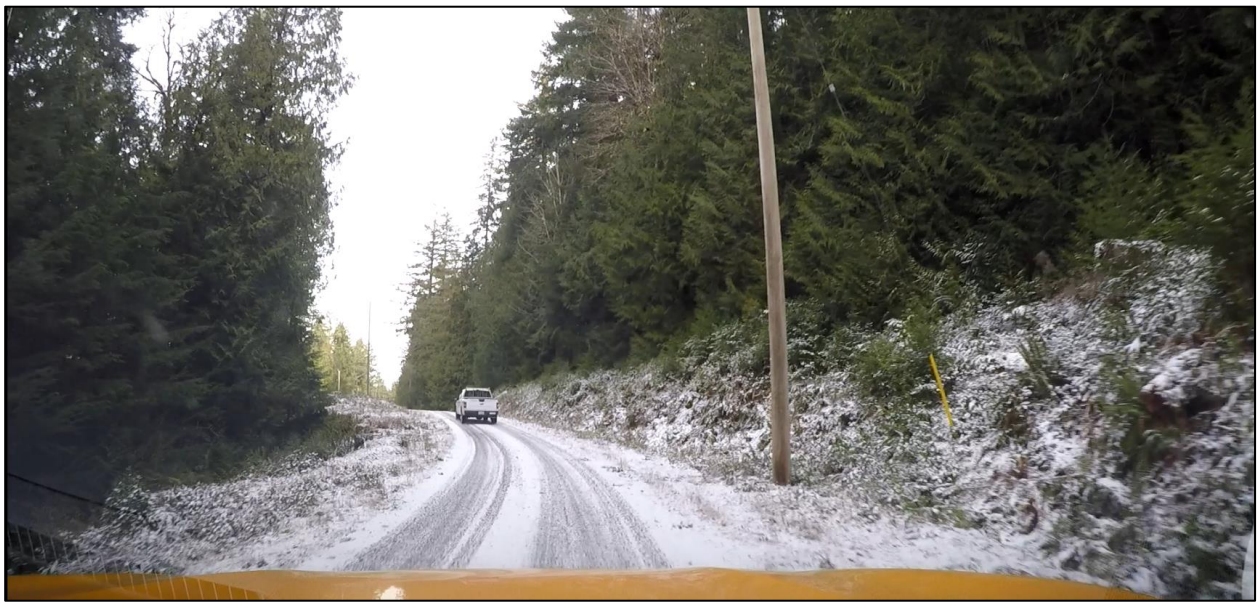

Figure 4.30: Typical Option 4A Cross Section – Leechtown Road

Figure 4.31: Typical Option 4A Cross Section – Leechtown Road

ALIGNMENT CONSIDERATIONS

This criteria outlines the variability of the options in terms of the straightness of the roadways and the steadiness of the change in elevation.

Option 1A – Niagara Main

Option 1A is primarily straight and cases of elevation changes occur over long segments of roadway. The southern portion of the route does experience a steep grade and has some curves with turning radii under 50 metres. Overall, the route typically follows the existing topography and does not feature excessively rolling terrain that would result in a high variability of elevation, as can be seen in ***Figure 4.32*** below. There are some minor hills that would affect variability, but these tend to be singular instances.

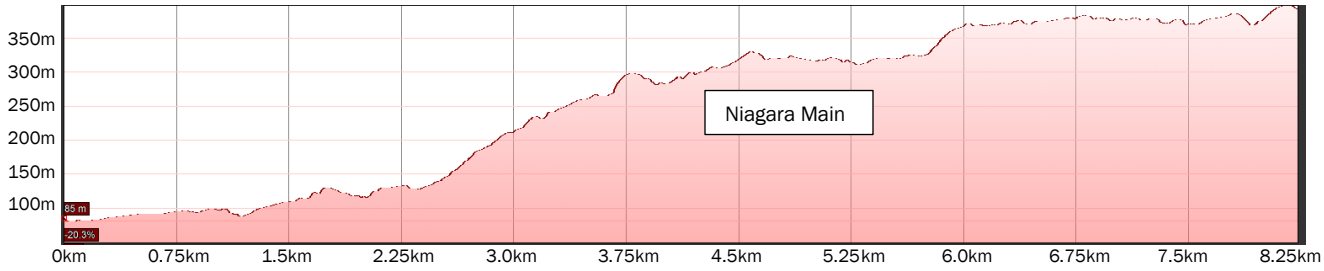

Figure 4.32: Google Earth Elevation Profile of Option 1A (Northern end on the Right)

Option 1B – Niagara Main in Watershed

While travelling through the Goldstream Water Supply Area, Option 2B features more variability in its horizontal alignment relative to Option 1A. There are multiple areas in which there are alternating curves as well as an area steep enough to warrant the usage of switchbacks. However, the variability in elevation changes is typically low, with more steady changes in elevation although there are some notable singular hills as can be seen in ***Figure 4.33*** below.

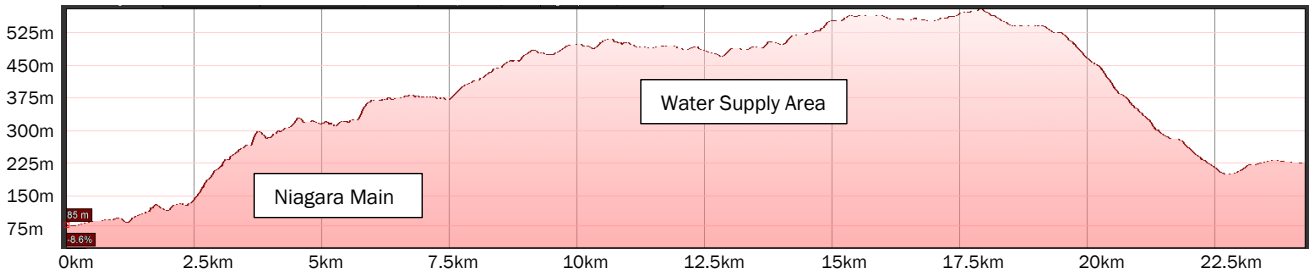

Figure 4.33: Google Earth Elevation Profile of Option 1B (Northern end on the Right)

Option 2A – Far West Alignment

Option 2A typically longer straighter sections of roadway. However, there are some hairpin turns along the route in which minimal turning radii are utilized. In addition, the West Jordan Main features some sections with higher frequencies of alternating horizontal curves as the roadway follows the topography. The elevation changes typically take place over longer sections of roadway with relatively consistent grading, although there is some variability throughout the route, as can be seen in ***Figure 4.34*** overleaf.

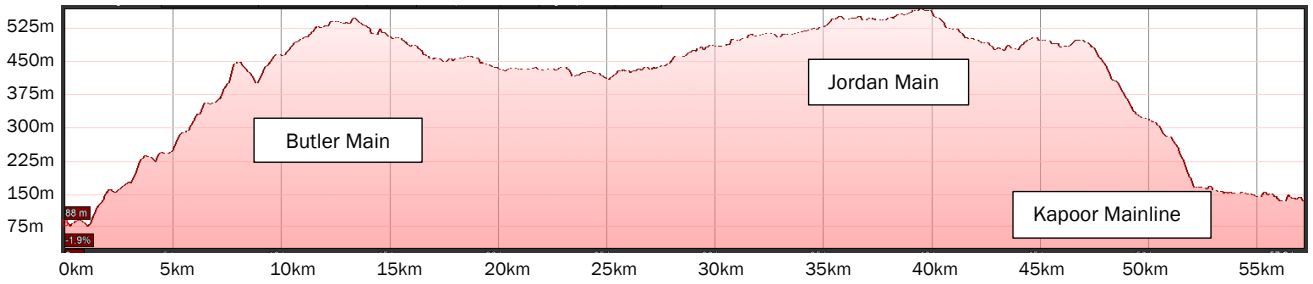

Figure 4.34: Google Earth Elevation Profile of Option 2A (Northern end on the Right)

Option 2B – Far West via Old Renfrew

Option 2B features a significant number of horizontal hairpin curves on the Old Renfrew Road and Williams Main where switchbacks are used to gain elevation. Many of the turns have limited turning radii. These two roads have relatively consistent grading however, with there being only some variability in grading on the Kapoor Mainline and the Butler Main, as seen in ***Figure 4.35*** below.

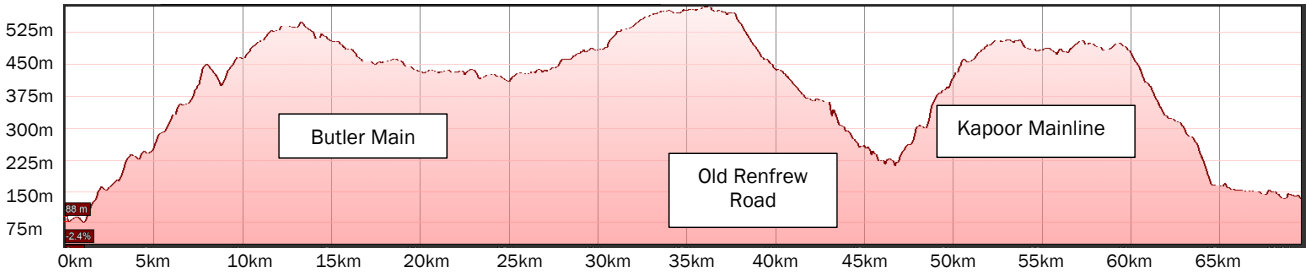

Figure 4.35: Google Earth Elevation Profile of Option 2B (Northern end on the Right)

Option 3A – Sooke Main / Kapoor Main

Option 3A experiences some frequent changes in horizontal alignment while on the Kapoor Main, some of which feature tight hairpin turns where long switchbacks are used. The Sooke Main also features multiple horizontal alignment changes with frequent curves. As can be seen in ***Figure 4.36*** some sections of Sooke Main and the southern end of the Kapoor Main feature rolling terrain, with frequently changing grades.

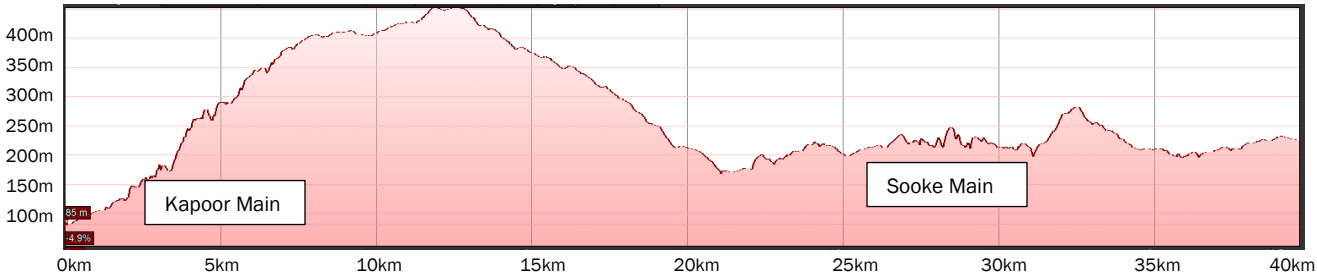

Figure 4.36: Google Earth Elevation Profile of Option 3A (Northern end on the Right)

Option 3B – Sooke Main / Boneyard

Option 3B experiences some frequent changes in horizontal alignment while on the Kapoor Main, some of which feature tight hairpin turns where long switchbacks are used. The Sooke Main also features multiple horizontal alignment changes with frequent curves. As can be seen in ***Figure 4.37*** some sections of Sooke Main and the Boneyard Main feature rolling terrain, with frequently changing grades.

Figure 4.37: Google Earth Elevation Profile of Option 3B (Northern end on the Right)

Option 4A – Old Highway / Kapoor Main

Option 4A, as with Option 3A, experiences some frequent changes in horizontal alignment while on the Kapoor Main, some of which feature tight hairpin turns where long switchbacks are used. The Leechtown Road portion also features two small sections, each less than a kilometre long, that feature frequent roadway curves with some tight turning radii. As can be seen in ***Figure 4.38*** the Leechtown Road and the southern end of the Kapoor Main feature rolling terrain, with frequently changing grades.

Figure 4.38: Google Earth Elevation Profile of Option 4A (Northern end on the Right)

GEOTECHNICAL CONCERNS

A high-level screening evaluation was carried out for each option based on geotechnical engineering constraints identified during site visits on the potential routes. Constraints include evidence of unstable terrain, significant rock/soil cut requirements, existing over-steepened embankments, and existing water crossings that may require new or upgraded structures. The following table summarizes the identified geotechnical engineering constraints and the anticipated risk and complexity of each option alignment.

Option 1A – Niagara Main

The Option 1A route is noted to have several minor geotechnical constraint and hazards. There is one section, approximately 10 to 20 metres in length, that is laterally constrained by a rock outcrop and which may require rock excavation to provide a two-lane cross section. The southern section of the route near the Japan Gulch Reservoir

was noted to have an existing cut slope with steep graded embankments. This cut slope may require geotechnical review if required to accommodate roadway improvements. Additionally, the route was observed to cross and be located adjacent to a FortisBC gas line, which may require a geotechnical review to identify potential impacts to the line and any required upgrades.

In general, the identified geotechnical or geohazard constraints for Option 1A are few or non-existent. Where identified, geotechnical constraints are generally considered to be routine and of low complexity.

Option 1B – Niagara Main in Watershed

The Option 1B route is noted to have several minor geotechnical constraint and hazards. There are at least seven sections of the route that were observed to be laterally constrained. Five of them are laterally constrained by bedrock outcrops each approximately 10 to 20 metres in length, that may require rock excavation to provide a two-lane cross section. Another section is approximately 150 metres in length and is constrained by Butchart Lake and a steep slope, which may require excavation into the slope to provide a two-lane cross section. The last section is approximately 50 to 100 metres in length and was observed to have both a steep grade and steep embankments, that may require a geotechnical review to assess the embankments to determine what is necessary to accommodate roadway improvements.

As Option 1B follows a similar route to Option 1, the route also crosses and is located adjacent to a FortisBC gas line, and an existing cut slope with steep embankments near the Japan Gulch Reservoir.

In general, Option 1B has some geotechnical or geohazard constraints of limited complexity to be assessed and managed.

Option 2A – Far West Alignment

Option 2A was observed to have at least six laterally constrained sections. Four of these are minor, consisting of 10 to 20-metre-long sections of bedrock outcrops that may require rock excavation. The other two sections are constrained by water features on one side and natural slopes on the other. To accommodate a two-lane cross section in these areas, excavation into the slope is likely to be required, however there no were no observed occurrences of rock outcrops. The areas include an approximately 180-metre-long section constrained by Butler Lake and an approximately 100-metre-long section constrained by a creek.

In general, Option 2A has a few geotechnical or geohazard constraints of limited complexity to be assessed and managed.

Option 2B – Far West via Old Renfrew

Option 2B was observed to have at least seven laterally constrained sections. Six of these consisted of 10 to 20-metre-long sections of rock outcrops that may require rock excavation to provide a two-lane cross section. The last section is the 180-metre-long section near Butler Lake which is constrained by the lake itself and a natural slope, which would require excavation into the slope. Additionally, a small section of the route was observed to be flooded by an intersecting creek, likely due to an obstruction in the culvert. Surface water management would be required in this section.

In general, Option 2B has some geotechnical or geohazard constraints of limited complexity to be assessed and managed.

Option 3A – Sooke Main / Kapoor Main

Option 3A was noted to traverse the Deception Dam and spillway and travel adjacent to the Sooke Dam and spillway. The potential for impacts to these existing structures would likely require a geotechnical review to identify potential risks and upgrades. Additionally, there were two other sections that have geotechnical hazards and constraints. The first is a narrow section of roadway with an in place retaining wall. The retaining wall could require replacement of upgrading to accommodate a wider roadway cross section. The second is a sections that has a steep cut slope and embankment, as well as a retaining wall supporting a small portion of the section. The embankment is noted to show some signs of slope movement, a geotechnical review may be required in order to assess the stability of the slope. The slope in question is shown below in ***Figure 4.39***.

Figure 4.39: Area of Slope

In general, Option 3A has some geotechnical or geohazard constraints of limited complexity to be assessed and managed.

Option 3B – Sooke Main / Boneyard

Option 3B is noted to travel through a steep-walled canyon while travelling alongside the Sooke River. The canyon is constrained by extensive bedrock exposure and steep terrain. The geotechnical complexity of the canyon section is considered to be high. Additionally, there are two noted sections with lateral constraints consisting of waterbodies and natural slopes. These include a 250-metre section at Lake Macdonald, and a 280-metre section by Boneyard Lake. in both cases, excavation into the slopes may be required.

In general, Option 3B has complex or difficult geotechnical / geohazard constraints.

Option 4A – Old Highway / Kapoor Main

As Option 4A also uses the Kapoor Main similar to Option 3A, the route has the same two geotechnical hazards in relation to the slope stability and potential for retaining wall replacement. In addition, Option 4A is also noted to have an approximately 250 metre section on Leechtown Road that is laterally constrained by steep embankments and a steep upper slope. Excavation into the slope may be required to provide a two-lane cross section.

In general, Option 4A has some geotechnical or geohazard constraints of limited complexity to be assessed and managed.

4.3.4 Capital Cost

The capital costs associated with a route will primarily be predicated on the length and cross section requirements of a route. Other special requirements would include protection of water resources, replacement of bridge structures, and more intensive / complex excavation or embankment construction requirements including rock bluff excavations, that are necessary due to pinch points resulting from topographical lateral constraints. At the screening stage no quantified costs will be developed, however a qualitative ranking will be given to help assess the likely magnitude of costs. The rankings and the rationale for the rankings are summarized in ***Table 4.17*** below.

Table 4.17: Qualitative Capital Cost Rankings

OPTION	RELEVANT ATTRIBUTES FOR CAPITAL COSTS	QUALITATIVE MAGNITUDE
1A	• 8.2 kilometres of existing roadway to upgrade; • 0.6 Kilometres of new roadway to construct; • 2 short bridges to construct / upgrade / replace; • CRD maintenance vehicles require accommodation during construction; • Few lateral constraints or geotechnical challenges.	$$
1B	• 24.3 kilometres of existing roadway to upgrade; • 3 short bridges to upgrade / replace; • CRD maintenance vehicles require accommodation during construction; • Some lateral constraints and geotechnical challenges.	$$$
2A	• 57.6 kilometres of existing roadway to upgrade; • 12 short bridge and 4 medium length bridges to upgrade / replace; • Logging vehicles require accommodation during construction; • Some lateral constraints and geotechnical challenges.	$$$$
2B	• 70.5 kilometres of existing roadway to upgrade; • 12 short bridge and 3 medium length bridges to upgrade / replace; • Logging vehicles require accommodation during construction; • Some lateral constraints and geotechnical challenges.	$$$$$
3A	• 39.8 kilometres of existing roadway to upgrade; • 6 short bridges to upgrade / replace; • Logging and CRD maintenance vehicles require accommodation during construction; • Some lateral constraints, geohazards, and geotechnical challenges.	$$$

OPTION	RELEVANT ATTRIBUTES FOR CAPITAL COSTS	QUALITATIVE MAGNITUDE
3B	• 32.2 kilometres of existing roadway to upgrade • 3 short, 2 medium length, and 1 long bridge to upgrade / replace; • Logging and CRD maintenance vehicles require accommodation during construction; • Significant geotechnical challenges associated with the Sooke River canyon.	$$$$$
4A	• 33.0 kilometres of existing roadway to upgrade; • 2 short bridges to replace; • Logging and CRD maintenance vehicles require accommodation during construction; • Some lateral constraints, geohazards, and geotechnical challenges.	$$$

4.4 Option Screening Summary

A summary of the screening criteria evaluations for each option is shown in ***Table 4.18***, overleaf. At the bottom of the table the outcome of the screening process is given along with the rationale behind the decision.

Table 4.18: Option Screening Summary and Outcome

CATEGORY	CRITERIA	OPTIONS						
		OPTION 1A	OPTION 1B	OPTION 2A	OPTION 2B	OPTION 3A	OPTION 3B	OPTION 4A
		NIAGARA MAIN	NIAGARA MAIN IN WATERSHED	FAR WEST ALIGNMENT	FAR WEST VIA OLD RENFREW	SOOKE MAIN / KAPOOR MAIN	SOOKE MAIN / BONEYARD	OLD HIGHWAY / KAPOOR MAIN
Environmental	Species at Risk Impacts	Potential impacts to: • 9 Wildlife Species; • 5 Critical Habit Parcels; • 1 Plant / Fungus Species; • 2 Ecosystems.	Potential impacts to: • 9 Wildlife Species; • 6 Critical Habit Parcels; • 2 Plant / Fungus Species; • 2 Ecosystems.	Potential impacts to: • 10 Wildlife Species; • 21 Critical Habit Parcels; • 12 Plant / Fungus Species; • 3 Ecosystems.	Potential impacts to: • 9 Wildlife Species; • 20 Critical Habit Parcels; • 12 Plant / Fungus Species; • 3 Ecosystems.	Potential impacts to: • 9 Wildlife Species; • 7 Critical Habit Parcels; • 2 Plant / Fungus Species; • 2 Ecosystems.	Potential impacts to: • 9 Wildlife Species; • 15 Critical Habit Parcels; • 8 Plant / Fungus Species; • 2 Ecosystems at Risk.	Potential impacts to: • 8 Wildlife Species; • 5 Critical Habit Parcels; • 2 Plant / Fungus Species; • 2 Ecosystems.
	Protected Areas Impacts	• 1 Provincial Park; • 1 Regional Park.	• 1 Provincial Park; • 1 Regional Park.	• 1 Provincial Park; • 4 Regional Parks.	• 1 Provincial Park; • 4 Regional Parks.	• 1 Provincial Park; • 1 Regional Park.	• 6 Regional Parks.	• 1 Provincial Park; • 1 Regional Park.
	Designated Sensitive Habitat Impacts	No anticipated impacts.	No anticipated impacts.	Potential impacts to 1 Old Growth Management Area.	Potential impacts to 1 Old Growth Management Area.	No anticipated impacts.	No anticipated impacts.	No anticipated impacts.
	Stream, Lake, Marine / Shoreline, and Wetland Aquatic Habitat Features Impacts	Potential interactions: • 29 Stream; • 1 Lake / Shoreline; • 6 Wetland.	Potential interactions: • 47 Stream; • 2 Lake / Shoreline; • 33 Wetland.	Potential interactions: • 307 Stream; • 18 Lake / Shoreline; • 10 Wetland.	Potential interactions: • 330 Stream; • 18 Lake / Shoreline; • 8 Wetland.	Potential interactions: • 69 Stream; • 7 Lake / Shoreline; • 33 Wetland.	Potential interactions: • 157 Stream; • 11 Lake / Shoreline; • 27 Wetland.	Potential interactions: • 51 Stream; • 5 Lake / Shoreline; • 14 Wetland.
	Registered Archaeological and Historical Sites Impacts	Insufficient data to determine potential impacts.	Insufficient data to determine potential impacts.	Potential impacts to: • 12 Archaeological sites; • 2 Historical sites.	Potential impacts to: • 12 Archaeological sites; • 2 Historical sites.	Insufficient data to determine potential impacts.	Insufficient data to determine potential impacts.	Insufficient data to determine potential impacts.
Socio-Community	Property Impacts	Potential impacts to the Sooke Hills Wilderness Regional Park. Moderate impacts when connecting to Goldstream Heights Drive.	Potential impacts to the Sooke Hills Wilderness Regional Park, however, overall mild impacts anticipated.	Severe impacts to Mosaic Forest Management properties.	Severe impacts to Mosaic Forest Management properties.	Mild potential impacts to the Sooke Hills Wilderness Regional Park.	Severe impacts to Mosaic Forest Management properties.	Mild potential impacts to the Sooke Hills Wilderness Regional Park.
	Community Disruption	Potential impacts to the Goldstream Heights rural residential area and Goldstream neighbourhood in Langford.	Potential impacts to the Shawnigan Station and Goldstream residential neighbourhoods	Potential impacts to the Shawnigan Lake Village area, and Shawnigan Station residential neighbourhood and Village of Sooke. The route could also act as a emergency detour for incidents on Highway 14.	Potential impacts to the Shawnigan Lake Village area, Shawnigan Station residential neighbourhood and Village of Sooke. The route could also act as a emergency detour for incidents on Highway 14.	Potential impacts to the Shawnigan Station and Goldstream residential neighbourhoods.	Potential impacts to the Shawnigan Station and the Village of Sooke. The route could also act as a emergency detour for incidents on Highway 14.	Potential impacts to the Shawnigan Station and Goldstream residential neighbourhoods.
	Water Resource Impacts	Located directly on the edge of the Drinking Water Protection Zone, likely no impacts to drinking water supply, but would increase wildfire risks. Would require security upgrades to the Japan Gulch Disinfection Facility.	Located directly on the edge of the Drinking Water Protection Zone, passes through the Goldstream and Sooke Water Supply Areas and directly adjacent to Lubbe Lake and Butchart Lake, and would increase wildfire risks. Would require security upgrades to the Japan Gulch Disinfection Facility.	Passes by an edge of the Leech River Watershed and overtop of one stream that connects downstream to the Leech River. Impacts to potential future drinking water supply could be mitigated.	No anticipated water resource impacts.	Passes through the Sooke and Goldstream Water Supply Areas as well as the Drinking Water Protection Zone. Is adjacent to the Sooke Reservoir with a minimum distance of 30 metres separation. Would require security upgrades to the Japan Gulch Disinfection Facility.	Passes through the Sooke Water Supply Area and is located adjacent to the Sooke Reservoir with a minimum distance of 30 metres separation.	Passes through the Sooke and Goldstream Water Supply Areas as well as the Drinking Water Protection Zone. Is adjacent to the Sooke Reservoir with a minimum distance of 15-20 metres separation. Would require security upgrades to the Japan Gulch Disinfection Facility.

CATEGORY	CRITERIA	OPTIONS						
		OPTION 1A	OPTION 1B	OPTION 2A	OPTION 2B	OPTION 3A	OPTION 3B	OPTION 4A
		NIAGARA MAIN	NIAGARA MAIN IN WATERSHED	FAR WEST ALIGNMENT	FAR WEST VIA OLD RENFREW	SOOKE MAIN / KAPOOR MAIN	SOOKE MAIN / BONEYARD	OLD HIGHWAY / KAPOOR MAIN
Engineering	Option Length	20.3 km total 8.2 km non-public roadway	33.9 km total 24.3 km non-public roadway	103.6 km total 57.6 km non-public roadway	116.7 km total 70.5 km non-public roadway	49.7 km total 39.8 km non-public roadway	71.0 km total 32.2 km non-public roadway	42.9 km total 33.0 km non-public roadway
	Bridges	2 short bridges likely requiring construction / replacement / upgrading.	3 short bridges likely requiring replacement / upgrading.	12 short bridges and 4 medium sized bridges likely requiring replacement / upgrading.	12 short bridges and 3 medium sized bridges likely requiring replacement / upgrading.	6 short bridges likely requiring replacement / upgrading.	5 short bridges, 2 medium bridges, and 1 long bridge likely requiring replacement / upgrading.	2 short bridges likely requiring replacement / upgrading.
	Design Criteria Compliance	Relatively flat terrain, limited lateral constraints, steep section near the southern end.	Steep section near southern end and within Goldstream Water Supply Area where switchbacks are used. Some laterally constrained sections.	Some laterally constrained sections less than 200 metres long. Sections of steep grades are typically short.	Several laterally constrained sections on Old Renfrew Road and Williams Main where steep grade and switchbacks are utilized.	Some minor areas of lateral constraints, however majority of route is on more open terrain.	Severely laterally constrained on the Boneyard Main where rock canyon faces on one side and a very steep slope into the Sooke River.	Some laterally constrained sections on Leechtown Road and Kapoor Main.
	Alignment Considerations	Primarily straight with consistent, if steep, grading.	Sections within the Goldstream Water Supply area feature variable grading and frequent back to back curves with some tight turning radii.	Typically, straighter consistently graded sections of road, although some sections of West Jordan Main feature higher frequencies of curves.	Section of the route on Old Renfrew Road and Williams Main feature frequent switchbacks with tight hairpin turns.	Frequent horizontal curves on Kapoor Main and some sections of Sooke Main. Sooke Main has variable grading. Kapoor Main has some tight turning radii.	Frequent horizontal curves on Kapoor Main and some sections of Sooke Main. Sooke Main and Boneyard Main feature variable grading.	Frequent horizontal curves on Kapoor Main and some sections of Leechtown Road, both of which have some tight turning radii. Leechtown Road is quite variable with grading.
	Geotechnical	Few or non-existent geotechnical or geohazard constraints, although a review may be necessary due to an adjacent FortisBC gas line.	Some geotechnical or geohazard constraints of limited complexity required to be assessed and managed, and a review may be necessary due to an adjacent FortisBC gas line.	Some geotechnical or geohazard constraints of limited complexity required to be assessed and managed.	Some geotechnical or geohazard constraints of limited complexity required to be assessed and managed.	Some geotechnical or geohazard constraints of limited complexity required to be assessed and managed.	Geotechnical and geohazard constraints are complex and difficult to overcome.	Some geotechnical or geohazard constraints of limited complexity required to be assessed and managed.
Capital Cost	Relative Capital Cost	$$	$$$	$$$$	$$$$$	$$$	$$$$$	$$$
	Screening Outcome	**Retained**	**Screened Out**	**Retained**	**Screened Out**	**Screened Out**	**Screened Out**	**Screened Out**
	Rationale	This option was retained for subsequent evaluation as it is the shortest detour route with potentially little required infrastructure and likely minimal direct impacts to drinking water supply.	This option was screened out from further consideration due to the proximity of the route to open water bodies within the Goldstream Water Supply area which could have significant detrimental impacts to the drinking water supply. Additionally, there would be more constrained and steeper roadway sections and geotechnical constraints in comparison with Option 1A.	This option was retained for subsequent evaluation as the route features few significant engineering challenges, mitigatable impacts to drinking water supply, and could be made into a public roadway. Additionally, is one of the three routes that would also act as an emergency detour route for Highway 14.	This option was screened out from further consideration due to the limited incremental utility the route would achieve in comparison to Option 2A.	This option was screened out from further consideration as the proximity of the route to the Sooke Lake Reservoir could have significant detrimental impacts to the drinking water supply.	This option was screened out from further consideration as the extreme lateral constraint of the route near the Boneyard Main gate would make widening of the route prohibitively expensive for a short segment.	This option was screened out from further consideration as the extreme proximity of the route to the Sooke Lake Reservoir could have significant detrimental impacts to the drinking water supply.

5. Option Evaluation

5.1 Option Evaluation Framework

The more detailed option evaluation process involved the application of a comprehensive evaluation framework for the retained emergency detour route options. In this section, the proposed evaluation framework is introduced and then followed by a description of the option evaluation for the emergency detour route options.

In order to compare and contrast the relative merits and drawbacks of each option, a set of high-level evaluation criteria was developed based on the Multiple Account Evaluation methodology typically used for MoTI planning studies. For this study, the following accounts are proposed:

- Customer Service;
- Socio-Community;
- Environmental; and
- Financial.

As shown in ***Figure 5.1***, the Economic Development Account was not utilized for this study. As the accounts have not been assigned specific weightings, each account is in essence weighted equally.

Figure 5.1: Multiple Account Evaluation – Accounts and Criteria

The proposed criteria under each account are a combination of quantitative and qualitative indicators that have been selected to provide sufficient comparative information that will assist in determining a preferred option. It is noted that for each criterion, the comparison of the option is relative to a base case which comprises a "do nothing" scenario. For this study, the base case would have traffic continuing to be diverted to the existing Pacific Marine Circle Route which connects Highway 18 in Lake Cowichan to Highway 14 in Port Renfrew and southwards through Sooke and Langford. The qualitative evaluation is used when specific measurements cannot readily be made, but there are obvious benefits or impacts as compared to the base case. These qualitative evaluations are more prominent in the Socio-Community, and Environmental Accounts. To evaluate qualitative scoring consistently, a five-level rating system was applied as shown in ***Table 5.1***.

Table 5.1: Qualitative Scoring Format

SCORE	MEANING
○	Significantly Worse
◔	Somewhat Worse
◑	Similar to Base Case / Neutral
◕	Somewhat Better
●	Significantly Better

The descriptions in the subsections below include a summary of the criterion characteristics and rationale, as well as a range of evaluation output. For consistency with business case development, a 25-year analysis period has been assumed for the applicable quantitative related criteria. For those criteria that are reported in monetized values, the values have been brought back to Present Value (PV) 2019$ for comparison purposes using a six percent annual discount rate.

The level of detail that was considered within each criterion in the option evaluation framework is related to the level of development of the options being considered. Options being considered have been developed to a single-line sketch level of detail, with horizontal alignments, vertical profiles, and several typical cross-sections for homogeneous segments.

5.1.1 Customer Service Account

The Customer Service Account considers traffic mobility and travel time savings. Documentation of the analysis methodology and related assumptions and other inputs will be included in the evaluation section.

TRAFFIC MOBILITY

Based upon the overall travel speed of routes, determinable through the overall design speeds of most roadways, an assessment of the level of mobility provided by each detour route will be conducted for a vehicle travelling to / from Duncan from / to Langford.

Evaluation Output:

This quantitative assessment will take into consideration the Route Travel Time (end to end of corridor).

TRAVEL TIME SAVINGS

Using the route travel times, an assessment of the impact on network travel times will be conducted in comparison to the base case in the form of generalized cost savings based upon several sensitivity scenarios on the proportion of Highway 1 traffic that would use the detour route.

Evaluation Output:

> *This quantitative assessment will compare the network travel time for several sensitivity scenarios of traffic directly impacted by the option, compared with the base case. The method will establish comparative travel times and monetization for each option. The results will be presented in vehicle hours travelled and monetized using BC MoTI value of travel time to form generalized cost savings. (Present Value over 25-years).*

5.1.2 Socio-Community Account

The Socio-Community Account considers property impacts, noise impacts, visual impacts, impacts to water resources, and community disruption impacts. Where possible, the impacts will be quantified, however, for some of these criteria, only a qualitative evaluation is practical.

PROPERTY IMPACTS

This criterion will consider the additional right-of-way required and quantify the number of individual properties impacted. Impacted properties will be identified based on their land use. Impacts to parks will be identified separately as well.

Evaluation Output:

> *The number and type (land use) of properties impacted and the total area (sq. metres) of the impact. The number of impacted properties will be further identified as full impacts or partial impacts.*

NOISE AND VISUAL IMPACTS

This qualitative criterion will consider the effects of temporary noise impacts and visual impacts that result from detouring vehicles passing residents and businesses adjacent to the emergency detour routes. A list of affected communities would be compiled, and the length of local and collector roadways used in the detour route would be determined. A rough high-level assessment on the number of residents along each route could also be determined. The results from these analyses would assist in determine a qualitative ranking relative to the base case (existing conditions).

Evaluation Output:

> *The qualitative score is based upon how significant the anticipated change in traffic volumes in proximity to adjacent properties is and whether the change is an increase or decrease in traffic volumes.*

WATER RESOURCE IMPACTS

This criterion will consider the potential impacts or risks to the potable water supply within the Capital Regional District Watersheds. The qualitative evaluation will determine whether each option would have water resource impacts in comparison to the base case (existing conditions).

Evaluation Output:

> *The qualitative score is based upon qualitative comparisons to the base case in relation to potential impacts to water resources such as the proximity of the alignments to watershed areas or crossings of watercourses that feed the watershed.*

COMMUNITY DISRUPTION

This criterion will consider the barrier effect of having regional traffic detour through local and collector roadways, as opposed to arterial roads or highways. A quantitative measurement of the length of local and collector type roadways will be provided, from which a qualitative ranking will be determined. Resource and forest service type roads in the alignments would not be included in the quantitative measurement due to the limited properties around said roads.

Evaluation Output:

> *The qualitative score is based upon community connectivity and accessibility impacts in relation to the length of public roadways each alternative route will travel upon.*

5.1.3 Environmental Account

The Environmental Account considers potential impacts to terrestrial and aquatic resources. Archaeological / historic sites of significance are also considered.

TERRESTRIAL IMPACTS

The relative severity of impacts to the terrestrial environment will be noted and ranked. The qualitative evaluation, based on high-level desk top research, will determine whether each option would have better, neutral or worse terrestrial impacts with respect to the base case (existing conditions). Considerations will be given to route overlap with sensitive ecological areas and at-risk species occurrences, and potential for vegetation clearing.

Evaluation Output:

> *The qualitative score is be based upon proximity and likelihood of impacts to ecological areas, at-risk species, and impacts to vegetation.*

AQUATIC IMPACTS

The relative severity of impacts to the aquatic environment will be noted and ranked. The qualitative evaluation, based on high-level desk top research, will determine whether each option would have better, neutral or worse terrestrial impacts with respect to the base case (existing conditions). Considerations will be given to potential impacts to wetlands, lakes, and watercourses in the form of deleterious materials, impacts to fish habitat, and watercourse crossing structure requirements.

Evaluation Output:

> *The qualitative score is based upon the number of nearby waterbody features such as wetlands, lakes, and watercourses and their likelihood of impacts from vehicles on the roadway alignments.*

ARCHAEOLOGICAL / HISTORICAL IMPACTS

Any archaeological or historically significant site impacts will be noted and ranked in terms of the severity of impact. The qualitative evaluation, based on high-level desk top research, will determine whether each option would be better, neutral or worse in terms of archaeological impacts relative to the base case (existing conditions).

Evaluation Output:

> *The qualitative score is based upon the number and types of archaeological and historical sites that are in proximity to the roadway alignments.*

5.1.4 Financial Account

The Financial Account considers the present value of capital, maintenance and rehabilitation costs, and property costs, as well as project salvage values on structural components. In comparison to any benefits generated in the customer service account, financial indicators such as Net Present Value and Benefit / Cost ratio can be calculated.

CAPITAL CONSTRUCTION COST

The construction cost of each option will be assessed at a high-level using a conceptual single line sketch and typical unit costs referenced from the Ministry's Construction and Rehabilitation Cost Guide. To determine high-level costs, detour alignments will be segmented into homogenous segments, which could then be estimated based on typical cross sections, construction material and activity rates, and segment lengths. These high-level estimates would include factors for design, resident engineering, mobilization, contingency, and management reserve. The cost is dependent on the extent of physical modifications and the complexity of the modifications (including noted geotechnical, utilities, drainage, and environmental compensation features).

Evaluation Output:

> *Total Construction Cost (Including Contingencies).*

PROPERTY COST

Property costs will be estimated based on the number of partial and total takes, and the type of property impacted. Costs will be based on current assessed values with appropriate factors or other assumptions to address acquisition costs, potential business impacts, and contingencies. Only those properties directly impacted by the expansion of the detour route rights-of-way are considered; business losses that could result from detouring traffic are not considered.

Evaluation Output:

Total Property Cost (Present Value).

MAINTENANCE, OPERATIONS AND REHABILITATION COST

Consideration for annual maintenance, operations and rehabilitation costs will be based on a 25-year service life, standard lane-kilometre costs and scheduled rehabilitation for major roadways. The cost will be expressed as a present value (PV).

Evaluation Output:

Maintenance, Operations and Rehabilitation Cost (Present Value).

SALVAGE VALUE

The salvage value of the proposed infrastructure in relation to structural components for each option at the end of the 25-year analysis period will be reported.

Evaluation Output:

Salvage Value (Present Value).

BENEFIT COST RATIO AND NET PRESENT VALUE

This calculation takes into consideration the present value of the monetarized benefits of each option (e.g. travel time savings benefits), capital costs, property costs, maintenance and rehabilitation costs, and salvage value.

Evaluation Output:

B/C Ratio, NPV (25-Year Benefits – Costs).

5.2 Option Evaluation Assessment

The following subsections summarizes the assessment of the criteria for the multiple accounts including customer service, socio-community, environmental, and financial. Conceptual design drawings of the routes have also been prepared and are shown in ***Appendix E.***

5.2.1 Customer Service Account

The following subsection summarizes the methodology and results of the analysis undertaken for the customer service account criteria including the traffic mobility criteria and the travel time savings criteria.

TRAFFIC MOBILITY

The traffic mobility criterion considers the anticipated travel times the base case and two alternative route options would have. These travel times were estimated twice, considering two separate starting locations with the same ending location. The first estimate is for vehicles travelling from the intersection of Highway 1 and Highway 18 to the interchange of Highway 1 and Highway 14, as this is the earliest turn off point for vehicles originating north of Duncan to make use of the Pacific Marine Circle Route base case. The second estimate begins at the intersection of Highway 1 with Shawnigan Lake Road, as this is the location from which vehicles are turned around when there is an incident on the Highway 1 Malahat segment.

In addition to the travel times noted above, there is one other travel time that is considered, which would only be applicable to Option 2A. This is because Option 2A could also be utilized by Highway 14 traffic during incidents that occur on Highway 14 between Drennan Street and Gillespie Road. Historically, there were 13 closure incidents with long durations (averaging to approximately 6.8 hours) on this section of Highway 14 between the years of 2009 to 2018, inclusive. The travel time measurements for these estimates are measured between the intersection of Dover Street and Highway 14 to the interchange between Highway 1 and Highway 14. For Option 2A, it is assumed that the detouring traffic would enter Highway 1 at the Shawnigan Lake Road intersection.

To estimate the travel times, the lengths of all the roadway segments making up the routes were divided by their posted speed limits and summed together. The default speed limit was assumed to be 50 km/h for those roads without noted speeds, with the exception of roadways within the Sooke Hills Wilderness Regional Park, for which a speed of 30 km/h was assumed based on advised environmental mitigations, which are discussed in Section 5.2.3. However, in order to account for travel speed reductions that would occur due to such things as reduced speed areas, potential delays at signalized intersections, single-lane alternating traffic patterns at bridges or pinch points, or passenger vehicles following behind slower moving heavy vehicles, all of the posted speeds were reduced by 5 km/h to a minimum of 30 km/h. The results of these measurements are summarized overleaf in ***Table 5.2***.

Table 5.2: Option Travel Times between Start Point and the Highway 1 / Highway 14 Interchange

OPTION	HIGHWAY 1 INCIDENTS		HIGHWAY 14 INCIDENTS
	TRAVEL TIME – STARTING FROM SHAWNIGAN LAKE ROAD	TRAVEL TIME – STARTING FROM HIGHWAY 18	TRAVEL TIME – SOOKE TO HIGHWAY 1 / HIGHWAY 14 INTERCHANGE
Base Case	237 min (3.95 hrs)	196 min (3.27 hrs)	208 min (3.47 hrs)
1A	35 min (0.633 hrs)	63 min (1.12 hrs)	N/A
2A	139 min (2.33 hrs)	152 min (2.53 hrs)	123 min (2.05 hrs)
1A Delta	- 202 min (3.37 hrs)	- 133 min (2.22 hrs)	N/A
2A Delta	- 98 min (1.63 hrs)	- 44 min (0.73 hrs)	- 85 min (1.25 hrs)

As a test of the reasonableness of the presented values above, the base case values were compared against Google Traffic travel times and were found to be quite close, with the Google estimated times ranging from 230-250 minutes and 190-210 minutes, respectively, depending on the time of day and levels of traffic. Due to the shorter lengths of the detour routes, the travel times decrease significantly for Option 1A, which is almost parallel to Highway 1, but decreases only somewhat for Option 2A due to the further distance that must be travelled to avoid the Greater Victoria Water Supply Area.

One thing to note is that the measurements summarized above in ***Table 5.2*** only include the time required to physically travel the routes, but do not consider the time required for MoTI, staff to come to the decision to open the routes, deploy flaggers, and open gated roadways. Vehicles that wish to take the detour before this time would be required to wait for an additional period of time as the detour route is opened. An example of how this would affect travel times is shown in ***Figure 5.2***.

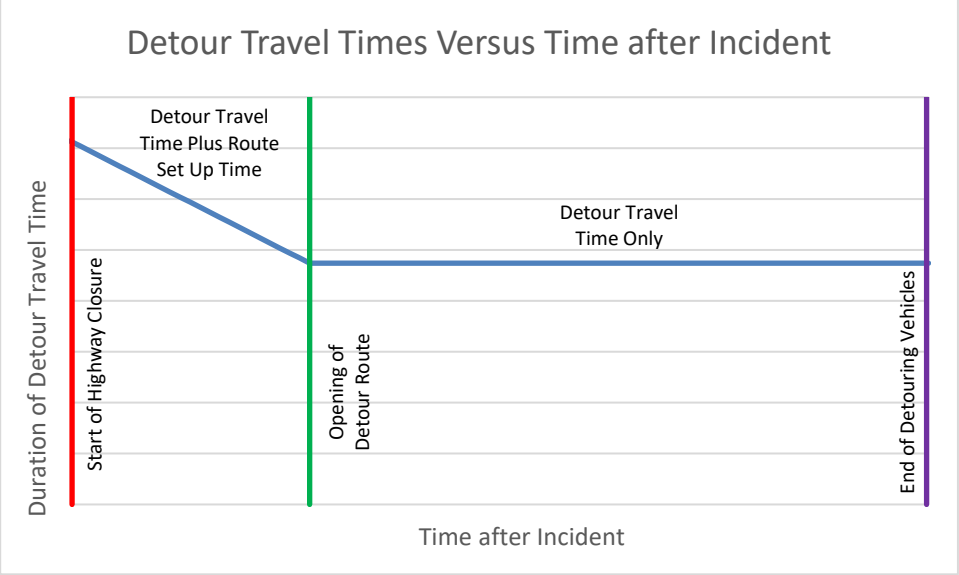

Figure 5.2: Detouring Vehicle Travel Times given Vehicle Start Time

The following set up times were assumed, and an average of half of these times will be added to the travel times of vehicles beginning to divert during the early stages of the incident:

- Base Case: 120 minutes of set up, averaging to an additional 60 minutes of travel time.
    - An additional two hours were added to the base case travel times to account for the travel time required for flaggers to reach their positions and wayfinding signs to be posted.
- Option 1A: 120 minutes of set up, averaging to an additional 60 minutes of travel time.
    - An additional two hours were added to the Option 1A travel times to account for the necessary communications between MoTI and Capital Regional District Staff and opening of gates along the route, travel times for flaggers to reach their positions, and wayfinding signs to be posted.
- Option 2A: 90 minutes of set up, averaging to an additional 45 minutes of travel time.
    - An additional 1.5 hours were added to the Option 2A travel times to account for the travel times for flaggers to reach their positions along the long route and wayfinding signs to be posted.

The resultant summation between the travel times and the assumed average set up times are shown in ***Table 5.3***.

Table 5.3: Option Travel Times with added Set Up Time

OPTION	HIGHWAY 1 INCIDENTS		HIGHWAY 14 INCIDENTS
	TRAVEL TIME PLUS SET UP TIME – SHAWNIGAN LAKE ROAD	TRAVEL TIME PLUS SET UP TIME – HIGHWAY 18	TRAVEL TIME PLUS SET UP TIME– OTTER POINT ROAD TO HIGHWAY 1 / HIGHWAY 14 INTERCHANGE
Base Case	297 min (4.95 hrs)	256 min (4.27 hrs)	328 min (5.47 hrs)
1A	80 min (1.33 hrs)	108 min (1.8 hrs)	N/A
2A	184 min (3.07 hrs)	197 min (3.28 hrs)	213 min (3.55 hrs)
1A Delta	- 217 min (3.62 hrs)	- 148 min (2.47 hrs)	N/A
2A Delta	- 113 min (1.88 hrs)	- 59 min (0.98 hrs)	- 115 min (1.92 hrs)

TRAVEL TIME SAVINGS

To calculate travel time savings, a series of sensitivity tests were conducted to determine the variation in travel time savings based upon the percentage of vehicles detouring to the alternative detour route during cases of long duration incidents. Traffic volumes on the Highway 1 Malahat Segment and the Highway 14 segment between Drennan Road and Gillespie Road were obtained through the publicly available MoTI traffic data website. Data was collected for Highway 1 over each month of 2018 from the permanent count station P-11-900NS, located 200 metres south of the Highway 1 intersection with Shawnigan Lake Road. Data was gathered for Highway 14 for the same year from the permanent count station P-11-3EW, located approximately 800 metres west of Humpback Road. The average travel volumes for each hour of all 365 days were determined and binned into six four-hour time period bins for either location. As the average duration of a long duration incident (defined as those longer than 2.5 hours) is approximately 7.15 hours (or 6.8 hours for Highway 14), the volume of the next time period bin was added to each bin to obtain a rough approximation of the volumes of vehicles that would be impacted by a highway closure occurring during that time period. These volumes were then multiplied by the various diversion rate scenarios to obtain the number of vehicles that would make use of a detour route.

To determine the exact benefits that are anticipated to be annually accrued by each option, diversion rates for both the base case and the options were determined. The general diversion rate for the base case was determined by reviewing the traffic volumes at the permanent count stations of P-11-900NS and P-11-3EW on days of highway closure relative to similar non-closure days during the same timeframe. This would be noticeable as vehicles that would not cross the station P-11-900NS due to a closure incident would cross the station P-11-3EW if using the Pacific Marine Circle Route detour. When accounting for the travel time of detouring vehicles, it was determined that the general usage of the base case detour is quite low, being in the range of 5-15% of traffic. A general rate of 10% will thus be used for the base case for both Highway 1 and Highway 14 closures. To determine the general extent of vehicles detouring via one of the option routes, a linear interpolation was used comparing the diversion rate to the length of the detour routes. the two points used in the interpolation included the base case (220 kilometres, 10% diversion) and an origin point of 0 km in length and 100% rate of diversion. From this rough linear interpolation, it was estimated that the diversion rates of the options would be 90% for Option 1A Niagara Main route and 50% for both the Highway 1 and Highway 14 detours via the Option 2A Far West route. However, both of these rates were reduced by 10% as Option 1A may be unpaved and may not accommodate large trucks, while Option 2A travels through a long stretch of "wilderness" with limited facilities, population centres, and cell service towers, which could discourage some potential users of the route. Therefore, the final diversion rates utilized would be 80% for Option 1A Highway 1 closures and 40% for both Option 2A Highway 1 and Highway 14 closures.

The resultant traffic volumes that would result from the diversion rates mentioned above are summarized below in ***Table 5.4*** for Highway 1 traffic and overleaf in ***Table 5.6*** for Highway 14. Full breakdowns of the resultant traffic volumes from various diversion rates are available in ***Table A1*** and ***Table A2*** of ***Appendix A***. The annual frequency for occurrences of long duration incidents during the specific time periods is shown in ***Table 5.5*** for Highway 1 and ***Table 5.7*** for Highway 14.

Table 5.4: Average Traffic Volumes on Highway 1 Malahat Segment

DIVERSION PERCENTAGE	TIME PERIOD AVERAGE TOTAL VOLUME (VEHICLES)					
	0 – 3	4 – 7	8 – 11	12 – 15	16 – 19	20 – 23
Typical	357	2,859	6,008	7,114	6,368	2,032
Typical Plus Next Period	3,217	8,867	13,122	13,482	8,400	2,389
10 %	322	887	1,312	1,348	840	239
40 %	1,287	3,547	5,249	5,393	3,360	956
80 %	2,574	7,094	10,498	10,786	6,720	1,911

Table 5.5: Long Duration Incident Time Period Frequency – Highway 1

TIME PERIOD (24 HRS)	NUMBER OF HISTORICAL LONG DURATION INCIDENTS (2009 – 2018)	PERCENTAGE	ANNUAL FREQUENCY OF LONG DURATION INCIDENTS
0 – 3	0	0 %	0
4 – 7	1	9.1 %	0.1
8 – 11	3	27.3 %	0.3
12 – 15	1	9.1 %	0.1
16 – 19	3	27.3 %	0.3
20 – 23	3	27.3 %	0.3
Total	11	100 %	1.1

Table 5.6: Average Traffic Volumes on Highway 14 – Drennan Street to Gillespie Road

DIVERSION PERCENTAGE	TIME PERIOD AVERAGE TOTAL VOLUME (VEHICLES)					
	0 – 3	4 – 7	8 – 11	12 – 15	16 – 19	20 – 23
Typical	2,554	6,350	8,805	8,922	5,336	1,423
Typical Plus Next Period	128	318	440	446	267	71
10 %	383	953	1,321	1,338	800	213
40 %	1,150	2,858	3,962	4,015	2,401	640

Table 5.7: Long Duration Incident Time Period Frequency – Highway 14 Drennan Street to Gillespie Road

TIME PERIOD (24 HRS)	NUMBER OF HISTORICAL LONG DURATION INCIDENTS (2009 – 2018)	PERCENTAGE	ANNUAL FREQUENCY OF LONG DURATION INCIDENTS
0 – 3	0	0 %	0
4 – 7	0	0 %	0
8 – 11	1	7.7 %	0.1
12 – 15	5	38.5 %	0.5
16 – 19	5	38.5 %	0.5
20 – 23	2	15.3 %	0.0
Total	13	100 %	1.3

The route travel time deltas that were previously determined in the traffic mobility subsection were used to determine a present value for a 25-year service period. To determine the exact number of person hours of travel saved by each option a number of assumptions were made. For simplification, all vehicles using the route were assumed to be passenger vehicles, as although trucks may be able to use the routes, there may be the need for them to proceed at specific time periods, due to some areas of the route being constrained, which would reduce the amount of travel time saved for this vehicle type. To this end, a monetized travel time rate of $ 18.9 per hour[4] and a vehicle occupancy rate of 1.28 persons per vehicle[5] were used to estimate a monetized travel time savings rate of $ 24.19 per hour per vehicle.

The anticipated network travel times for each time period multiplied by the anticipated annual frequency of incidents on Highway 1 as well as those on Highway 14 are presented in ***Table 5.8*** overleaf. Full breakdowns of the travel time savings for each scenario are available in ***Appendix A***, in ***Table A3*** to ***Table A7***. The values represent the anticipated travel times for all vehicles, including both those that use the detour and those that wait for the highway to reopen. For Highway 1 the measurements represent vehicles travelling between Shawnigan Lake Road and the Highway 14 interchange with Highway 1. For Highway 14 the measurements represent vehicles travelling between Dover Street and the Highway 14 interchange with Highway 1 For those vehicles waiting for the highway to reopen it is assumed that the average waiting time would be equal to 60% of the average closure duration. This 60% accounts for an average waiting time of half the duration of closure, plus additional time for a driver to be alerted of the highway reopening and travel back to the highway.

[4] Obtained from MoTI document, *Default Values for Benefit Cost Analysis in British Columbia 2018*, Apex Engineering 2018

[5] Obtained from Capital Regional District document, *2017 Capital Regional District Origin Destination Household Travel Survey*, Malatest 2017

Table 5.8: Travel Times Given Highway 1 / Highway 14 Incident Occurrence Times and Diversion Percentages

OPTION	DIVERSION %	ANNUALIZED INCIDENT TRAVEL TIME SAVINGS PER TIME PERIOD (HRS)						
		0 – 3	4 – 7	8 – 11	12 – 15	16 – 19	20 – 23	TOTAL
Base Hwy 1	10 %	0	3,799	16,864	5,776	10,795	3,071	40,305
Opt 1A Hwy 1	80 %	0	1,373	6,096	2,088	3,902	1,110	14,568
Opt 2A Hwy 1	40 %	0	3,160	14,029	4,804	8,980	2,554	33,528
Base Hwy 14	10 %	0	0	3,550	17,984	10,755	1,147	33,436
Opt 2A Hwy 14	40 %	0	0	2,926	14,825	8,866	946	27,563

The annualized benefits based on the diversion rates for the year 2018 are summarized in ***Table 5.9*** below. A full breakdown of the various annualized benefits between all diversion rate cases is summarized in ***Appendix A, Table A8*** to ***Table A10***.

Table 5.9: Annual Monetized Benefits

OPTION	INCIDENT OCCURANCE ON	BASE CASE DIVERSION RATE	OPTION DIVERSION RATE	TRAVEL TIME SAVINGS (HRS)	ANTICIPATED ANNUALIZED BENEFITS ($,000S)
1A	Highway 1	10 %	80 %	25,737	$ 623
2A	Highway 1	10 %	40 %	6,777	$ 164
2A	Highway 14	10 %	40 %	5,873	$ 142

The anticipated annual travel time savings per diversion rate presented above were then assessed over a 25-year service period. The rate of traffic growth, which would directly correspond to the growth in travel time savings, was assumed to be equal to the historical 10-year annual growth rate of the Uniform Traffic Volume Segments for Highway 1 and Highway 14. For Highway 1, a rate of 1 % from UTVS 12 was used, which corresponds to the segment of Highway 1 between the Shawnigan Lake Road intersection and just west of West Shore Parkway intersection. For Highway 14, a rate of 1.5 % from UTVS 295 was used, which corresponds to the segment of Highway 14 between the Stone Creek Bridge to Glenshire Road. The rate was obtained from publicly available MoTI traffic data. Present values of the monetized travel time savings were then determined using a discount rate of 6%. The present values that were calculated for either option given the various diversion rate scenarios are shown below in ***Table 5.10***.

Table 5.10: Present Value Travel Time Savings

INCIDENT LOCATION	OPTION 1A (2019 $M)	OPTION 2A (2019 $M)
Highway 1	$ 7.6	$ 2.0
Highway 14	$ 0.0	$ 1.8
Total	**$ 7.6**	**$ 3.8**

It should be noted that this analysis did not specifically consider the potential for some drivers to forgo their trips entirely (i.e. drivers missing scheduled appointments or deciding to skip tourism travel). As such, in this analysis, these drivers are included in the percentage of vehicles that don't take the detour (85-95 % in the base case), and so are treated the same as those drivers who are delayed until the highway opens.

5.2.2 Socio-Community Account

The following subsection summarizes the assessments completed for the socio-community account criteria including property impacts, noise and visual impacts, water resource impacts, and community disruption.

PROPERTY IMPACTS

Property impacts were assumed to result from impacts to privately owned properties. To determine the anticipated magnitude of impact that either route would have, a 50 metre right of way was assumed to be required from all properties that are not owned by some level of government. As such, properties and road right-of-ways under the jurisdiction of the province, the Capital Regional District, or local municipalities were assumed to not result in impacts. An exception to this are the properties located within the CRD jurisdiction of the Leech River Watershed, as there is an existing agreement between the CRD and TimberWest, which gives TimberWest the right of first refusal to said properties. The resultant anticipated area of property impacts for the routes are shown below in ***Table 5.11***. As there would be a large impact to Mosaic Forest Management properties in Option 2A, the area of impact for Mosaic Forest Management is presented as a subset of the total area.

Table 5.11: Estimated Property Impacts

OPTION	AREA REQUIRED FROM MOSAIC FOREST MANAGEMENT (HA)	AREA REQUIRED FROM OTHER PROPERTY OWNERS (HA)	TOTAL NON-GOVERNMENT PROPERTY REQUIREMENTS (HA)
1A	0.0	5.0	5.0
2A	250.7	5.1	255.8

It should be noted that the area of impact for Option 1A was a general assumption, as the properties that would be impacted by the right-of-way will be subdivided into smaller properties in the near future. As such, it was assumed that the route would impact one property fully, the size of which was based on similar already subdivided properties to the north. Additionally, it is assumed that the area within Sooke Hills Regional Park would not count towards the property impacts, but would require additional parkland compensation.

It should also be noted that the area of property required from Mosaic Forest Management for Option 2A could be reduced by nearly 21.2 hectares. (approximately 4.2 km of roadway). This could be achieved by utilizing an existing BC MoTI right-of-way on Renfrew Road, located just north of the proposed alignment, northwest of Grant Lake. However, the road along this right-of-way would require additional capital investment to upgrade to a necessary standard for usage as a detour route, particularly as the road has previously been partially deactivated.

NOISE AND VISUAL IMPACTS

When incidents occur and the detour routes are activated, traffic volumes on Highway 1 Malahat segment are rerouted through residential areas to reach the start of the detours. During this time, the rerouted highway traffic would result in both noise and visual impacts to the nearby residents. To determine what the magnitude of these impacts could be, all of the routes, including the base case, were buffered out by 50 metres to each side and then overlapped with data from the 2016 Canadian Census at a dissemination block level. The residential populations of each dissemination block were assumed to be equally distributed throughout the area of the block, and thus impacted population numbers can determined by comparing the overlapping area of a block to its full area. The residential populations that would be impacted by noise and visual impacts can thusly be estimated as shown below

in ***Table 5.12***. It should be noted that all segments on Highway 1 and on Highway 14 from Otter Point Road to Highway 1 were not included in these assessments, as these would be higher volume roadways where the incremental increases to noise and visual impacts would not be significant.

Table 5.12: Estimated Totals of Impacted Residential Population

OPTION	FULL DISSEMINATION BLOCK AREA (HA)	OVERLAP AREA WITH 50M BUFFER (HA)	FULL AREA POPULATION	OVERLAP AREA POPULATION	OVERLAP AREA POPULATION – ROUNDED
Base Case	459,809	1,755	13,487	1,183	1,150
1A	10,283	202	3,730	248	250
2A	121,890	826	8,195	458	450

As can be seen in the table above, both of the options would pass by significantly fewer residential populations in comparison to the base case and would thus have fewer impacts during activation of the detour.

Evaluation Output – Overall the options, in terms of noise and visual impacts, are qualitatively rated in comparison to the base case (existing conditions at Base Case Circle Route) as follows:

- *Option 1A Niagara Main – Significantly Better.*
- *Option 2A Far West Alignment – Significantly Better.*

WATER RESOURCE IMPACTS

To reiterate the points discussed in Section 4.3.2, the primary use for water resources in the project area is for drinking water supply for the Greater Victoria Water Service Area. The service area is supplied by three watershed areas including the Goldstream Water Supply Area, the Sooke Lake Water Supply Area, and the Leech River Watershed, which combined make up the Greater Victoria Water Supply Area. The first two watershed areas are currently in use for supplying the Japan Gulch Disinfection Facility with water, and the Sooke Lake Water Supply Area also supplies the Sooke River Road Disinfection Facility. The Leech River Watershed area is currently not used for drinking water supply, however there is a tunnel connection to the Sooke Lake Reservoir that would provide capacity for future growth in the region. There are twelve municipalities that source their water from the Greater Victoria Water Supply Area.

Important features in the watersheds include the Goldstream River, the Goldstream Lake Reservoir, the Lubbe Lake Reservoir, the Butchart Lake Reservoir, the Sooke Lake Reservoir, the Deception Reservoir, and the Leech River. As these features all connect to the disinfection facilities downstream, they are considered to be highly sensitive to potential contamination. In addition to the three watersheds, there is also a buffer zone surrounding the southwestern portion of the Goldstream Water Supply Area, which prevents public access and development near to the watershed. Additionally, the buffer zone also helps to mitigate the risks of wildfire within the watershed, with monitoring for fire watch including regular aerial monitoring and 24/7 on call fire response crews and equipment. These features can be seen in ***Figure 5.3***, overleaf. A full scale11x17 version is available in ***Appendix A***. Mitigation of wildfire risks within the watershed during an emergency detour route activation would need to be considered, and in extreme fire danger rating periods of the year, mitigations may not be feasible to facilitate an effective emergency detour deployment simultaneously.

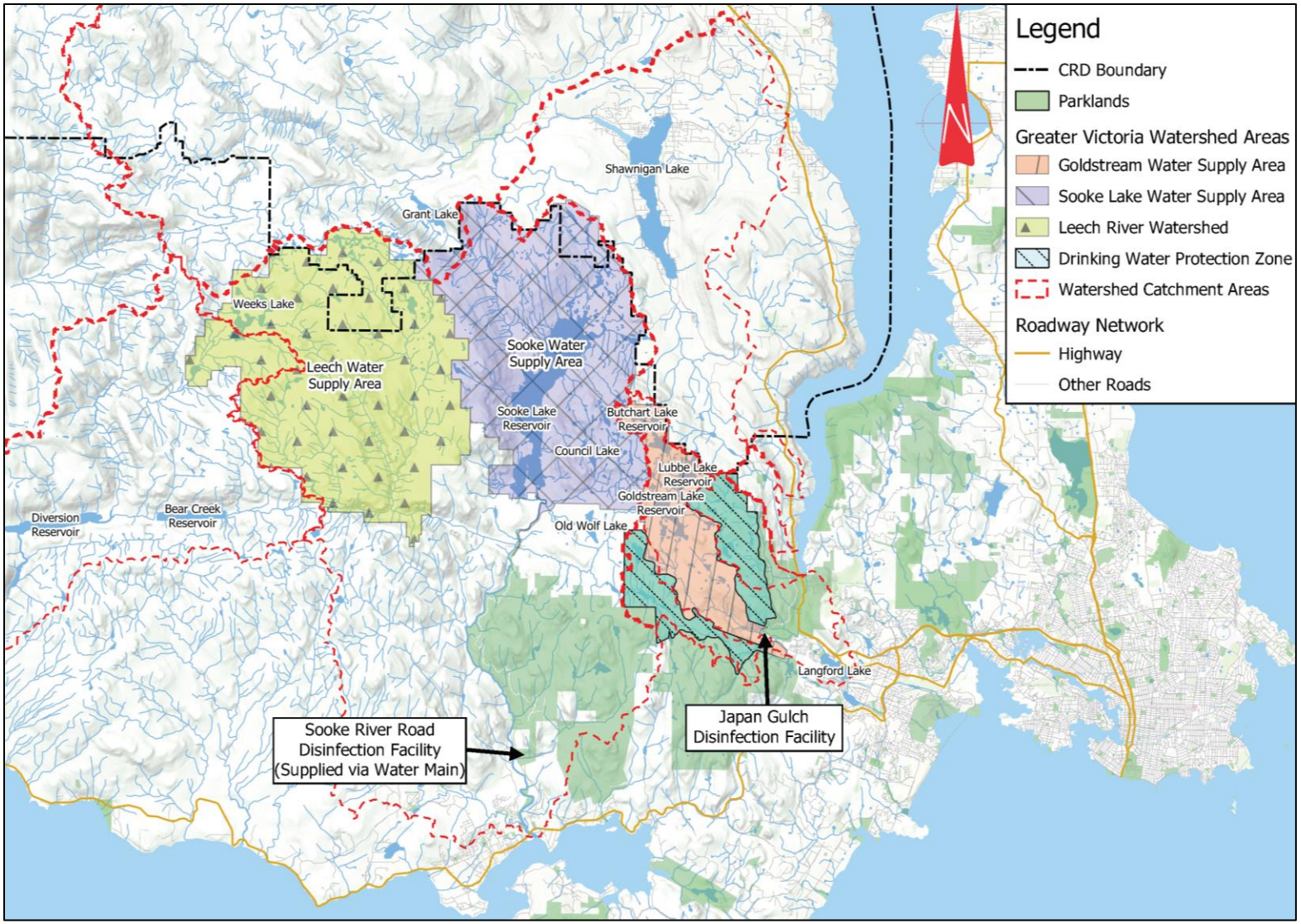

Figure 5.3: Capital Regional District Water Supply Areas Catchment Areas and Water Resource Features

Base Case

The base case travels along Highway 18, the Pacific Marine Circle Road, and Highway 14. While doing so, the route passes through multiple municipalities including Duncan, Somenos, Lake Cowichan, Mesachie Lake, Port Renfrew, Sooke, and Langford. At no point does the route pass through the Greater Victoria Water Supply Area, meaning that there would be no impacts to the communities of Sooke and Langford as these are supplied by said area. Additionally, the communities of Duncan, Somenos, Mesachie Lake, and Port Renfrew are supplied by groundwater wells, and would not be significantly impacted by the infrequent activation of the detour route. The last community, Lake Cowichan, obtains water from the nearby Lake Cowichan, which could lead to water resource impacts. However, the base case route does not pass closer than 80 metres to the waters edge, and does so downstream of the main lake body. As such, the base case is not anticipated to experience potential water resource impacts from the usage of the route as a detour for Highway 1.

Option 1A – Niagara Main

The Option 1A route travels through the Goldstream Water Supply Area near the southeasternmost tip of the area, for a total distance of approximately one kilometre, close by the Japan Gulch Disinfection Facility. However, the route never passes closer than 350 metres from the outermost boundary of the watershed, and the route is located on the downstream side. After passing through the Goldstream Water Supply Area, the route follows the boundary of the Drinking Water Protection Area for a distance of approximately 5.3 kilometres. As the route is located downstream of the watershed catchment area, the potential for impacts to the watershed and the drinking water supply is considered to be minimal, however there would still be the presence of vehicles within the designated water supply area boundary, and along the edge of the Drinking Water Protection Area boundary. This could potentially lead to minor amounts of deleterious substances entering the watershed and cause a significant increase in wildfire risk, the biggest threat in the water supply area. After crossing the Goldstream River, the alignment would pass in close proximity to and may bisect the CRD Japan Gulch Disinfection Facility compound. Public access to the facility and the surrounding area is restricted in order to secure the disinfection facilities and keep the public away from the disinfection chemical and processes contained within the buildings beyond the westerly end of Sooke Lake Road. As such, the facility would require security revisions / upgrades to continue the protection of the facility from the emergency detour roadway, as well as operational procedure adjustments to maintain public safety in relation to the separation of the public from facility areas that require the loading, storage, and injection of chemical treatments including ammonia and chlorine. It is envisioned that certain operational procedures in the handling of water treatment chemicals may be unmitigable in that an emergency detour activation could not occur simultaneously with scheduled chemical storage delivery processes, or a chemical release emergency situation.

Option 2A – Far West Alignment

Option 2A would pass through a small corner of the Leech River Watershed area for a total of approximately 4.1 kilometres. However, the route would only include approximately one kilometre in which the route would be within the catchment area for the Leech River, with the rest of the distance within the watershed being located downstream of the catchment area. To this end, there is a single mapped watercourse that is anticipated to have the potential for the introduction of contaminants to the Leech River, with some of the watercourse being located outside of the designated watershed boundary. To mitigate the potential impacts that could result from this crossing, additional infrastructure could be implemented, which could take the form of multiple oil water separators, concrete roadside barriers to mitigate the potential for vehicles to go off-road, open bottom structures, or even a redirection of the watercourse channel such that it would drain into another area that is not included in the Greater Victoria Water Supply Area.

Evaluation Output – Overall the options, in terms of potential impacts to water resources, are qualitatively rated in comparison to the base case (existing conditions at Base Case Circle Route) as follows:

- *Option 1A Niagara Main –Somewhat Worse.*
- *Option 2A Far West Alignment – Somewhat Worse.*

COMMUNITY DISRUPTION

When an emergency detour route has been implemented due to an incident requiring a road closure along the Malahat Highway, the volume of traffic on the detour that temporarily travels through existing urban or suburban areas will act as a barrier making crossing the route more difficult for local residents and potentially disrupting community connectivity temporarily. To assess the potential for temporary community disruption by the emergency detour route options, the length of existing public roads along each route was determined. Arterial class roads were assessed separately as although there are higher populations along these roadways, they are designed with limited crossing opportunities. The Collector and Local road classes were considered more significant in terms of potential community disruption concerns.

Base Case

The base case travels on Highway 18, the Pacific Marine Circle Route, and Highway 14. The route passes through the more densely populated communities of Somenos, Lake Cowichan, Mesachie Lake, Port Renfrew, Sooke, Saseenos, Colwood, and Langford. However, the only non-Arterial and non-Highway classified roads used by the base case that are close to populated areas is Deering Road, located near Port Renfrew. When passing through the other communities, the route is always on either an Arterial or Highway classified roadway.

Option 1A – Niagara Main

The southern segments of Option 1A route travel through the Goldstream neighbourhood in Langford. This neighbourhood is a suburban residential area with some local commercial businesses and potentially could experience severe issues during the detour implementation. Also, the northern segments of Option 1A travel through the rural area of Goldstream Heights. This is a rural residential development area of very low density with large acre lots sparsely positioned along the route with very little need for crossing interactions. Although the length of this route through existing areas is relatively long the areas of potential community disruption are relatively small.

Option 2A – Far West Alignment

The northern segments of the detour route would pass through the Shawnigan Lake Village area at the north end of Shawnigan Lake. Also, should traffic be directed onto the emergency detour at the Shawnigan Lake Road / Highway 1 intersection, the detour would pass through the Shawnigan Station which is a small single family home residential neighbourhood, of about 100 houses, straddling Shawnigan Lake Road south of Shawnigan Lake. The south segment of the detour would pass through a residential community including city parks and commercial lands within the Municipality of Sooke on Otter Point Road.

To provide a quantitative measure of the level of potential severance caused by the rerouting of traffic through local roadways, the population within 200 metres of the routes were determined. Population was determined in a similar manner to the noise and visual impacts criteria, with the 2016 Canadian Census statistics for dissemination block areas being utilized. The estimated populations for each route are shown in ***Table 5.13*** overleaf.

Table 5.13: Residential Population near Detour Route Collector and Local Roadways

OPTION	OVERLAPPING AREA NEAR PUBLIC COLLECTOR AND LOCAL ROADS (HA)	OVERLAPPING POPULATION NEAR PUBLIC COLLECTOR AND LOCAL ROADS	OVERLAPPING POPULATION ROUNDED
Base	108	58	50
1A	439	945	950
2A	577	1,263	1,250

It should be noted that the base case only has an estimated 58 individuals that would be impacted by community disruption on Local and Collector level streets as the majority of the route is located on Arterial roadways. Therefore, to provide some additional context, the overlapping populations within 200 metres of the Arterial classified road segments of the routes were also determined, as shown in ***Table 5.14*** below. Additionally, as the base case is primarily located on Arterial level roads, the total number of affected individuals could be decreasing with the implementation of the options, however the severity of community disruption for each individual could rise, as the traffic is rerouted onto smaller streets.

Table 5.14: Residential Population near Detour Route Arterial Roadways

OPTION	OVERLAPPING AREA NEAR PUBLIC ARTERIAL ROADS (HA)	OVERLAPPING POPULATION NEAR ARTERIAL ROADS	OVERLAPPING POPULATION ROUNDED
Base	2,667	11,942	11,950
1A	68	51	50
2A	1,845	8,419	8,400

Evaluation Output – Overall the options, in terms of community disruption, are qualitatively rated in comparison to the base case (existing conditions at Base Case Circle Route) as follows:

- *Option 1A Niagara Main – Significantly Worse.*
- *Option 2A Far West Alignment – Significantly Worse.*

The qualitative rankings were determined above due to the significant increases to affected populations along Local and Collector level streets. However, Option 1A also includes a very significant decrease to the affected population that are located near to Arterial roadways.

5.2.3 Environmental Account

Under this account, the three types of impacts considered include: terrestrial impacts, aquatic impacts, and archaeological / historical impacts. Summarized information from reviewing applicable documents, spatial datasets, and field observations from the two-day driving tour are provided on ***Figures 2*** to ***26,*** all of which are in ***Appendix F***.

TERRESTRIAL IMPACTS

To assess terrestrial impacts a desk-top review was conducted of terrestrial environmental information available from web-based resources. Also, the following reports and spatial data were provided by the CRD or obtained through the MOTI, and reviewed if applicable to selected Options:

- Environmental Inventory and Impact Assessment of the proposed route of the Trans Canada Trail through the Sooke Hills Wilderness Regional Park Reserve and adjacent CRD Watershed Lands (Latitude Conservation Solutions Company 2016);
- Human-wildlife interaction risk assessment for the Sea to Sea Green Blue Belt and Sooke Hills Wilderness Regional Park Reserves (MacHutchon 2016);
- Sooke Hills Wilderness and Mount Wells Regional Parks – Terrestrial Ecosystem Mapping and Wildlife Ratings Table (BC Ministry of Environment, Lands and Parks [MELP] 2001);
- Vegetation Resources Inventory for CRD Lands; and
- Malahat Project Preliminary Overview of Three Design Options in the Area of Goldstream River to the Summit (Golder 2006).

Although detailed inventories and reports were available for the area to be affected by the Option 1A Niagara Main route, there was not a similar degree of detailed information available for Option 2A Far West Alignment. Based on the high-level planning objectives of this multiple account evaluation process and the need to have equivalent data with which to make comparisons between the two short-listed options, these studies were not incorporated into this assessment, in detail. If the Option 1A Niagara Main route moves forward, the list above serves to guide future more detailed assessment efforts.

Visual observations made by a BC Registered Professional Biologist (RPBio) during a driving tour along the 2-wheel drive vehicle accessible portions of the routes were also recorded for the following terrestrial habitat features:

- High-level field observations of the habitat attributes visible from roadside vantage points in forest stands designated as marbled murrelet critical habitat, and other mature forest stands observed that were deemed to provide potential suitable nesting habitat for marbled murrelet;
- Rock outcrops and cliff faces;
- Old-growth forest;
- General wildlife observations; and
- CRD representatives on the tour also provided information on a western toad migration area and barrier fencing installed along Sooke Main south of Sooke Lake (Option 3A).

Based on the desktop review and driving tour conducted, the following evaluations of the relative terrestrial environmental impacts are provided for the two short-listed options.

Terrestrial Ecosystems

Understanding of the ecosystem types within each option alignment provides context for the nature of terrestrial habitat features and wildlife species that could be affected by each option.

Option 1A – Niagara Main

Option 1A extends across two biogeoclimatic units, the moist maritime Coastal Douglas-fir (CDFmm) and the eastern very dry maritime Coastal Western Hemlock (CWHxm1) variant. The CDFmm is within the rainshadow of the Vancouver Island and Olympic Mountains that results in warm and dry summers and mild, wet winters with water deficits common on drier sites.

The CWHxm1 occurs at low elevations (0-700 metres) on the east side of Vancouver Island. The CWH zone is on average, the rainiest zone in British Columbia and typically has a cool mesothermal climate including cool summers and mild winters.

Option 2A – Far West Alignment

Option 2A extends across six biogeoclimatic units including the CDFmm and CWHxm1 summarized above. The four additional biogeoclimatic units include: the submontane moist maritime CWH variant (CWHmm1), the montane moist maritime CWH variant (CWHmm2), the western very dry maritime (CWHxm2), and the montane very wet maritime CWH variant (CWHvm2). The CWHxm2 is virtually identical to the CWHxm1, with slightly less shrub diversity to the CWHxm1 described above.

The CWHmm1 is restricted to Vancouver Island on the eastern side of the Vancouver Island Ranges above the CWHxm1 and CWHxm2. The biogeoclimatic unit occurs generally between 450 to 700 metres in elevation with moist, mild winters and cool but dry summers. Zonal forests are dominated by western hemlock, amabilis fir, and coast Douglas-fir with a shrubby understory of salal, dull Oregon-grape, red huckleberry, and Alaskan blueberry.

The CWHmm2 occurs at higher elevations (700 to 1100 metres) on the eastern side of the Vancouver Island Ranges below the Mountain Hemlock biogeoclimatic zone. The CWHmm2 has cooler temperatures, shorter growing seasons and heavy snowfall compared to the CWHmm1. Zonal forests are similar to the CWHmm1; however, minor amounts of yellow cedar, and mountain hemlock occur at higher elevation wetter sites. The shrub and moss layers are also well developed in the CWHmm2.

The CWHvm2 is located at 400 to 800 metres in elevation on the western slopes of the Coast Mountains above the CWHvm1. The climate in this biogeoclimatic unit is cool, with short growing seasons and extensive snowpack. Dominant forest canopy includes: western hemlock, amabilis fir, yellow cedar, and mountain hemlock. The understory has a thick shrub layer dominated by Alaskan blueberry, oval-leaved blueberry, and a sparse herb layer including five-leaved bramble.

Wildlife, Plant and Ecosystems at Risk

Within the study area, the species with the most designated critical habitat parcels in the area and of highest potential risk for additional species-specific survey requirements, construction timing restrictions and the potential need to re-route the road alignment, is marbled murrelet, a provincially blue-listed and federally threatened marine bird species. Marbled murrelets nest in mature and old growth coniferous forest typically within 30 kilometres of the coast, but have been documented up to 80 kilometres inland. Nest sites are selected with preference for forest patches with higher densities of larger diameter trees, large diameter limbs, and mossy limbs. There are reptile critical habitat parcels including sharp-tailed snake (*Contia tenuis*; provincially red-listed and federally endangered)

and western painted turtle, Pacific Coast Population (*Chrysemys picta*; provincially red-listed and federally threatened and endangered [*Species at Risk Act*]) near the short-listed route options and base case circle route as well as a critical habitat parcel for a butterfly species (dun skipper vestris ssp. [*Euphyes vestris*; provincially red-listed and federally threatened]).

High-level field observations to assess the habitat quality within marbled murrelet designated critical habitat parcels were undertaken, where possible, during the driving tour of the routes on February 6th and 7th, 2019. Incidental observation of old growth forest and suitable nesting trees were made during the field tour and waypoints were taken where potentially suitable nesting habitat may be present near mapped critical habitat polygons. If evidence of tree clearing was observed within mapped marbled murrelet critical habitat areas, this was recorded in the field notes as a "disturbance". The results of these field observations as well as desktop analysis are summarized in ***Table 5.15***. A full breakdown of all the field observations are available in the full terrestrial impact write-up in ***Appendix B*** and in ***Figures 2*** to ***26,*** all of which are in ***Appendix F***.

Table 5.15: Number of Species at Risk Observation Records and Critical Habitat Parcels Crossed or within 100 metres of Option Alignment

OPTION	WILDLIFE SPECIES AT RISK OBSERVATION RECORDS	CRITICAL HABITAT PARCELS	PLANT / FUNGUS SPECIES AT RISK OBSERVATION RECORDS	ECOSYSTEM AT RISK OBSERVATION RECORDS	SUM (ORDERED LEAST TO MOST DESIRABLE)
Base Case Circle Route	33 records in total	28 parcels in total	14 records in total	3 records in total	78
2A – Far West Alignment	12 records in total	21 parcels in total	12 records in total	3 records in total	48
1A – Niagara Main	9 records in total	5 parcels in total	1 record total	2 records in total	17

Option 1A – Niagara Main

The Option 1A Niagara Main route has far fewer mapped critical habitat parcels (total of three mapped) with one parcel appearing to provide suitable nesting habitat for marbled murrelet based on visual observations. The other two parcels were not field verified during the high-level driving tours. It also has slightly fewer wildlife observation records as compared to Option 2A, but similar types of wildlife present (i.e., mammal, bird, amphibian, and numerous butterfly species). In terms of vegetation species and ecosystems at risk, it has far fewer recorded vegetation species at risk occurrence records and a similar number of ecosystems at risk, neither of which is a great differentiator, as these criteria are highly influenced by the total length of route and previous survey effort. The Niagara Main route is much shorter than Option 2A Far West Alignment and the Base Case circle route.

Construction of resource roadway upgrades or new roadway segments in proximity to previously identified observation records for wildlife, plant, fungus and ecosystems at risk would require additional survey effort to confirm the presence of these species and ecosystems, and appropriate mitigation.

Vegetation clearing and grubbing activities associated with upgrading the existing maintenance roads along the emergency bypass route should be conducted within the appropriate breeding bird "least risk periods" outlined in *Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (BC MOE 2014). This will serve to reduce potential contravention of Section 34 of the *BC Wildlife Act*, and the federal *Migratory Birds Convention Act* which protects migratory birds and their nests and "least risk windows" as defined in these documents.

At risk plant and ecosystem surveys are also recommended during optimal flowering times (spring, late summer, to allow for surveys that more definitively confirm presence / absence in areas to be disturbed) in areas where vegetation removal is expected.

Option 2A – Far West Alignment

The Option 2A Far West Alignment route has more mapped critical habitat parcels (total of nine mapped) and one parcel appeared to have suitable nesting habitat for marbled murrelet based on visual observations. The other eight parcels were not field verified during the high-level driving tour. It also has slightly more wildlife observation records than Option 1A, but similar types of wildlife present (i.e., mammal, bird, amphibian, and numerous butterfly species).

Construction of upgrades to resource roadways through a federally designated critical habitat area for marbled murrelet would require detailed surveys for marbled murrelet critical habitat suitability (described above in Option 1A). Construction of the upgrades to the resource roads, in addition to any potential requirements for short new sections of roadway in proximity to previously identified observation records for wildlife, plant, fungus, and ecosystems at risk would require additional survey effort to confirm presence. Vegetation clearing and grubbing activities within the Project area should be conducted within the appropriate breeding bird "least risk periods" and at-risk plant and ecosystem surveys, as outlined in Option 1A above.

Protected Areas and Sensitive Habitats

As described in the Screening Assessment, the presence of a protected area or sensitive wildlife habitat within 100 metres of a road alignment is of importance because the proximity (and in some cases, bisection of a protected area with a new or upgraded roadway) is associated with increased risk of wildlife-vehicle collision, including species at risk (mammals, reptiles and amphibians), habitat destruction (physical loss of habitats and sensory disturbance of wildlife from construction and road traffic once operational), invasive plant spread (road / vehicle vector), and most importantly: bisecting of undeveloped native vegetation types and habitats that have already been deemed important enough to protect within a designated regional or provincial park. The severing and fragmentation of formerly contiguous and legally protected ecosystems with roadways has inherent impacts on ecosystem function and area sensitive wildlife species, among other impacts. It should be noted that the short listed options do generally follow existing resource roads, which have already introduced some fragmentation of the ecosystems.

The results of desktop analysis are reflected in the output in ***Table 5.16*** below and ***Table 5.17*** overleaf as well as in ***Figures 2*** to ***26,*** all of which are in ***Appendix F***. For the full details on the exact parks that are in proximity to the options, please see the full terrestrial impact write-up in ***Appendix B***.

Table 5.16: Number of Protected Areas (Provincial /National Parks, Conservation Areas, and Regional Parks) Crossed or within 100 metres of Option Alignment

OPTION	PROVINCIAL / NATIONAL PARKS	CONSERVATION AREAS	REGIONAL PARKS	SUM (ORDERED LEAST TO MOST DESIRABLE)
Base Case Circle Route	3 Parks	None	5 Parks	8
2A – Far West Alignment	1 Park*	None	4 Parks	5
1A – Niagara Main	1 Park	None	1 Park*	2

* These parks would be newly bisected by the proposed option alignments by road construction or upgrades. These would include the Sooke Hills Wilderness Park for Option 1A, and the Koksilah River Park A for Option 2A.

Table 5.17: Number of Designated Sensitive Habitat Features (including OGMAs, WMAs) Crossed or within 100 metres of Option Alignment

OPTION	OGMAS	WMAS	SUM (ORDERED LEAST TO MOST DESIRABLE)
Base Case Circle Route	6 (legal)	1 (red-legged frog Lens Creek side channel)	7
2A – Far West Alignment	1 (non-legal)	None	1
1A – Niagara Main	None	None	0

It should be noted that although the count of parks, OGMAs, and WMAs that could be affected provides a high-level indication of level of potential effects, the more important measure is the degree to which a new roadway would affect the current conditions, i.e., a new road segment or upgraded road segment adjacent to a protected area has lower impact than a new or upgraded road right of way that bisects a previously undisturbed natural area

Option 1A – Niagara Main

Considering protected areas and sensitive habitats, Option 1A does not directly affect any designated sensitive habitat features (OGMAs or WMAs), but would bisect the CRD's Sooke Hills Wilderness Regional Park and would run along the edge of Goldstream Provincial Park. Additionally, there would be impacts to the Great Trail alignment, which would require relocation to mitigate for active transportation users and vehicles. There are currently no motorized vehicles allowed within the Sooke Hills Wilderness Regional Park or the Great Trail other than maintenance vehicles and occasional logging access to adjacent parcels of private forest lands via land access agreements. There have been many studies and inventories conducted within the Sooke Hills Wilderness Regional Park area, and it is a highly valued protected wilderness area. Construction of a highway detour route via upgrading resource roads through this area could have a significant effect on this protected area which has been established primarily for maintaining ecological integrity. The frequency of vehicle traffic for an emergency detour route of this nature is low, but if used, the volume and increase in vehicle traffic during deployment compared to current conditions would represent a significant change. The total length of the proposed Option 1A Niagara Main route within the eastern Sooke Hills Wilderness Regional Park area is approximately 5.4 kilometres and the total north-to-south length of this eastern area of the park is approximately 6.8 km. This means the proposed low occurrence emergency detour route in this location would effectively bisect or sever almost 80% of the eastern park area and represent a new environmental stressor on the regional park area habitat and wildlife during the infrequent detour deployments. The Option 1A Niagara Main route is also adjacent to Goldstream Provincial Park. This may represent a new environmental stressor on the provincial park area habitat and wildlife. The base case circle route is in proximity to more designated sensitive habitat features and protected areas, but it represents the steady-state / current conditions. Wildlife and ecosystems in proximity to this existing public roadway will have adapted, to some degree, to its presence.

Option 2A – Far West Alignment

Considering protected areas and sensitive habitats, Option 2A affects one designated sensitive habitat feature (1 non-legal OGMA), would pass through Koksilah River Provincial Park on existing public roads and could affect four Regional Parks which are located in proximity to the route, including Sooke Hills Wilderness Regional Park. The location where Option 2A passes adjacent to these four Regional Parks would be within the existing base case detour route and which is an existing public road. As such, these impacts are pre-existing occurrences. The primary section of Option 2A affecting a protected area is within Koksilah River Provincial Park. The Koksilah River Provincial Park is a 230-hectare area with both "intensive recreation" and "natural environment" zoning that is accessible

from Renfrew Road, which is a public road. The Option 2A route would continue along the existing Renfrew Road gravel roadway route for an approximate length of one kilometre, partially through and / or adjacent to the natural environment zoned portion of the park. The natural environment zone is intended to be maintained in natural condition while allowing minimal appropriate recreational activities such as camping, wildlife viewing, mountain biking, horseback riding, and angling. Approximately 350 metres of Option 2A would pass through the "intensive recreation zone" portion of the park that allows for readily accessible outdoor recreation opportunities and facilities (e.g., Burnt Bridge over Koksilah River). The entire east-west width of the park is approximately 4.7 km. This means the proposed emergency detour route in this location could be adjacent to approximately 20 percent of the south western park area. Given the relatively higher recreational use in this park compared to the Sooke Hills Wilderness Provincial Park, and shorter length of upgraded resource road, the relative impacts of an emergency detour route through this protected area are expected to be lower. The frequency of vehicle traffic for an emergency detour route of this nature is low, but if used, the volume and increase in vehicle traffic compared to current conditions would be significant during those periods. Although the base case circle route is in proximity to more designated sensitive habitat features and protected areas than Option 2A, it represents the steady-state / current conditions. Wildlife and ecosystems in proximity to the existing base case roadway will have adapted, to some degree, to its presence and vehicle traffic. Over the longer term, in consideration of future population growth and traffic volumes, Option 2A is preferable as it will not as significantly bisect previously established wildlife reserve areas or regional parks relative to Option 1A, nor would it impact the Great Trail alignment.

Environmental Approval Processes and Additional Surveys Required

The environmental approval processes required for each shortlisted option that are general (relate to both terrestrial and aquatic impacts) or terrestrial in nature are provided below. In BC, proposed projects and activities may be subject to the following environmental assessment processes:

- The current *Canadian Environmental Assessment Act*, 2012 (*CEAA*) is triggered when proposed physical activities are listed as "designated projects" in the federal *Regulations Designating Physical Activities* (Government of Canada 2012). The federal government has proposed amendments to federal environmental assessment legislation under a new *Impact Assessment Act* (Government of Canada 2019). The act and related *Regulations Designating Physical Activities* are suggested to be enacted in the summer of 2019 and would replace the existing legislation.
- The *British Columbia Environmental Assessment Act* 2002 (*BCEAA*) when a proposed project exceeds thresholds specified in the provincial *Reviewable Projects Regulation* 2002 (Government of BC 2002).

For a full breakdown of all the applicable environmental processes and additional surveys that would be required for each alternative route, please see the full terrestrial impact write-up in ***Appendix B***.

Evaluation Output – Overall the options, in terms of terrestrial impacts across all criteria considered, are qualitatively rated in comparison to the base case (existing conditions at Base Case Circle Route) as follows:

- *Option 1A Niagara Main – Somewhat Better.*
- *Option 2A Far West Alignment – Somewhat Better.*

The rating for both options is based primarily on the reduction of detour traffic that would use the Pacific Marine Circle Route, instead diverting traffic to areas featuring fewer occurrences of at-risk species. However, both options also have environmental drawbacks. Option 1A Niagara Main is heavily weighted by the route's alignment through

the Sooke Hills Wilderness Regional Park which makes it highly undesirable from a terrestrial environment and regulatory approvals perspective. Construction of a detour route via upgrading resource roads through the wilderness park is not likely to be entirely mitigable and may create irreversible changes to ecosystem function. More detailed quantitative assessment is required, beyond the scope of this planning-level assessment. Considering the standard mitigation hierarchy of avoid, mitigate, restore, and if required, offset, the recommended course of action if this option is pursued includes incorporation of all four actions. Following a more detailed inventory and species-specific surveys, avoidance of sensitive habitat features through route micro-siting may be achievable. In-design mitigation could include retention of granular surface (i.e. not paving) for the road surface through the park, minimizing road widening, enforcement of slower speed limits through the park, active traffic control personnel to avoid wildlife collisions, incorporation of catchment basins to collect road runoff and contaminants (in the event of a spill), and incorporation of appropriate wildlife crossing structures or species-specific considerations for the local species to be affected. Restoration of habitat areas within the Sooke Hills Park that are currently degraded is another possibility. Based on consultation with the CRD, MOTI and MENV, the appropriate location for compensatory offsetting, in the form of an alternate wilderness regional park area, could be investigated. The offsetting should follow provincial policy and procedures as laid out in the *Environmental Mitigation Policy* (BC MOE 2014a) and *Procedures for Mitigating Impacts on Environmental Value*s (Environmental Mitigation Procedures) (BC MOE 2014b) and be provided at a compensation ratio that CRD deems appropriate. The rating for Option 2A is based on the long route length which will likely trigger the provincial EA process and possibly the federal EA process for development of a paved all-season road (as defined under the provincial *BCEAA* and the existing *CEAA, 2012*). It would not trigger the revised federal EA process under the proposed IAA. The rating for Option 2A is also based on the requirement for new disturbances within undisturbed areas (with sensitive habitat features and designated areas); however, these environmental effects associated with Option 2A are considered largely mitigable based on the desktop information reviewed, and preferable to Option 1A.

AQUATIC IMPACTS

A desk-top review was conducted using aquatic environmental information available from web-based resources. Also, the following reports and spatial data provided by the CRD were also reviewed at a high-level for relevant aquatic species and habitat information:

- CRD Sooke Lake Stream Assessments – fish stream assessment data (Madrone 2017); and
- Stream Crossing Evaluation for TransCanada Trail - Niagara Main to 15N (CRD 2015 Draft Figure).

As with the Terrestrial Impacts assessment, although detailed inventories and reports were available for the general area to be affected by the Option 1A Niagara Main route, there was not a similar degree of detailed information available for Option 2A Far West Alignment. Based on the high-level planning objectives of this multiple account evaluation process and the need to have equivalent data with which to make comparisons between the two short-listed options, these detailed studies were not completely incorporated in detail into this assessment.

Visual observations made by a BC Registered Professional Biologist (RPBio) during a driving tour along the 2-wheel drive vehicle accessible portions of the routes were also recorded for major stream crossings (existing clear span bridges) and wetlands, where possible.

The results of desktop analysis and field observations are reflected in the output in ***Table 5.18*** and in ***Figures 2*** to ***26,*** all of which are in ***Appendix F***. A full breakdown of the various types of waterbodies is available in the full

aquatic impact write-up in ***Appendix B***. It should be noted that some water features have more than one interaction with the 100 metre buffer zone, and have thus been counted twice.

It should be noted that the existing industrial resource logging roads or CRD maintenance roads are already in operation over these alignments on a regular basis. Therefore, the relevance of considering aquatic habitat within 100 metres is related to the increased risk of water quality impairment, potential requirement for new or upgraded watercourse crossing structures along the existing routes, and environmental permitting (greater with fish presence, greatest with salmonid presence).

Table 5.18: Number of Interactions with Streams, Lakes, Marine / Shoreline and Wetlands: Crossed or Within 100 Metres of Option Alignment

OPTION	STREAMS[6]	LAKES OR MARINE / SHORELINE	WETLANDS[7]	SUM (ORDERED LEAST TO MOST DESIRABLE)
Base Case Circle Route	411	24	7	442
2A – Far West Alignment	307	18	10	335
1A – Niagara Main	29	1	6	36

Option 1A – Niagara Main

The Option 1A Niagara Main route would potentially affect aquatic habitat features at 36 locations. Based on the high-level screening assessment, it is known that many of these features are salmonid fish-bearing watercourses. Based on a high-level review of drainage structure inventory spatial data provided by CRD, many existing stream crossing structures are corrugated steel pipe (CSP) culverts. The driving tour of this route identified one clear span bridge over the Goldstream River and approximately seven watercourse crossings with culverts. Major stream crossings included the Goldstream River mainstem plus tributaries and Niagara Creek. It should be noted that not all stream crossings were identified during the high-level field tour due to timing constraints. Observations from the field tour are georeferenced and shown on ***Figure 25*** and ***Figure 26,*** all of which are in ***Appendix F***. A greater level of assessment beyond this high-level tally is outside the planning-level scope of this assessment.

For general information on the potential federal, provincial and local government approvals required for development of an emergency bypass route in this location please see the full aquatic impact write-up in ***Appendix B***.

Option 2A – Far West Alignment

The Option 2A Far West Alignment route would potentially affect aquatic habitat features at 335 locations. Based on the high-level screening assessment, it is known that many of these features are salmonid fish-bearing watercourses. The driving tour of this route identified at least 16 clear-span bridges and numerous watercourse crossings. The northern portion of Option 2A travels alongside Koksilah River and crosses numerous tributaries to this salmon bearing river. Other major stream crossings include a tributary to the Leech River, Jordan River, and Bear Creek. Option 2A also crosses through a portion of the northwest corner of the Leech River Watershed. The Leech River Watershed area is planned to become an additional drinking water supply area to supplement the Sooke Lake Reservoir. Observations from the field tour are georeferenced and shown on ***Figures 15*** to ***24,*** all of which are

[6] Note: includes major watercourses, definite and indefinite streams, intermittent streams, and ditches.

[7] Note: wetlands were mapped at large scale (1:2,500) within CRD Greater Victoria Water Supply Area boundaries only, therefore, the counts of wetlands being compared between options outside of, or inside of the Water Supply Area boundary where more detailed wetland mapping was undertaken, should not be considered a primary factor in this assessment, it is considered here only because it is a high-level assessment for initial screening purposes.

in ***Appendix F***. A greater level of assessment beyond this high-level tally is outside the planning-level scope of this assessment.

For general information on the potential federal, provincial and local government approvals required for development of an emergency bypass route in this location please see the full aquatic impact write-up in ***Appendix B***.

Evaluation Output – Overall the options, in terms of aquatic impacts, are qualitatively rated in comparison to the base case (existing conditions at Base Case Circle Route) as follows:

- *Option 1A Niagara Main – Significantly Better.*
- *Option 2A Far West Alignment – Somewhat Better.*

The significantly better rating for Option 1A Niagara Main is heavily weighted by the route's relatively short length and much fewer interactions with aquatic habitat than the base case circle route; however, there will still likely be new disturbances required in fish bearing aquatic habitats that represent likely mitigable aquatic environment effects. The somewhat better rating for Option 2A is based on the long route length which will likely trigger the provincial EA process for development of this new paved all-season road (as defined under the provincial BCEAA). The rating for Option 2A is also based on the fact there will likely be new disturbances required in fish bearing aquatic habitats that are likely mitigable, but also changes within the Leech River watershed area which is planned to become an additional drinking water supply area to supplement the Sooke Lake Reservoir (CRD 2019b). It is anticipated that any stream crossing structures currently creating water quality or fish passage issues along this route (i.e., culverts) would be replaced with either open bottom structures or clear-span bridges as part of the detailed project design and this could mitigate and improve existing effects on fish passage and downstream water quality.

ARCHAEOLOGICAL / HISTORICAL IMPACTS

A desk-top review was conducted of archaeological and historical information available from the following web-based resources:

- The Provincial Heritage Register (PHR) maintained by the Archaeology Branch, Ministry of Forests, Lands, Natural Resource Operations and Rural Development was accessed to identify registered archaeological and historical sites within the Option Alignments;
- Archaeology Branch approved archaeological predictive models (Government of BC 2019b);
- The provincial Consultative Areas Database to identify First Nations with potential Aboriginal interests in the short-listed options and use existing information on coordination requirements of specific First Nations groups of interest (Government of BC 2019c); and
- Google Earth imagery.

Archaeological potential is a term used to describe the likelihood of archaeological sites to be located within a certain area, such as a project area. Generally speaking, areas described as having "low" archaeological potential are areas where the discovery of archaeological sites is considered to be unlikely. In contrast, areas of "high" archaeological potential are areas where the biophysical characteristics of the area suggest that the discovery of an archaeological site is more likely. Common factors that are used to assess archaeological potential include slope, aspect, soil drainage, and proximity to potable water, transportation corridors (i.e. major rivers), and shorelines.

Characteristics that tend to reduce archaeological potential include steep terrain, poorly drained areas, and areas that have been subject to significant ground disturbance.

In some areas of British Columbia, archaeological predictive models that incorporate pertinent data such as existing archaeological site locations, historical land use and biophysical characteristics to identify areas where archaeological sites are expected to be located have been developed. The BC Archaeology Branch maintains a database of approved predictive models for archaeologists to review when conducting archaeological assessments. This database is accessible through the Remote Access to Archaeological Data application and was reviewed for this Option Screening Assessment.

The results of desktop analysis are reflected in the output below in ***Table 5.19***.

Table 5.19: Number of Previously Identified and Registered Heritage Sites Crossed or within 100 metres of Option Alignment

OPTION	ARCHAEOLOGICAL SITE	HISTORICAL SITE – FORMALLY RECOGNIZED	HISTORICAL SITE - UNPROTECTED NOT RECOGNIZED
Base Case Circle Route	17	0	0
1A – Niagara Main	0	0	0
2A – Far West Alignment	12	2	0

In addition to the registered heritage sites mentioned above, a number of First Nations communities and organizations have documented Aboriginal interest in the areas around the options. The results of the search of the provincial Consultative Areas Database indicated that the following First Nations communities and organizations have a documented Aboriginal interest in both route options:

- Cowichan Tribes;
- Esquimalt First Nation;
- Halalt First Nation;
- Lake Cowichan First Nation;
- Lyackson First Nation;
- Malahat Nation;
- Pauquachin First Nation;
- Penelakut Tribe;
- Scia'new First Nation;
- Songhees Nation;
- Stz'uminus First Nation;
- Te'Mexw Treaty Association;
- Tsartlip First Nation;
- Tsawout First Nation; and
- Tseycum First Nation.

Option 1A – Niagara Main

Based on the review of the PHR, there are no registered archaeological sites or historic places in or within 100 metres of Option 1A Niagara Main. The closest registered heritage site to Option 1A Niagara Main comprises shell midden and two possible cairns, which are located approximately 560 metres to the northeast of Option 1A Niagara Main. The absence of registered archaeological and historic sites within the Option 1A Alignment is a likely indicator of a data gap and not a lack of archaeological resources within the Option 1A Niagara Main alignment. Completion

of additional archaeological studies (e.g. archaeological overview assessment or archaeological impact assessment) could address this data gap.

Option 1A Niagara Main traverses variable terrain comprising saddles, side slopes and benches that is primarily moderate to well drained and passes immediately east of Wigglesworth Lake and intersects Goldstream River, Niagara Creek, Langford Creek, Waugh Creek, Arbutus Creek, Irving Creek as well as numerous unnamed drainages which would likely have been used as travel corridors and provided access to potable water and subsistence resources. Portions of the Option 1A Niagara Main have been modelled as having archaeological potential (Hul'muquim Treaty Group 2005, Eldridge and Parker 2007). Based on these results, the potential for heritage resources within Option 1A – Niagara Main is considered to exist.

The results of the search of the provincial Consultative Areas Database indicated no other specific documented aboriginal interests beyond those mentioned previously. Many of British Columbia's First Nations have developed their own heritage policies and permitting systems. It is currently understood that none of the First Nations communities and organizations that have documented Aboriginal interest in Option 1A Niagara Main have cultural heritage permitting systems.

Option 2A – Far West Alignment

Based on the review of the PHR and Google Earth imagery, there are no registered archaeological sites or historic places that intersect the existing road network. There are 12 registered archaeological sites and two registered historic places within 100 metres of Option 2A Far West Alignment. Of the 12 registered archaeological sites, two comprise surface lithics, one consists of an earthwork trench embankment, two comprise shell midden and have been designated legacy status by the British Columbia Archaeology Branch, one comprises shell midden and burial, one comprises shell midden and a burial and a trench embankment, one comprises shell midden and a cairn and the remaining four comprise shell midden. The two registered historic places are the Mill Bay Church and Cemetery and the Shawnigan Lake Fire Hall and Shawnigan Lake Museum.

The limited number of registered archaeological and historic sites within the Option 2A Far West Alignment is a likely indicator of a data gap within the Option 2A Far West Alignment. Completion of additional archaeological studies (e.g. archaeological overview assessment or archaeological impact assessment) could address this data gap.

Option 2A Far West Alignment traverses variable terrain comprising saddles, side slopes and benches that is primarily moderate to well drained and passes immediately north of Shawnigan Lake, Poirier Lake, east of Young Lake, east of Butler Lake, south of Glen Lake and along the shoreline of Sooke Harbour. Option 2A Far West Alignment intersects or parallels Shawnigan Creek, Leech River, Koksilah River, Jordan River, Tripp Creek, College Creek, Sooke River, Bear Creek, Lannon Creek, Saseenos Creek, Ayum Creek, Firehall Creek, Veitch Creek, Bilston Creek, Colwood Creek as well as numerous unnamed drainages which would likely have been used as travel corridors and provided access to potable water and subsistence resources. Portions of the Option 2A Far West Alignment have been modelled as having archaeological potential (Hul'muquim Treaty Group 2005, Eldridge and Parker 2007, Parker 2008). Based on these results, the potential for heritage resources within Option 2A – Far West Alignment is considered to exist.

In addition to those groups mentioned previously, the results of the search of the provincial Consultative Areas Database indicated that the following other First Nations communities and organizations have documented Aboriginal interest in Option 2A Far West Alignment only:

- Pacheedaht First Nation; and,
- T'sou-ke First Nation.

Many of British Columbia's First Nations have developed their own heritage policies and permitting systems. It is currently understood that none of the First Nations communities and organizations that have documented Aboriginal interest in Option 2A Far West Alignment have cultural heritage permitting systems.

Evaluation Output – Overall the options, in terms of archaeological / historical impacts, are qualitatively rated in comparison to the base case (existing conditions) as follows:

- *Option 1A Niagara Main – Significantly Better.*
- *Option 2A Far West Alignment – Somewhat Better.*

This qualitative evaluation is based solely on the available data. Though none of the registered archaeological or historic places within the Base Case, Option 1A or Option 2A intersect the existing road network, the likelihood that heritage resources would be impacted as a result of pursuing either Option 1A or Option 2A is considered to be high when compared to the Base Case.

This archaeological and historic places review does not comprise a formal archaeological overview assessment or an archaeological impact assessment and is considered an internal planning tool that is confidential in nature. As such, this archaeological and heritage review does not include a preliminary field reconnaissance or notifying or liaising with potentially affected First Nations to determine whether they have heritage information that could contribute to this review at this stage.

5.2.4 Financial Account

This section outlines the estimated high-level financial costs that would be associated with the implementation of the routes, including capital costs, property costs, maintenance and rehabilitation and operational costs, and the anticipated salvage value. Costs are presented in their estimated values and their present 2019 values, assuming a service period of 25-years and a six percent discount rate.

CAPITAL COSTS

Construction Costs

The capital construction costs were estimated at a high-level, using a composite per linear metre quantities and rate for homogeneous sections of the two routes. The construction is anticipated to take 2.5 years starting in 2019, with operations assumed to begin in 2022 for both options. This is because Option 1A can be anticipated to have a long permitting schedule as it travels through a regional park, while Option 2A can be anticipated to have a long construction schedule due to its length. The estimated capital construction costs are shown in ***Table 5.20*** overleaf. A breakdown of the assumptions and rates used in the calculation of these estimates are available in ***Appendix C***.

It should be noted that the FortisBC line that parallels and occasionally crosses the Niagara Main in Option 1A is assumed to have an overhead coverage greater than one metre in depth such that it would not be affected by vehicular traffic and no special allowances would be required. As such, it is anticipated the gas line would remain in place during and after construction with only minor mitigations required.

Table 5.20: Capital Construction Cost Estimates

CONSTRUCTION ACTIVITY	OPTION 1A ($,000S)	OPTION 2A ($,000S)
Roadway Costs	$6,315	$41,080
Structural Costs	$2,736	$14,350
Water Protection	$200	$1,000
Environmental Impacts	$100	$500
Environmental Compensation	$500	$0
Traffic Management	$100	$1,000
Construction Subtotal	$9,952	$57,930
Mobilization (5%)	$498	$2,896
Preliminary Design (4%)	$398	$2,317
Detailed Design (8%)	$796	$4,634
Resident Engineering (10%)	$995	$5,793
Project Management (10%)	$995	$5,793
Contingency (100%)	$13,634	$79,364
Project Cost Subtotal	$27,268	$158,728
Management Reserve (10%)	$2,727	$15,873
Total	**$29,994**	**$174,601**
Total Rounded to Next Half Million	**$30,000***	**$175,000***

* Note: Cost estimates assume a LVR standard design, and could be lower for both options provided a detour operational guideline and traffic management plan were established with corresponding reduced engineering criteria.

Property Costs

To determine the cost for acquisition of a road right-of-way, the land assessment values of a selection of Mosaic Forest Management properties and private non-forestry properties were determined, and an average per hectare rates were estimated using the areas. The resultant rates are $2,500 / hectare for Mosaic Forest Management lands, and $10,900 / hectare for private non-forestry lands. A contingency of 30% was also applied. The property costs anticipated for the two detour routes are presented below in ***Table 5.21***. As the property acquisition is anticipated to occur in the first year, the present value would equal the total estimated cost.

Table 5.21: Property Value Estimates

OPTION	AREA OF MOSAIC PROPERTIES(HA)	AREA OF OTHER PRIVATE PROPERTIES(HA)	PROPERTY COST ($MILLION)	PROPERTY COST WITH CONTINGNECY ($MILLION)
1A	0.0	5	$ 0.4	$ 0.5
2A	250.7	5.1	$ 5.3	$ 6.9

Total Capital Costs

The cost breakdowns and total project cost (not including escalation) of both options are summarized below in *Table 5.22*.

Table 5.22: Total Capital Cost Breakdown

CONSTRUCTION ACTIVITY	OPTION 1A ($MILLION)	OPTION 2A ($MILLION)
Property Costs	$ 0.4	$ 5.3
Construction / Mobilization Costs	$ 10.4	$ 60.8
Engineering / Project Management Costs	$ 3.2	$ 18.6
Contingency	$ 13.7	$ 81.3
Management Reserve	$ 2.7	$ 15.9
Total	**$ 30.5**	**$ 181.9**

MAINTENANCE, OPERATIONS, AND REHABILITATION COST

The cost of maintenance and rehabilitation would only be applicable for the net incremental increase in roadway that would be implemented as part of a detour route. For the most part, the new roadway would come in the form of roadway widening, as the roads already partially exist in the form of gravel roadways. For the existing public roadways, it is assumed that the net increase in maintenance costs would be negligible. Additionally, it is assumed that the Pacific Marine Circle Route would remain in operation, and would thusly not represent a decrease in maintenance responsibilities. The overall net increases in the length of roadway lanes and bridge deck area is shown below in *Table 5.23*.

Table 5.23: New Net Quantities of Roadway and Bridge Deck

OPTION	NET LANE KILOMETRES PAVED (LN-KM)	NET LANE KILOMETRES GRAVEL (LN-KM)	BRIDGE AREA TOTAL (M2)	BRIDGE AREA DELTA (M2)
1A	0.0	6.6	435	361
2A	113.7	- 56.9	2,360	1037

Operational costs are assumed to consist of charge out rates for traffic control persons (TCPs) and changeable message signs (CMSs). Based upon an Incident Traffic Management Plan from MoTI, it was determined that the base case Pacific Marine Circle Route requires approximately 37 TCPs and 11 CMSs over a length of 188 kilometres. It is assumed that the alternative detour routes would require similar amounts of TCPs and CMSs on a per length basis. As such, Option 1A would require 4 TCPs and 2 CMS while Option 2A would require 20 TCPs and 6 CMSs.

The monetized maintenance, rehabilitation, and operational costs are shown in *Table 5.24* below.

Table 5.24: Maintenance, Rehabilitation, and Operational Cost Estimates

OPTION	NET ANNUAL MAINTENANCE COSTS ($,000S)	AVERAGE OPERATIONAL COSTS ($,000S)	NET PAVED ROADWAY REHAB COSTS ($,000S, 15-YEAR PERIOD)	NET GRAVEL ROADWAY REHAB COSTS ($,000S, 5-YEAR PERIOD)	NET BRIDGE REHAB COSTS ($,000S 30-YEAR PERIOD)	TOTAL PRESENT VALUE (PV $MILLION 2019)
1A	$ 22	$ 2	$ 0	$ 132	$ 542	$ 0.6 M
2A	$ 381	$ 9	$ 11,370	- $ 1,136	$ 1,556	$ 6.2 M

SALVAGE VALUE

Salvage value represents the remaining life / benefits the mitigation option has beyond the evaluation period. The estimated present values for salvage are shown in ***Table 5.25*** below. The methodology used to calculate

Table 5.25: Salvage Value Estimates

OPTION	SALVAGE ($MILLION)	PRESENT VALUE (PV $MILLION 2019)
1A	$ 7.3	$ 1.4
2A	$ 48.6	$ 9.5

BENEFIT COST RATIO AND NET PRESENT VALUE

The following benefit cost ratios and net present values in ***Table 5.26*** were determined.

Table 5.26: Benefit Cost Ratio and Net Present Values

OPTION	BENEFITS (PV $MILLION 2019)	COSTS (PV $MILLION 2019)	BENEFIT COST RATIO (B/C, PV $MILLION 2019)	NET PRESENT VALUE (PV $MILLION 2019)
1A	$ 7.6	$ 29.7	0.26	- $ 22.1
2A	$ 3.8	$ 178.6	0.02	- $ 174.8

5.3 Option Evaluation Summary and Outcome

The table overleaf, ***Table 5.27***, provides a summary of the evaluation assessments for each criteria and provides an outcome for the evaluation of each criteria point. The two potential emergency detour route alternatives are compared against the do-nothing base case, in which Highway 1 traffic continues to be diverted to the Pacific Marine Circle Route, which is an existing route that travels through Lake Cowichan and Port Renfrew via Highways 18 and 14 in order to detour around the Malahat Segment of Highway 1.

Table 5.27: Option Evaluation Summary and Outcome

ACCOUNT	CRITERIA	UNITS	OPTIONS		
			BASE CASE	OPTION 1A	OPTION 2A
			CIRCLE ROUTE (DO NOTHING)	NIAGARA MAIN	FAR WEST ALIGNMENT
Customer Service	Traffic Mobility	Travel Time (hrs)	~ 4.0 hrs Hwy 1 incidents ~ 3.5 hrs Hwy 14 incidents	~ 0.6 hrs for Hwy 1 incidents N/A for Hwy 14 incidents	~ 2.3 for Hwy 1 incidents ~ 2 hrs for Hwy 14 incidents
	Travel Time Savings	$M (2019 PV)	N/A	$ 7.6	$ 3.8
Socio-Community	Property Impacts	Property Area (ha)	N/A	5.0 hectares total, 0.0 hectares of Mosaic Forest Management	255.8 hectares total, 250.7 hectares of Mosaic Forest Management
	Noise and Visual Impacts	Qualitative / # of Residents	1,150 residents within 50 m of lower volume roadways.	~250 residents within 50 m of lower volume roadways. Significantly Better ●	~450 residents within 50 m of lower volume roadways. Significantly Better ●
	Water Resource Impacts	Qualitative	Water supply areas that the base case passes through are either groundwater supplied, or upstream of the route, therefore negligible impacts are anticipated from usage of the base case.	Located directly on the edge of the Drinking Water Protection Zone and the southeasternmost portion of the Goldwater Supply Area. Does not enter the water catchment area, but does pass close to the Japan Gulch Disinfection Facility and increases wildfire risks. Somewhat Worse ◔	Passes by an edge of the Leech River Watershed and overtop of one stream that connects downstream to the Leech River, however mitigation measures could be taken and have been included in the cost estimate. Somewhat Worse ◔
	Community Disruption	Qualitative / # of Residents	~50 residents near collector and local roads ~11,950 residents near arterial roads	~950 residents near collector and local roads ~50 residents near arterial roads The number of residents that would be disturbed by increased traffic on local and collector roadways would significantly increase relative to the base case, however, the number of residents near arterial roadways would decrease. Significantly Worse ○	~1,250 residents near collector and local roads ~8,400 residents near arterial roads The number of residents that would be disturbed by increased traffic on local and collector roadways would significantly increase relative to the base case, and those near arterial roadways would only slightly decrease. Significantly Worse ○

ACCOUNT	CRITERIA	UNITS	OPTIONS		
			BASE CASE	OPTION 1A	OPTION 2A
			CIRCLE ROUTE (DO NOTHING)	NIAGARA MAIN	FAR WEST ALIGNMENT
Environmental	Terrestrial Impacts	Qualitative	78 At-risk species nearby, Crosses 2 Provincial Parks, 1 National Park, and 5 Regional Parks Crosses 6 legal OGMAs and 1 WMA	17 At-risk species nearby Passes near 1 Provincial and bisects 1 Regional Park, also impacts the Great Trail Crosses no OGMAs or WMAs Has significantly fewer terrestrial impacts and results in detouring vehicles passing through far fewer instances of at risk species than the base case. As Option 1A bisects the Sooke Hills Regional Park there are anticipated to be some impacts to fauna and flora in the park that would be difficult to entirely mitigate. Significantly Better ●	48 At-risk species nearby Minorly bisects 1 Provincial Park and passes near 4 Regional Parks Crosses one non-legal OGMA Would result in detouring vehicles passing fewer instances of at risk species. Due to the length of Option 2A, the provincial environmental assessment process would likely be triggered. The existing federal environmental assessment process may be triggered (CEAA, 2012), but not the new federal *Impact Assessment Act* (IAA). Somewhat Better ◕
	Aquatic Impacts	Qualitative	442 interactions with water courses and waterbodies	36 interactions with water courses / waterbodies The route has significantly fewer interactions with aquatic features, and would therefore have fewer interactions between detouring vehicles and water bodies. It should be noted that these would be new impacts to fish bearing features. Significantly Better ●	335 interactions with water courses / waterbodies The route length would likely trigger the provincial environmental assessment process and would result in disturbances of fish bearing habitats that may be mitigatable. It is anticipated that stream crossing structures currently creating water quality or fish passage issues would be replaced with clear span or open bottom structures. Somewhat Better ◕
	Archaeological / Historical Impacts	Qualitative	There are 17 registered archaeological sites within 100 metres of the Pacific Marine Circle Route.	Although no registered archaeological sites or historic places intersect with the option, there is considered to be a high likelihood of impacts to unregistered sites. Significantly Better ●	There are 12 registered archaeological sites and 2 historic places within 100 metres of the route, although none intersect. There is considered to be a high likelihood of impacts to unregistered sites. Somewhat Better ◕

ACCOUNT	CRITERIA	UNITS	OPTIONS		
			BASE CASE	OPTION 1A	OPTION 2A
			CIRCLE ROUTE (DO NOTHING)	NIAGARA MAIN	FAR WEST ALIGNMENT
Financial	Capital Cost	$M (2019 PV)	N/A	$ 30.0	$ 175.0
	Property Cost	$M (2019 PV)	N/A	$ 0.5	$ 6.9
	Maintenance Costs	$M (2019 PV)	N/A	$ 0.6	$ 6.2
	Salvage Value	$M (2019 PV)	N/A	$ 1.4	$ 9.5
	B/C Ratio	Ratio	N/A	0.26	0.02
	NPV	$M (2019 PV)	N/A	- $ 22.1	- $ 174.8
Evaluation Outcome			**Possible (Status Quo)**	**Preferred**	**Possible**
Rationale			Although the base case involves a very long detour for vehicles travelling between Victoria and areas north of the Shawnigan Lake Road intersection, the route already exists and would have no net impacts to water resources or the environment. Additionally, the average number of incidents a year, in which the route would be required, is quite low, with an anticipated 1.1 incidents a year.	This option has a lower capital cost and greater travel time savings of the two alternative emergency detour route options. This option also has significantly fewer interactions with aquatic features and does not enter the water catchment area of the CRD's water supply area, although it would pass in close proximity to, and may bisect the CRD Japan Gulch Disinfection Facility compound. One significant drawback of this option is that it crosses the Sooke Hills Regional Park which would result in impacts to fauna and flora in the park that would be difficult to entirely mitigate. Environmental compensation will likely be required to address unmitigated impacts.	Although not identified as the preferred route option, this option is still possible. There are significant travel time savings for this option when compared to the base case, particularly as this route also has the benefit of offering a Highway 14 detour alternative. This option passes by an edge of the Leech River Watershed and overtop of one stream that connects downstream to the Leech River, however mitigation measures could be taken. Drawbacks of this option are the high cost and the significantly increased number of residents that would be disturbed by increased traffic on local and collector roadways relative to the base case, during a Highway 1 detour deployment.

6. Conclusions

The Trans-Canada Highway is the main north-south corridor on Vancouver Island and serves as a critical route for commuting, moving goods, linking communities, and supporting a thriving tourism industry in the region. While long duration full highway closures are infrequent, during the rare event of an emergency closure of the Malahat between Shawnigan Lake Road and West Shore Parkway, there are limited alternative route options for a detour to enable traffic to bypass the affected site.

Seven possible alternative Malahat Highway emergency detour routes have been generated for consideration. A screening process was conducted to identify any short comings which would result in some options being eliminated from further consideration. This resulted in only two short-listed options being taken forward for a more detailed assessment using the Multiple Account Evaluation (MAE) framework, Option 1A Niagara Main Option and Option 2A Far West Alignment.

The relative merits and drawbacks of these two options against the base case (Pacific Marine Circle Route), was conducted using a high-level evaluation which was based on the Multiple Account Evaluation methodology typically used for MoTI planning studies. For this study, the following accounts and criteria were applied:

- Customer Service (Traffic Mobility and Travel Time Savings);
- Socio-Community (Property Impacts, Noise and Visual Impacts, Water Resource Impacts, and Community Disruption);
- Environmental (Terrestrial Impacts, Aquatic Impacts, and Archaeological / Historical Impacts); and
- Financial (Capital Cost, Property Cost, Maintenance Costs, Salvage Value, Benefit / Cost Ratio, and Net Present Value).

Option 1A Niagara Main is seen to be feasible from a construction perspective and is the preferred option. This option has a lower capital cost and greater travel time savings of the two alternative emergency detour route options. This option also has significantly fewer interactions with aquatic features and does not enter the water catchment area of the Capital Region District's water supply. However, there are three primary drawbacks of this option. One drawback being that the option bisects and severs the Sooke Hills Regional Park and Great Trail alignment along the Niagara Main road, which would result in impacts to fauna and flora in the park, and the requirement to relocate a section of the Great Trail, all of which would be difficult to entirely mitigate. Environmental compensation will likely be required to address unmitigated impacts. The second drawback is that the alignment passes in close proximity to and may bisect the CRD Japan Gulch Disinfection Facility compound. The facility would require security revisions / upgrades to continue the protection of the facility from the emergency detour roadway, as well as operational procedure adjustments to maintain public safety in relation to separation of the public from facility areas that require the loading, storage, and injection of chemical treatments including ammonia and chlorine. It is envisioned that certain operational procedures in the handling of water treatment chemicals may be unmitigable in that an emergency detour activation could not occur simultaneously with scheduled chemical storage delivery processes, or a chemical release emergency situation. The last drawback would be the increase in wildfire risks that come from vehicles travelling alongside the water protection buffer zone during the activation of the emergency detour.

Option 2A Far West Alignment is also seen to be feasible from a construction perspective, however it is not the preferred option. The lengthy distance of the route results in a very significant capital cost given the design standards. Additionally, the length results in a lower travel time savings than Option 1A, even though Option 2A would also be able to act as a detour route for long duration closures on Highway 14 between Drennan Street and Gillespie Road. Asides from the capital costs, the two largest drawbacks of this option are the increased number of residents that would be impacted by detouring traffic and the crossing of a watercourse that connects downstream to the Leech River, although both of these drawbacks could be mitigated against.

Finally, the Status Quo could be maintained in the future, resulting in traffic operations assumed in the Base Case. Although this is not the most desirable for traffic operations due to the long detour times involved, there would be no additional costs or impacts as the existing detour routes currently exist. As the anticipated average annual number of long duration incidents is only 1.1 per year, which could also decrease as more improvements to Highway 1 are undertaken, the overall effective usage of an additional detour route alternative is somewhat low.

All three of the options mentioned above, including Option 1A, Option 2A, and the Base Case (status quo) could be viable outcomes that could be pursued in the future. Each of the options could be supported depending on the specific weighting given to individual evaluation criteria. As there was no specific weighting used for this study, meaning that all the criteria were treated equally, the preferred option that was identified was Option 1A, the Niagara Main.

Appendix A

Customer Service Benefits

Full Tables

Table A1: Average Traffic Volumes on Highway 1 Malahat Segment

DIVERSION PERCENTAGE	TIME PERIOD AVERAGE TOTAL VOLUME (VEHICLES)					
	0 – 3	4 – 7	8 – 11	12 – 15	16 – 19	20 – 23
Typical	357	2,859	6,008	7,114	6,368	2,032
Typical Plus Next Period	3,217	8,867	13,122	13,482	8,400	2,389
5 %	161	443	656	674	420	119
10 %	322	887	1,312	1,348	840	239
15 %	482	1,330	1,968	2,022	1,260	358
20 %	643	1,773	2,624	2,696	1,680	478
25 %	804	2,217	3,281	3,371	2,100	597
30 %	965	2,660	3,937	4,045	2,520	717
35 %	1,126	3,103	4,593	4,719	2,940	836
40 %	1,287	3,547	5,249	5,393	3,360	956
45 %	1,447	3,990	5,905	6,067	3,780	1,075
50 %	1,608	4,434	6,561	6,741	4,200	1,195
55 %	1,769	4,877	7,217	7,415	4,620	1,314
60 %	1,930	5,320	7,873	8,089	5,040	1,434
65 %	2,091	5,764	8,529	8,763	5,460	1,553
70 %	2,252	6,207	9,185	9,437	5,880	1,673
75 %	2,412	6,650	9,842	10,112	6,300	1,792
80 %	2,574	7,094	10,498	10,786	6,720	1,911
85 %	2,734	7,537	11,154	11,460	7,140	2,031
90 %	2,895	7,980	11,810	12,134	7,560	2,150

Table A2: Average Traffic Volumes on Highway 14 – Drennan Street to Gillespie Road

DIVERSION PERCENTAGE	TIME PERIOD AVERAGE TOTAL VOLUME (VEHICLES)					
	0 – 3	4 – 7	8 – 11	12 – 15	16 – 19	20 – 23
Typical	2,554	6,350	8,805	8,922	5,336	1,423
Typical Plus Next Period	128	318	440	446	267	71
5 %	255	635	881	892	534	142
10 %	383	953	1,321	1,338	800	213
15 %	511	1,270	1,761	1,784	1,067	285
20 %	639	1,588	2,201	2,231	1,334	356
25 %	766	1,905	2,642	2,677	1,601	427
30 %	894	2,223	3,082	3,123	1,868	498
35 %	1,022	2,540	3,522	3,569	2,134	569
40 %	1,150	2,858	3,962	4,015	2,401	640
45 %	1,277	3,175	4,403	4,461	2,668	711
50 %	1,405	3,493	4,843	4,907	2,935	783
55 %	1,533	3,810	5,283	5,353	3,202	854
60 %	1,660	4,128	5,723	5,799	3,468	925
65 %	1,788	4,445	6,164	6,246	3,735	996
70 %	1,916	4,763	6,604	6,692	4,002	1,067
75 %	2,044	5,080	7,044	7,138	4,269	1,138
80 %	2,043	5,080	7,044	7,138	4,269	1,138
85 %	2,171	5,398	7,484	7,584	4,536	1,210
90 %	2,299	5,715	7,925	8,030	4,802	1,281

Table A3: Base Case Travel Times Given Highway 1 Incident Occurrence Time and Diversion Percentage

DIVERSION PERCENTAGE	ANNUALIZED INCIDENT TRAVEL TIME SAVINGS PER TIME PERIOD (HRS)						
	0 – 3	4 – 7	8 – 11	12 – 15	16 – 19	20 – 23	TOTAL
5 %	0	3,801	16,876	5,780	10,803	3,073	40,333
10 %	0	3,799	16,864	5,776	10,795	3,071	40,305
15 %	0	3,796	16,852	5,772	10,788	3,069	40,277
20 %	0	3,793	16,841	5,768	10,780	3,066	40,248
25 %	0	3,791	16,829	5,764	10,773	3,064	40,220
30 %	0	3,788	16,817	5,759	10,765	3,062	40,192
35 %	0	3,785	16,805	5,755	10,758	3,060	40,163
40 %	0	3,783	16,793	5,751	10,750	3,058	40,135
45 %	0	3,780	16,781	5,747	10,742	3,056	40,106
50 %	0	3,777	16,769	5,743	10,735	3,054	40,078
55 %	0	3,775	16,758	5,739	10,727	3,051	40,050
60 %	0	3,772	16,746	5,735	10,720	3,049	40,021
65 %	0	3,769	16,734	5,731	10,712	3,047	39,993
70 %	0	3,767	16,722	5,727	10,704	3,045	39,965
75 %	0	3,764	16,710	5,723	10,697	3,043	39,936
80 %	0	3,761	16,698	5,719	10,689	3,041	39,908
85 %	0	3,759	16,686	5,715	10,682	3,038	39,880
90 %	0	3,756	16,674	5,711	10,674	3,036	39,851

Table A4: Option 1A Travel Times Given Highway 1 Incident Occurrence Time and Diversion Percentage

DIVERSION PERCENTAGE	ANNUALIZED INCIDENT TRAVEL TIME SAVINGS PER TIME PERIOD (HRS)						
	0 – 3	4 – 7	8 – 11	12 – 15	16 – 19	20 – 23	TOTAL
5 %	0	3,652	16,214	5,553	10,379	2,952	38,750
10 %	0	3,500	15,539	5,322	9,947	2,829	37,137
15 %	0	3,348	14,864	5,091	9,515	2,707	35,525
20 %	0	3,196	14,190	4,860	9,084	2,584	33,913
25 %	0	3,044	13,515	4,629	8,652	2,461	32,301
30 %	0	2,892	12,841	4,398	8,220	2,338	30,689
35 %	0	2,740	12,166	4,167	7,788	2,215	29,077
40 %	0	2,589	11,492	3,936	7,356	2,093	27,465
45 %	0	2,437	10,817	3,705	6,925	1,970	25,853
50 %	0	2,285	10,143	3,474	6,493	1,847	24,241
55 %	0	2,133	9,468	3,243	6,061	1,724	22,629
60 %	0	1,981	8,794	3,012	5,629	1,601	21,017
65 %	0	1,829	8,119	2,781	5,197	1,478	19,405
70 %	0	1,677	7,445	2,550	4,766	1,356	17,792
75 %	0	1,525	6,770	2,319	4,334	1,233	16,180
80 %	0	1,373	6,096	2,088	3,902	1,110	14,568
85 %	0	1,221	5,421	1,857	3,470	987	12,956
90 %	0	1,069	4,747	1,626	3,038	864	11,344

Table A5: Option 2A Travel Times Given Highway 1 Incident Occurrence Time and Diversion Percentage

DIVERSION PERCENTAGE	ANNUALIZED INCIDENT TRAVEL TIME SAVINGS PER TIME PERIOD (HRS)						
	0 – 3	4 – 7	8 – 11	12 – 15	16 – 19	20 – 23	TOTAL
5 %	0	3,723	16,531	5,661	10,582	3,010	39,507
10 %	0	3,643	16,173	5,539	10,353	2,945	38,653
15 %	0	3,562	15,816	5,417	10,124	2,880	37,799
20 %	0	3,482	15,458	5,294	9,895	2,815	36,945
25 %	0	3,401	15,101	5,172	9,667	2,750	36,090
30 %	0	3,321	14,743	5,049	9,438	2,685	35,236
35 %	0	3,240	14,386	4,927	9,209	2,620	34,382
40 %	0	3,160	14,029	4,804	8,980	2,554	33,528
45 %	0	3,079	13,671	4,682	8,751	2,489	32,673
50 %	0	2,999	13,314	4,560	8,523	2,424	31,819
55 %	0	2,918	12,956	4,437	8,294	2,359	30,965
60 %	0	2,838	12,599	4,315	8,065	2,294	30,110
65 %	0	2,757	12,241	4,192	7,836	2,229	29,256
70 %	0	2,677	11,884	4,070	7,607	2,164	28,402
75 %	0	2,596	11,526	3,948	7,379	2,099	27,548
80 %	0	2,516	11,169	3,825	7,150	2,034	26,693
85 %	0	2,435	10,812	3,703	6,921	1,969	25,839
90 %	0	2,355	10,454	3,580	6,692	1,904	24,985

Table A6: Base Case Travel Times Given Highway 14 Incident Occurrence Time and Diversion Percentage

DIVERSION PERCENTAGE	ANNUALIZED INCIDENT TRAVEL TIME SAVINGS PER TIME PERIOD (HRS)						
	0 – 3	4 – 7	8 – 11	12 – 15	16 – 19	20 – 23	TOTAL
5 %	0	0	3,563	18,050	10,795	1,152	33,560
10 %	0	0	3,550	17,984	10,755	1,147	33,436
15 %	0	0	3,536	17,917	10,715	1,143	33,312
20 %	0	0	3,523	17,850	10,675	1,139	33,188
25 %	0	0	3,510	17,784	10,636	1,135	33,064
30 %	0	0	3,497	17,717	10,596	1,130	32,940
35 %	0	0	3,484	17,650	10,556	1,126	32,816
40 %	0	0	3,471	17,584	10,516	1,122	32,692
45 %	0	0	3,457	17,517	10,476	1,117	32,568
50 %	0	0	3,444	17,450	10,436	1,113	32,444
55 %	0	0	3,431	17,384	10,396	1,109	32,320
60 %	0	0	3,418	17,317	10,356	1,105	32,196
65 %	0	0	3,405	17,250	10,316	1,100	32,072
70 %	0	0	3,392	17,184	10,277	1,096	31,948
75 %	0	0	3,378	17,117	10,237	1,092	31,824
80 %	0	0	3,365	17,050	10,197	1,088	31,700
85 %	0	0	3,352	16,983	10,157	1,083	31,576
90 %	0	0	3,339	16,917	10,117	1,079	31,452

Table A7: Option 2A Travel Times Given Highway 14 Incident Occurrence Time and Diversion Percentage

DIVERSION PERCENTAGE	ANNUALIZED INCIDENT TRAVEL TIME SAVINGS PER TIME PERIOD (HRS)						
	0 – 3	4 – 7	8 – 11	12 – 15	16 – 19	20 – 23	TOTAL
5 %	0	0	3,495	17,706	10,589	1,130	32,919
10 %	0	0	3,413	17,294	10,343	1,103	32,154
15 %	0	0	3,332	16,883	10,097	1,077	31,388
20 %	0	0	3,251	16,471	9,851	1,051	30,623
25 %	0	0	3,170	16,060	9,604	1,025	29,858
30 %	0	0	3,089	15,648	9,358	998	29,093
35 %	0	0	3,007	15,237	9,112	972	28,328
40 %	0	0	2,926	14,825	8,866	946	27,563
45 %	0	0	2,845	14,413	8,620	920	26,798
50 %	0	0	2,764	14,002	8,374	893	26,033
55 %	0	0	2,682	13,590	8,128	867	25,268
60 %	0	0	2,601	13,179	7,882	841	24,503
65 %	0	0	2,520	12,767	7,636	814	23,737
70 %	0	0	2,439	12,356	7,389	788	22,972
75 %	0	0	2,358	11,944	7,143	762	22,207
80 %	0	0	2,276	11,533	6,897	736	21,442
85 %	0	0	2,195	11,121	6,651	709	20,677
90 %	0	0	2,114	10,710	6,405	683	19,912

Table A8: Anticipated Annualized Benefits for Option 1A Given Diversion Rates – Highway 1

Diversion %		Base Case Diversion Rates																	
		5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%
Option 1A Diversion Rates	5%	$38	$38	$37	$36	$36	$35	$34	$34	$33	$32	$31	$31	$30	$29	$29	$28	$27	$27
	10%	$77	$77	$76	$75	$75	$74	$73	$73	$72	$71	$70	$70	$69	$68	$68	$67	$66	$66
	15%	$116	$116	$115	$114	$114	$113	$112	$112	$111	$110	$109	$109	$108	$107	$107	$106	$105	$105
	20%	$155	$155	$154	$153	$153	$152	$151	$151	$150	$149	$148	$148	$147	$146	$146	$145	$144	$144
	25%	$194	$194	$193	$192	$192	$191	$190	$190	$189	$188	$187	$187	$186	$185	$185	$184	$183	$183
	30%	$233	$233	$232	$231	$231	$230	$229	$229	$228	$227	$226	$226	$225	$224	$224	$223	$222	$222
	35%	$272	$272	$271	$270	$270	$269	$268	$268	$267	$266	$265	$265	$264	$263	$263	$262	$261	$261
	40%	$311	$311	$310	$309	$309	$308	$307	$307	$306	$305	$304	$304	$303	$302	$302	$301	$300	$300
	45%	$350	$350	$349	$348	$348	$347	$346	$346	$345	$344	$343	$343	$342	$341	$341	$340	$339	$339
	50%	$389	$389	$388	$387	$387	$386	$385	$385	$384	$383	$382	$382	$381	$380	$380	$379	$378	$378
	55%	$428	$428	$427	$426	$426	$425	$424	$424	$423	$422	$421	$421	$420	$419	$419	$418	$417	$417
	60%	$467	$467	$466	$465	$465	$464	$463	$463	$462	$461	$460	$460	$459	$458	$458	$457	$456	$456
	65%	$506	$506	$505	$504	$504	$503	$502	$502	$501	$500	$499	$499	$498	$497	$497	$496	$495	$495
	70%	$545	$545	$544	$543	$543	$542	$541	$541	$540	$539	$538	$538	$537	$536	$536	$535	$534	$534
	75%	$584	$584	$583	$582	$582	$581	$580	$580	$579	$578	$577	$577	$576	$575	$575	$574	$573	$573
	80%	$623	$623	$622	$621	$621	$620	$619	$619	$618	$617	$616	$616	$615	$614	$614	$613	$612	$612
	85%	$662	$662	$661	$660	$660	$659	$658	$658	$657	$656	$655	$655	$654	$653	$653	$652	$651	$651
	90%	$701	$701	$700	$699	$699	$698	$697	$697	$696	$695	$694	$694	$693	$692	$692	$691	$690	$690

Table A9: Anticipated Annualized Benefits for Option 2A Given Diversion Rates – Highway 1

Diversion %		Base Case Diversion Rates																	
		5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%
Option 2A Diversion Rates	5%	$20	$19	$19	$18	$17	$17	$16	$15	$14	$14	$13	$12	$12	$11	$10	$10	$9	$8
	10%	$41	$40	$39	$39	$38	$37	$37	$36	$35	$34	$34	$33	$32	$32	$31	$30	$30	$29
	15%	$61	$61	$60	$59	$59	$58	$57	$57	$56	$55	$54	$54	$53	$52	$52	$51	$50	$50
	20%	$82	$81	$81	$80	$79	$79	$78	$77	$76	$76	$75	$74	$74	$73	$72	$72	$71	$70
	25%	$103	$102	$101	$101	$100	$99	$99	$98	$97	$96	$96	$95	$94	$94	$93	$92	$92	$91
	30%	$123	$123	$122	$121	$121	$120	$119	$119	$118	$117	$116	$116	$115	$114	$114	$113	$112	$112
	35%	$144	$143	$143	$142	$141	$141	$140	$139	$138	$138	$137	$136	$136	$135	$134	$134	$133	$132
	40%	$165	$164	$163	$163	$162	$161	$161	$160	$159	$158	$158	$157	$156	$156	$155	$154	$154	$153
	45%	$185	$185	$184	$183	$183	$182	$181	$181	$180	$179	$178	$178	$177	$176	$176	$175	$174	$174
	50%	$206	$205	$205	$204	$203	$203	$202	$201	$200	$200	$199	$198	$198	$197	$196	$196	$195	$194
	55%	$227	$226	$225	$225	$224	$223	$223	$222	$221	$220	$220	$219	$218	$218	$217	$216	$216	$215
	60%	$247	$247	$246	$245	$245	$244	$243	$243	$242	$241	$240	$240	$239	$238	$238	$237	$236	$236
	65%	$268	$267	$267	$266	$265	$265	$264	$263	$262	$262	$261	$260	$260	$259	$258	$258	$257	$256
	70%	$289	$288	$287	$287	$286	$285	$285	$284	$283	$282	$282	$281	$280	$280	$279	$278	$278	$277
	75%	$309	$309	$308	$307	$307	$306	$305	$305	$304	$303	$302	$302	$301	$300	$300	$299	$298	$298
	80%	$330	$329	$329	$328	$327	$327	$326	$325	$324	$324	$323	$322	$322	$321	$320	$320	$319	$318
	85%	$351	$350	$349	$349	$348	$347	$347	$346	$345	$344	$344	$343	$342	$342	$341	$340	$340	$339
	90%	$371	$371	$370	$369	$369	$368	$367	$367	$366	$365	$364	$364	$363	$362	$362	$361	$360	$360

Table A10: Anticipated Annualized Benefits for Option 2A Given Diversion Rates – Highway 14

Diversion %		Base Case Diversion Rates																	
		5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%
Option 2A Diversion Rates	5%	$16	$13	$10	$7	$4	$1	-$2	-$5	-$8	-$11	-$14	-$17	-$20	-$23	-$26	-$29	-$32	-$35
	10%	$34	$31	$28	$25	$22	$19	$16	$13	$10	$7	$4	$1	-$2	-$5	-$8	-$11	-$14	-$17
	15%	$53	$50	$47	$44	$41	$38	$35	$32	$29	$26	$23	$20	$17	$14	$11	$8	$5	$2
	20%	$71	$68	$65	$62	$59	$56	$53	$50	$47	$44	$41	$38	$35	$32	$29	$26	$23	$20
	25%	$90	$87	$84	$81	$78	$75	$72	$69	$66	$63	$60	$57	$54	$51	$48	$45	$42	$39
	30%	$108	$105	$102	$99	$96	$93	$90	$87	$84	$81	$78	$75	$72	$69	$66	$63	$60	$57
	35%	$127	$124	$121	$118	$115	$112	$109	$106	$103	$100	$97	$94	$91	$88	$85	$82	$79	$76
	40%	$145	$142	$139	$136	$133	$130	$127	$124	$121	$118	$115	$112	$109	$106	$103	$100	$97	$94
	45%	$164	$161	$158	$155	$152	$149	$146	$143	$140	$137	$134	$131	$128	$125	$122	$119	$116	$113
	50%	$182	$179	$176	$173	$170	$167	$164	$161	$158	$155	$152	$149	$146	$143	$140	$137	$134	$131
	55%	$201	$198	$195	$192	$189	$186	$183	$180	$177	$174	$171	$168	$165	$162	$159	$156	$153	$150
	60%	$219	$216	$213	$210	$207	$204	$201	$198	$195	$192	$189	$186	$183	$180	$177	$174	$171	$168
	65%	$238	$235	$232	$229	$226	$223	$220	$217	$214	$211	$208	$205	$202	$199	$196	$193	$190	$187
	70%	$256	$253	$250	$247	$244	$241	$238	$235	$232	$229	$226	$223	$220	$217	$214	$211	$208	$205
	75%	$275	$272	$269	$266	$263	$260	$257	$254	$251	$248	$245	$242	$239	$236	$233	$230	$227	$224
	80%	$293	$290	$287	$284	$281	$278	$275	$272	$269	$266	$263	$260	$257	$254	$251	$248	$245	$242
	85%	$312	$309	$306	$303	$300	$297	$294	$291	$288	$285	$282	$279	$276	$273	$270	$267	$264	$261
	90%	$330	$327	$324	$321	$318	$315	$312	$309	$306	$303	$300	$297	$294	$291	$288	$285	$282	$279

Appendix B

Full Environmental Account Write-Up for Terrestrial Impacts and Aquatic Impacts

TERRESTRIAL IMPACTS

To assess terrestrial impacts a desk-top review was conducted of terrestrial environmental information available from web-based resources. Also, the following reports and spatial data were provided by the CRD or obtained through the MOTI, and reviewed if applicable to selected Options:

- Environmental Inventory and Impact Assessment of the proposed route of the Trans Canada Trail through the Sooke Hills Wilderness Regional Park Reserve and adjacent CRD Watershed Lands (Latitude Conservation Solutions Company 2016);
- Human-wildlife interaction risk assessment for the Sea to Sea Green Blue Belt and Sooke Hills Wilderness Regional Park Reserves (MacHutchon 2016);
- Sooke Hills Wilderness and Mount Wells Regional Parks – Terrestrial Ecosystem Mapping and Wildlife Ratings Table (BC Ministry of Environment, Lands and Parks [MELP] 2001);
- Vegetation Resources Inventory for CRD Lands; and
- Malahat Project Preliminary Overview of Three Design Options in the Area of Goldstream River to the Summit (Golder 2006).

Although detailed inventories and reports were available for the area to be affected by the Option 1A Niagara Main route, there was not a similar degree of detailed information available for Option 2A Far West Alignment. Based on the high-level planning objectives of this multiple account evaluation process and the need to have equivalent data with which to make comparisons between the two short-listed options, these studies were not incorporated into this assessment, in detail. If the Option 1A Niagara Main route moves forward, the list above serves to guide future more detailed assessment efforts.

Visual observations made by a BC Registered Professional Biologist (RPBio) during a driving tour along the 2-wheel drive vehicle accessible portions of the routes were also recorded for the following terrestrial habitat features:

- High-level field observations of the habitat attributes visible from roadside vantage points in forest stands designated as marbled murrelet critical habitat, and other mature forest stands observed that were deemed to provide potential suitable nesting habitat for marbled murrelet;
- Rock outcrops and cliff faces;
- Old-growth forest;
- General wildlife observations; and
- CRD representatives on the tour also provided information on a western toad migration area and barrier fencing installed along Sooke Main south of Sooke Lake (Option 3A).

Based on the desktop review and driving tour conducted, the following evaluations of the relative terrestrial environmental impacts are provided for the two short-listed options.

Terrestrial Ecosystems

Understanding of the ecosystem types within each option alignment provides context for the nature of terrestrial habitat features and wildlife species that could be affected by each option.

Option 1A – Niagara Main

Option 1A extends across two biogeoclimatic units, the moist maritime Coastal Douglas-fir (CDFmm) and the eastern very dry maritime Coastal Western Hemlock (CWHxm1) variant. The CDFmm is within the rainshadow of the Vancouver Island and Olympic Mountains that results in warm and dry summers and mild, wet winters with water deficits common on drier sites.

The CWHxm1 occurs at low elevations (0-700 metres) on the east side of Vancouver Island. The CWH zone is on average, the rainiest zone in British Columbia and typically has a cool mesothermal climate including cool summers and mild winters.

Option 2A – Far West Alignment

Option 2A extends across six biogeoclimatic units including the CDFmm and CWHxm1 summarized above. The four additional biogeoclimatic units include: the submontane moist maritime CWH variant (CWHmm1), the montane moist maritime CWH variant (CWHmm2), the western very dry maritime (CWHxm2), and the montane very wet maritime CWH variant (CWHvm2). The CWHxm2 is virtually identical to the CWHxm1, with slightly less shrub diversity to the CWHxm1 described above.

The CWHmm1 is restricted to Vancouver Island on the eastern side of the Vancouver Island Ranges above the CWHxm1 and CWHxm2. The biogeoclimatic unit occurs generally between 450 to 700 metres in elevation with moist, mild winters and cool but dry summers. Zonal forests are dominated by western hemlock, amabilis fir, and coast Douglas-fir with a shrubby understory of salal, dull Oregon-grape, red huckleberry, and Alaskan blueberry.

The CWHmm2 occurs at higher elevations (700 to 1100 metres) on the eastern side of the Vancouver Island Ranges below the Mountain Hemlock biogeoclimatic zone. The CWHmm2 has cooler temperatures, shorter growing seasons and heavy snowfall compared to the CWHmm1. Zonal forests are similar to the CWHmm1; however, minor amounts of yellow cedar, and mountain hemlock occur at higher elevation wetter sites. The shrub and moss layers are also well developed in the CWHmm2.

The CWHvm2 is located at 400 to 800 metres in elevation on the western slopes of the Coast Mountains above the CWHvm1. The climate in this biogeoclimatic unit is cool, with short growing seasons and extensive snowpack. Dominant forest canopy includes: western hemlock, amabilis fir, yellow cedar, and mountain hemlock. The understory has a thick shrub layer dominated by Alaskan blueberry, oval-leaved blueberry, and a sparse herb layer including five-leaved bramble.

Wildlife, Plant and Ecosystems at Risk

A detailed list of observation records for wildlife, plant, and fungus species and ecosystems at risk and wildlife critical habitat parcels within both short-listed options and the base case is provided in ***Table B1***. The species with the most designated critical habitat parcels in the area and of highest potential risk for additional species-specific survey requirements, construction timing restrictions and the potential need to re-route the road alignment, is marbled murrelet, a provincially blue-listed and federally threatened marine bird species. Marbled murrelets nest in mature and old growth coniferous forest typically within 30 kilometres of the coast, but have been documented up to 80 kilometres inland. Nest sites are selected with preference for forest patches with higher densities of larger diameter trees, large diameter limbs, and mossy limbs. There are reptile critical habitat parcels including sharp-tailed snake (*Contia tenuis*; provincially red-listed and federally endangered) and western painted turtle, Pacific Coast Population (*Chrysemys picta*; provincially red-listed and federally threatened and endangered [*Species at Risk Act*]) near the short-listed route options and base case circle route as well as a critical habitat parcel for a

butterfly species (dun skipper vestris ssp. [*Euphyes vestris*; provincially red-listed and federally threatened]) (see ***Table B1***).

High-level field observations to assess the habitat quality within marbled murrelet designated critical habitat parcels were undertaken, where possible, during the driving tour of the routes on February 6th and 7th, 2019. Incidental observation of old growth forest and suitable nesting trees were made during the field tour and waypoints were taken where potentially suitable nesting habitat may be present near mapped critical habitat polygons. If evidence of tree clearing was observed within mapped marbled murrelet critical habitat areas, this was recorded in the field notes as a "disturbance". The results of these field observations as well as desktop analysis are reflected in the output in ***Table B1*** and in ***Figures 2*** to ***26,*** all of which are in ***Appendix F***.

Table B1: Number of Species at Risk Observation Records and Critical Habitat Parcels Crossed or within 100 metres of Option Alignment

OPTION	WILDLIFE SPECIES AT RISK OBSERVATION RECORDS	CRITICAL HABITAT PARCELS	PLANT / FUNGUS SPECIES AT RISK OBSERVATION RECORDS	ECOSYSTEM AT RISK OBSERVATION RECORDS	SUM (ORDERED LEAST TO MOST DESIRABLE)
Base Case Circle Route	33 records in total: Ermine, *anguinae* ssp. (4) Cowichan Lake lamprey (1); Northern red-legged frog (4); wandering salamander (1); Common ringlet *insulana* ssp. (3); Dromedary jumping-slug (1); Dun skipper (1); Warty jumping-slug (3); Western branded skipper, *oregonia* ssp. (1) 1 sensitive record (species unknown) 2 mapped great blue heron colonies Approximately 11 mapped bald eagle nests	28 parcels in total: marbled murrelet – final (18); sharp-tailed snake – proposed (1); western painted turtle Pacific Coast pop. – proposed (9)	14 records in total: Common bluecup (1); Heterocodon (1); Least moonwort (1) Lobb's water-buttercup (2); Macoun's groundsel (1); Peacock vinyl (1); Sandmat (1); Slimleaf onion (1); Smith's fairybells (3); Waterwort water-milfoil (1); White-top aster (1)	3 records in total: Douglas-fir / Dull Oregon-grape (1); Roemer's Fescue – Junegrass (1); Western Redcedar / Common Snowberry (1)	78
2A – Far West Alignment	12 records in total: Sensitive (1), Ermine *aunguinae* ssp. (2), great blue heron *fannini* ssp. (1), northern red-legged frog (2), common ringlet *insulana* ssp. (1), dun skipper (1), Edward's beach moth (1), western branded skipper *oregonia* ssp. (1) 1 mapped great blue heron colony 1 mapped bald eagle nest	21 parcels in total: marbled murrelet (9), western painted turtle coast pop. (9), sharp-tailed snake (1), dun skipper *vestris* ssp. (2) Of the 9 potential marbled murrelet critical habitat parcels, one was confirmed to contain features that appeared suitable for marbled murrelet nesting. The other 8 parcels were not visited during the driving tour	12 records in total: peacock vinyl (1), common bluecup (1), hertocodon (2), Howell's violet (1), least moonwort (1) Lobb's water-buttercup (2), Macoun's groundsel (1), prairie lupine (1), Vancouver Island beggarticks (1), white-top aster (1)	3 records in total: Douglas fir/dull Oregon grape (1), grand fir/dull Oregon grape (1), Roemer's fescue – junegrass (1)	48

OPTION	WILDLIFE SPECIES AT RISK OBSERVATION RECORDS	CRITICAL HABITAT PARCELS	PLANT / FUNGUS SPECIES AT RISK OBSERVATION RECORDS	ECOSYSTEM AT RISK OBSERVATION RECORDS	SUM (ORDERED LEAST TO MOST DESIRABLE)
1A – Niagara Main	9 records in total: Ermine, anguinae ssp. (1) Western screech-owl, *kennicottii* ssp. (1); Northern red-legged frog (1); Common ringlet *insulana* ssp. (1); Propertius duskywing (1); Dun skipper (2); Western branded skipper, *oregonia* ssp. (1) 1 sensitive record (species unknown) No mapped great blue heron colonies or bald eagle nests	5 parcels in total: marbled murrelet – final (3); western painted turtle Pacific Coast pop. – proposed (1); Dun skipper *vestris* ssp. – final (1) Of the 3 potential marbled murrelet critical habitat parcels, one was confirmed to contain features that appeared suitable for marbled murrelet nesting. The other 2 parcels were not visited during the driving tour	1 record total: Heterocodon (1);	2 records in total: Douglas-fir / Dull Oregon-grape (2)	17

Option 1A – Niagara Main

The Option 1A Niagara Main route has far fewer mapped critical habitat parcels (total of three mapped) with one parcel appearing to provide suitable nesting habitat for marbled murrelet based on visual observations. The other two parcels were not field verified during the high-level driving tours. It also has slightly fewer wildlife observation records as compared to Option 2A, but similar types of wildlife present (i.e., mammal, bird, amphibian, and numerous butterfly species). In terms of vegetation species and ecosystems at risk, it has far fewer recorded vegetation species at risk occurrence records and a similar number of ecosystems at risk, neither of which is a great differentiator, as these criteria are highly influenced by the total length of route and previous survey effort. The Niagara Main route is much shorter than Option 2A Far West Alignment and the Base Case circle route.

Construction of resource roadway upgrades or new roadway segments in proximity to previously identified observation records for wildlife, plant, fungus and ecosystems at risk would require additional survey effort to confirm the presence of these species and ecosystems, and appropriate mitigation.

Vegetation clearing and grubbing activities associated with upgrading the existing maintenance roads along the emergency bypass route should be conducted within the appropriate breeding bird "least risk periods" outlined in *Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (BC MOE 2014). This will serve to reduce potential contravention of Section 34 of the *BC Wildlife Act*, and the federal *Migratory Birds Convention Act* which protects migratory birds and their nests. "Least risk windows" as defined by these documents are:

- Bald eagle: September 1 – December 31;
- Osprey (*Pandion haliaetus*): September 15 – March 31;
- Heron (*Ardea* sp.): September 15 – January 15;
- Other raptors: October 1 – February 28; and
- Passerines: September 1 – February 28.

At risk plant and ecosystem surveys are also recommended during optimal flowering times (spring, late summer, to allow for surveys that more definitively confirm presence / absence in areas to be disturbed) in areas where vegetation removal is expected.

Option 2A – Far West Alignment

The Option 2A Far West Alignment route has more mapped critical habitat parcels (total of nine mapped) and one parcel appeared to have suitable nesting habitat for marbled murrelet based on visual observations. The other eight parcels were not field verified during the high-level driving tour. It also has slightly more wildlife observation records than Option 1A, but similar types of wildlife present (i.e., mammal, bird, amphibian, and numerous butterfly species).

Construction of upgrades to resource roadways through a federally designated critical habitat area for marbled murrelet would require detailed surveys for marbled murrelet critical habitat suitability (described above in Option 1A). Construction of the upgrades to the resource roads, in addition to any new sections of roadway in proximity to previously identified observation records for wildlife, plant, fungus, and ecosystems at risk would require additional survey effort to confirm presence. Vegetation clearing and grubbing activities within the Project area should be conducted within the appropriate breeding bird "least risk periods" and at-risk plant and ecosystem surveys, as outlined in Option 1A above.

Protected Areas and Sensitive Habitats

As described in the Screening Assessment, the presence of a protected area or sensitive wildlife habitat within 100 metres of a road alignment is of importance because the proximity (and in some cases, bisection of a protected area with a new or upgraded roadway) is associated with increased risk of wildlife-vehicle collision, including species at risk (mammals, reptiles and amphibians), habitat destruction (physical loss of habitats and sensory disturbance of wildlife from construction and road traffic once operational), invasive plant spread (road / vehicle vector), and most importantly: bisecting of undeveloped native vegetation types and habitats that have already been deemed important enough to protect within a designated regional or provincial park. The severing and fragmentation of formerly contiguous and legally protected ecosystems with roadways has inherent impacts on ecosystem function and area sensitive wildlife species, among other impacts. It should be noted that the short listed options do generally follow existing resource roads, which have already introduced some fragmentation of the ecosystems.

The results of desktop analysis are reflected in the output in ***Table B2***, ***Table B3*** and in ***Figures 2*** to ***26,*** all of which are in ***Appendix F***.

Table B2: Number of Protected Areas (Provincial /National Parks, Conservation Areas, and Regional Parks) Crossed or within 100 metres of Option Alignment

OPTION	PROVINCIAL / NATIONAL PARKS	CONSERVATION AREAS	REGIONAL PARKS	SUM (ORDERED LEAST TO MOST DESIRABLE)
Base Case Circle Route	3 Parks: French Beach Park A; Juan De Fuca Park A; Also: Pacific Rim National Park Reserve of Canada National Park	None	5 Parks: Ayum Creek Regional Park Reserve Galloping Goose Regional Trail Jordan River Regional Park Sea to Sea Regional Park Sooke Hills Wilderness Regional Park	8
2A – Far West Alignment	1 Park: Koksilah River Park A*	None	4 Parks: Ayum Creek Regional Park Reserve Galloping Goose Regional Trail Sea to Sea Regional Park Sooke Hills Wilderness Regional Park	5
1A – Niagara Main	1 Park: Goldstream Park A	None	1 Park: Sooke Hills Wilderness Regional Park*	2

* These parks would be newly bisected by the proposed option alignments by new construction or road upgrades.

Table B3: Number of Designated Sensitive Habitat Features (including OGMAs, WMAs) Crossed or within 100 metres of Option Alignment

OPTION	OGMAS	WMAS	SUM (ORDERED LEAST TO MOST DESIRABLE)
Base Case Circle Route	6 (legal)	1 (red-legged frog Lens Creek side channel)	7
2A – Far West Alignment	1 (non-legal)	None	1
1A – Niagara Main	None	None	0

Option 1A – Niagara Main

Considering protected areas and sensitive habitats, Option 1A does not directly affect any designated sensitive habitat features (OGMAs or WMAs), but would bisect the CRD's Sooke Hills Wilderness Regional Park and would run along the edge of Goldstream Provincial Park. There are currently no motorized vehicles allowed within the Sooke Hills Wilderness Regional Park other than maintenance vehicles and occasional logging access to adjacent parcels of private forest lands via land access agreements. There have been many studies and inventories conducted within the Sooke Hills Wilderness Regional Park area, and it is a highly valued protected wilderness area. Construction of a highway detour route via upgrading resource roads through this area could have a significant effect on this protected area which has been established primarily for maintaining ecological integrity. The frequency of vehicle traffic for an emergency detour route of this nature is low, but if used, the volume and increase in vehicle traffic during deployment compared to current conditions would represent a significant change. The total length of the proposed Option 1A Niagara Main route within the eastern Sooke Hills Wilderness Regional Park area is approximately 5.4 kilometres and the total north-to-south length of this eastern area of the park is approximately 6.8 km. This means the proposed low occurrence emergency detour route in this location would effectively bisect or sever almost 80% of the eastern park area and represent a new environmental stressor on the regional park area habitat and wildlife during the infrequent detour deployments. The Option 1A Niagara Main route is also adjacent to

Goldstream Provincial Park. This may represent a new environmental stressor on the provincial park area habitat and wildlife. The base case circle route is in proximity to more designated sensitive habitat features and protected areas, but it represents the steady-state / current conditions. Wildlife and ecosystems in proximity to this existing public roadway will have adapted, to some degree, to its presence.

Option 2A – Far West Alignment

Considering protected areas and sensitive habitats, Option 2A affects one designated sensitive habitat feature (1 non-legal OGMA), would pass through Koksilah River Provincial Park on existing public roads and could affect four Regional Parks which are located in proximity to the route, including Sooke Hills Wilderness Regional Park. The location where Option 2A passes adjacent to these four Regional Parks would be within the existing base case detour route and which is an existing public road. As such, these impacts are pre-existing occurrences. The primary section of Option 2A affecting a protected area is within Koksilah River Provincial Park. The Koksilah River Provincial Park is a 230-hectare area with both "intensive recreation" and "natural environment" zoning that is accessible from Renfrew Road, which is a public road. The Option 2A route would continue along the existing Renfrew Road gravel roadway route for an approximate length of one kilometre, partially through and / or adjacent to the natural environment zoned portion of the park. The natural environment zone is intended to be maintained in natural condition while allowing minimal appropriate recreational activities such as camping, wildlife viewing, mountain biking, horseback riding, and angling. Approximately 350 metres of Option 2A would pass through the "intensive recreation zone" portion of the park that allows for readily accessible outdoor recreation opportunities and facilities (e.g., Burnt Bridge over Koksilah River). The entire east-west width of the park is approximately 4.7 km. This means the proposed emergency detour route in this location could be adjacent to approximately 20 percent of the south western park area. Given the relatively higher recreational use in this park compared to the Sooke Hills Wilderness Provincial Park, and shorter length of upgraded resource road, the relative impacts of an emergency detour route through this protected area are expected to be lower. The frequency of vehicle traffic for an emergency detour route of this nature is low, but if used, the volume and increase in vehicle traffic compared to current conditions would be significant during those periods. Although the base case circle route is in proximity to more designated sensitive habitat features and protected areas than Option 2A, it represents the steady-state / current conditions. Wildlife and ecosystems in proximity to the existing base case roadway will have adapted, to some degree, to its presence and vehicle traffic. Over the longer term, in consideration of future population growth and traffic volumes, Option 2A is preferable as it will not as significantly bisect previously established wildlife reserve areas or regional parks relative to Option 1A.

Environmental Approval Processes and Additional Surveys Required

The environmental approval processes required for each shortlisted option that are general (relate to both terrestrial and aquatic impacts) or terrestrial in nature are provided below. In BC, proposed projects and activities may be subject to the following environmental assessment processes:

- The current *Canadian Environmental Assessment Act*, 2012 (*CEAA*) is triggered when proposed physical activities are listed as "designated projects" in the federal *Regulations Designating Physical Activities* (Government of Canada 2012). The federal government has proposed amendments to federal environmental assessment legislation under a new *Impact Assessment Act* (Government of Canada 2019). The act and related *Regulations Designating Physical Activities* are suggested to be enacted in the summer of 2019 and would replace the existing legislation.
- The *British Columbia Environmental Assessment Act* 2002 (*BCEAA*) when a proposed project exceeds thresholds specified in the provincial *Reviewable Projects Regulation* 2002 (Government of BC 2002).

Option 1A – Niagara Main

High-level consideration of likely environmental survey and approval processes for Option 1A Niagara Main is provided below:

- At risk plant and ecosystem surveys are recommended during optimal flowering times (spring, late summer) in areas where vegetation removal is expected. These surveys are recommended once MOTI has finalized the selected design option and prior to ground disturbance. The Federal Policy on Wetland Conservation states a "no net loss" on wetland function must be mitigated through restoration or compensation (offsetting) on Federal Lands and waters (Government of Canada 1991). Although the Project does not pass through Federal land, provincial ministries may still recommend protection of these areas through the permitting process.
- Species at risk (SAR) related permits may be required if salvage of SAR required, for example.
- Construction of a new or upgraded roadway through a regional park in the Capital Regional District, which is managed under the *Local Government Act* (Government of BC 2015), would likely require approval and issuance of a permit from the CRD.
- Construction of a new or upgraded roadway through a provincial park would likely require a Park Use Permit under the *BC Park Act* granted by BC Parks (Government of BC 2019a). The BC Ministry of Environment authorizes the use of land within provincial parks and protected areas through the Park Use Permit application process. It should be noted that "only applications that are considered by BC Parks to be compatible with the conservation and recreation objectives identified for the park(s) involved in the proposal may be approved" (Government of BC 2019a). Discussion would be required with BC Parks, and an online application form would be required along with fee payment. In addition, public notification and First Nations consultation may be required (Government of BC 2019a).
- The project is unlikely to trigger *BCEAA* because the total length of new road is well below 20 km. Under Part 8 of the *Reviewable Projects Regulation* (*BCEAA*), a transportation project would trigger the *BCEAA* process when it includes over 20 kilometres of new paved two-lane highway. The threshold for triggering *BCEAA* for new transportation projects is described under Part 8 of the regulation, subject to subsection (2), a new facility consisting of > 20 continuous kilometres of paved public highway with > 2 lanes.
- The project is unlikely to trigger *CEAA, 2012* as it is not within a designated wildlife area listed under the federal *Wildlife Area Regulations* (CRC 1609; Government of Canada 2019a) or migratory bird sanctuary listed under the *Migratory Bird Sanctuary Regulations* (CRC 1036; Government of Canada 2019b) and does not consist of a new right of way over 50 kilometres length. Under *CEAA 2012*, projects are subject to the act and approval process if either threshold is met:
    - The construction, operation, decommissioning and abandonment, in a wildlife area or migratory bird sanctuary, of a new (h) railway line or public highway; and
    - The construction, operation, decommissioning and abandonment of a new (c) all-season public highway that requires a total of 50 kilometres or more of new right of way.
- The new federal *Impact Assessment Act* would also not likely be triggered, as the threshold has been increased to a total of 75 kilometres or more of new right of way.

Option 2A – Far West Alignment

High-level consideration of likely environmental survey and approval processes for Option 2A Far West Alignment is provided below:

- At risk plant and ecosystem surveys are recommended during optimal flowering times (spring, late summer) in areas where vegetation removal is expected. These surveys are recommended once MOTI has finalized the selected design option and prior to ground disturbance. The Federal Policy on Wetland Conservation states a "no net loss" on wetland function must be mitigated through restoration or compensation (offsetting) on Federal Lands and waters (Government of Canada 1991). Although the Project does not pass through Federal land, provincial ministries may still recommend protection of these areas through the permitting process.
- SAR related permits, if any.
- Construction of a new or upgraded roadway through a provincial park would likely require a Park Use Permit under the *BC Park Act* granted by BC Parks (Government of BC 2019a). The BC Ministry of Environment authorizes the use of land within provincial parks and protected areas through the Park Use Permit application process. It should be noted that "only applications that are considered by BC Parks to be compatible with the conservation and recreation objectives identified for the park(s) involved in the proposal may be approved" (Government of BC 2019a). Discussion would be required with BC Parks, and an online application form would be required along with fee payment. In addition, public notification and First Nations consultation may be required (Government of BC 2019a).
- The project is likely to trigger *BCEAA* as it would meet the threshold for assessment under the *Reviewable Projects Regulation*. The proposed route alignment of Option 2A includes a segment of 57.6 kilometres of new paved highway that is currently gravel surface. Under Part 8 of the *Reviewable Projects Regulation* (*BCEAA*), a transportation project would trigger the *BCEAA* process when it includes over 20 kilometres of new paved two-lane highway. The threshold for triggering *BCEAA* for new transportation projects is described under Part 8 of the regulation: Subject to subsection (2), a new facility consisting of greater than 20 continuous kilometres of paved public highway with greater than 2 lanes.
- The project may trigger the existing federal EA process under *CEAA 2012*, based on the length of the route. Although it is not within a designated wildlife area listed under the federal *Wildlife Area Regulations* (CRC 1609; Government of Canada 2019a), as only approximately 5.9 kilometres of the total 57.6 kilometres of new paved highway proposed is within an existing BC MoTI right of way. Additionally, as noted in Section 5.2.2, there does exist a section of BC MoTI right of way that could be utilized, which would result in the length of the route within existing right of way to increase to approximately 10.3 km. Under *CEAA, 2012*, projects are subject to the act and approval process if either threshold is met:
    - The construction, operation, decommissioning and abandonment, in a wildlife area or migratory bird sanctuary, of a new (h) railway line or public highway; and
    - The construction, operation, decommissioning and abandonment of a new (c) all-season public highway that requires a total of 50 kilometres or more of new right of way.
- The new federal *Impact Assessment Act* would not likely be triggered, as the threshold has been increased to a total of 75 kilometres or more of new right of way.

Evaluation Output – Overall the options, in terms of terrestrial impacts across all criteria considered, are qualitatively rated in comparison to the base case (existing conditions at Base Case Circle Route) as follows:

- *Option 1A Niagara Main – Somewhat Better.*
- *Option 2A Far West Alignment – Somewhat Better.*

The rating for both options is based primarily on the reduction of detour traffic that would use the Pacific Marine Circle Route, instead diverting traffic to areas featuring fewer occurrences of at-risk species. However, both options also have environmental drawbacks. Option 1A Niagara Main is heavily weighted by the route's alignment through the Sooke Hills Wilderness Regional Park which makes it highly undesirable from a terrestrial environment and regulatory approvals perspective. Construction of a detour route via upgrading resource roads through the wilderness park is not likely to be entirely mitigable and may create irreversible changes to ecosystem function. More detailed quantitative assessment is required, beyond the scope of this planning-level assessment. Considering the standard mitigation hierarchy of avoid, mitigate, restore, and if required, offset, the recommended course of action if this option is pursued includes incorporation of all four actions. Following a more detailed inventory and species-specific surveys, avoidance of sensitive habitat features through route micro-siting may be achievable. In-design mitigation could include retention of granular surface (i.e. not paving) for the road surface through the park, minimizing road widening, enforcement of slower speed limits through the park, active traffic control personnel to avoid wildlife collisions, incorporation of catchment basins to collect road runoff and contaminants (in the event of a spill), and incorporation of appropriate wildlife crossing structures or species-specific considerations for the local species to be affected. Restoration of habitat areas within the Sooke Hills Park that are currently degraded is another possibility. Based on consultation with the CRD, MOTI and MENV, the appropriate location for compensatory offsetting, in the form of an alternate wilderness regional park area, could be investigated. The offsetting should follow provincial policy and procedures as laid out in the *Environmental Mitigation Policy* (BC MOE 2014a) and *Procedures for Mitigating Impacts on Environmental Value*s (Environmental Mitigation Procedures) (BC MOE 2014b) and be provided at a compensation ratio that CRD deems appropriate. The rating for Option 2A is based on the long route length which will likely trigger the provincial EA process and possibly the federal EA process for development of a paved all-season road (as defined under the provincial *BCEAA* and the existing *CEAA, 2012*). It would not trigger the revised federal EA process under the proposed IAA. The rating for Option 2A is also based on the requirement for new disturbances within undisturbed areas (with sensitive habitat features and designated areas); however, these environmental effects associated with Option 2A are considered largely mitigable based on the desktop information reviewed, and preferable to Option 1A.

AQUATIC IMPACTS

A desk-top review was conducted using aquatic environmental information available from web-based resources. Also, the following reports and spatial data provided by the CRD were also reviewed at a high-level for relevant aquatic species and habitat information:

- CRD Sooke Lake Stream Assessments – fish stream assessment data (Madrone 2017); and
- Stream Crossing Evaluation for TransCanada Trail - Niagara Main to 15N (CRD 2015 Draft Figure).

As with the Terrestrial Impacts assessment, although detailed inventories and reports were available for the general area to be affected by the Option 1A Niagara Main route, there was not a similar degree of detailed information available for Option 2A Far West Alignment. Based on the high-level planning objectives of this multiple account

evaluation process and the need to have equivalent data with which to make comparisons between the two short-listed options, these detailed studies were not completely incorporated in detail into this assessment.

Visual observations made by a BC Registered Professional Biologist (RPBio) during a driving tour along the 2-wheel drive vehicle accessible portions of the routes were also recorded for the major stream crossings (existing clear span bridges) and wetlands, where possible. The results of desktop analysis and field observations are reflected in the output in ***Table B4*** and in ***Figures 2*** to ***26,*** all of which are in ***Appendix F***.

Table B4: Number of Streams, Lakes, Marine / Shoreline and Wetlands Crossed or within 100 metres of Option Alignment

OPTION	STREAMS	LAKES OR MARINE / SHORELINE	WETLANDS[8]	SUM (ORDERED LEAST TO MOST DESIRABLE)
Base Case Circle Route	411 total interactions (some features with more than 1 intersection with 100 m route buffer): 45 major watercourses with known fish bearing watercourse include Fairy Creek, Harris Creek, Jordan River, Renfrew Creek, Robertson Creek, and San Juan River; 154 (definite streams); 207 (indefinite streams); 3 (intermittent streams); 2 (ditches)	24 total interactions (some features with more than 1 intersection with 100 m route buffer): 23 (waterbodies) 1 (marine/shoreline)	7 in total: 3 (marshes) 4 (swamps)	442
2A – Far West Alignment	307 total interactions (some features with more than 1 intersection with 100 m route buffer): 30 major watercourses with known fish bearing watercourse including the Jordan River, Koksilah River, and Sooke River; 145 definite streams with known fishing bearing creeks including Bear Creek, Bilston Creek, DeMamiel Creek, Jordan River, Koksilah River, and Shawnigan Creek; 128 (indefinite streams); 2 (intermittent stream – Bilston Creek fish bearing confirmed); 2 (ditches)	18 total interactions (some features with more than 1 intersection with 100 m route buffer): 15 (waterbodies); 2 (manmade waterbodies – Bear Creek Reservoir); 1 (marine/shoreline)	10 in total: 6 (marshes) 2 (swamps) 2 (1:2,500 scale CRD mapped)	335
1A – Niagara Main	29 total interactions (some features with more than 1 intersection with 100 m route buffer): 16 (definite streams with the Goldstream River known as fish bearing; 10 (indefinite streams); 3 (ditches)	1 (waterbody)	6 in total: 5 (1:2,500 scale CRD mapped) 1 (marsh)	36

[8] Note: wetlands were mapped at large scale (1:2,500) within CRD Greater Victoria Water Supply Area boundaries only, therefore, the counts of wetlands being compared between options outside of, or inside of the Water Supply Area boundary where more detailed wetland mapping was undertaken, should not be considered a primary factor in this assessment, it is considered here only because it is a high-level assessment for initial screening purposes.

Option 1A – Niagara Main

The Option 1A Niagara Main route would potentially affect aquatic habitat features at 36 locations. Based on the high-level screening assessment, it is known that many of these features are salmonid fish-bearing watercourses. Based on a high-level review of drainage structure inventory spatial data provided by CRD, many existing stream crossing structures are corrugated steel pipe (CSP) culverts. The driving tour of this route identified one clear span bridge over the Goldstream River and approximately seven watercourse crossings with culverts. Major stream crossings included the Goldstream River mainstem plus tributaries and Niagara Creek. It should be noted that not all stream crossings were identified during the high-level field tour due to timing constraints. Observations from the field tour are georeferenced and shown on ***Figure 25*** and ***Figure 26,*** all of which are in ***Appendix F***. A greater level of assessment beyond this high-level tally is outside the planning-level scope of this assessment.

General information on the potential federal, provincial and local government approvals required for development of an emergency bypass route in this location is provided:

- The route is within both the Cowichan Valley Regional District and Capital Regional District. The Cowichan Valley Regional District has a Natural Environmental Development Permit process for work proposed within riparian areas. The Capital Regional District is split into a number of municipal jurisdictions including Juan de Fuca Electoral Area, District of Sooke, District of Metchosin, City of Langford. Option 1A overlaps the Juan de Fuca Electoral Area and is adjacent to the City of Langford. Local development permit processes should be investigated for each of these jurisdictions as environmental development permits may be required when working in riparian areas.
- In addition, the provincial *Riparian Areas Regulation* (RAR) applies within the Capital Regional District and Cowichan Valley and a RAR report may be required for work in and around mapped watercourses within these regional districts to be completed by a qualified environmental professional.
- More detailed confirmation of provincial approval processes requires a more detailed review of the requirements for stream crossing upgrades or new crossing structures at each location where the new road alignment crosses a watercourse. In general, any works in proximity to freshwater aquatic habitat may require provincial authorization under the *BC Water Sustainability Act* depending on the nature of the activities and proximity to watercourses (i.e., any works proposed below the high-water mark, culvert or bridge installations, culvert replacement, or stream infilling / relocation).
- The requirement under the *Fisheries Act* for Fisheries and Oceans Canada (DFO) review or Authorization, or just self-assessment by a qualified professional would be dependent on the type of crossing structure to be installed at each new or upgraded crossing location (i.e., clear span bridge or culvert) and installation methods including the need for temporary or permanent fill below the high water mark. Channel realignment would likely require DFO review and potential Authorization, whereas installation of clear span crossings may only require a self-assessment (if no fill below the high-water mark is required).

Option 2A – Far West Alignment

The Option 2A Far West Alignment route would potentially affect aquatic habitat features at 335 locations. Based on the high-level screening assessment, it is known that many of these features are salmonid fish-bearing watercourses. The driving tour of this route identified at least 16 clear-span bridges and numerous watercourse crossings. The northern portion of Option 2A travels alongside Koksilah River and crosses numerous tributaries to this salmon bearing river. Other major stream crossings include a tributary to the Leech River, Jordan River, and Bear Creek. Option 2A also crosses through a portion of the northwest corner of the Leech River Watershed. The Leech River Watershed area is planned to become an additional drinking water supply area to supplement the Sooke

Lake Reservoir. Observations from the field tour are georeferenced and shown on ***Figures 15*** to ***24,*** all of which are in ***Appendix F***. A greater level of assessment beyond this high-level tally is outside the planning-level scope of this assessment.

General information on the potential federal, provincial and local government approvals required for development of an emergency bypass route in this location is provided:

- The route is within both the Cowichan Valley Regional District and Capital Regional District. The Cowichan Valley Regional District has a Natural Environmental Development Permit process for work proposed within riparian areas.
- In addition, the provincial *Riparian Areas Regulation* (RAR) applies within the Capital Regional District and Cowichan Valley and a RAR report may be required for work in and around mapped watercourses within these regional districts to be completed by a qualified environmental professional.
- The Capital Regional District is split into a number of municipal jurisdictions including the City of Colwood, City of Langford, District of Metchosin and District of Sooke. Local development permit processes should be investigated for each of these jurisdictions as environmental development permits may be required when working in riparian areas.
- The provincial and federal (DFO) approval process descriptions related to the *Water Sustainability Act* and *Fisheries Act* are identical to those provided for Option 1A above.

Evaluation Output – Overall the options, in terms of aquatic impacts, are qualitatively rated in comparison to the base case (existing conditions at Base Case Circle Route) as follows:

- *Option 1A Niagara Main – Significantly Better.*
- *Option 2A Far West Alignment – Somewhat Better.*

The significantly better rating for Option 1A Niagara Main is heavily weighted by the route's relatively short length and much fewer interactions with aquatic habitat than the base case circle route; however, there will still likely be new disturbances required in fish bearing aquatic habitats that represent likely mitigable aquatic environment effects. The somewhat better rating for Option 2A is based on the long route length which will likely trigger the provincial EA process for development of this new paved all-season road (as defined under the provincial BCEAA). The rating for Option 2A is also based on the fact there will likely be new disturbances required in fish bearing aquatic habitats that are likely mitigable, but also changes within the Leech River watershed area which is planned to become an additional drinking water supply area to supplement the Sooke Lake Reservoir (CRD 2019b). It is anticipated that any stream crossing structures currently creating water quality or fish passage issues along this route (i.e., culverts) would be replaced with either open bottom structures or clear-span bridges as part of the detailed project design and this could mitigate and improve existing effects on fish passage and downstream water quality.

Appendix C

Cost Estimates

The following assumptions were made when producing the cost estimates:

- Option 1A is unpaved due to the route being within the Sooke Hill Wilderness Regional Park.
- Option 2A is paved as the route would likely become a public road. The pavement thickness is assumed to be 75mm in thickness.
- Concrete barriers are assumed in sections with steep slopes.
- Culverts and assumed to be required for mapped watercourses which are not crossed by bridge.
- General roadway costs are estimated using a composite linear metre cost based on general quantity assumptions.
- The following lump sum costs were added:
    - Water Protection Features:
        - General lump sums to add features such as oil water separators to protect water resources;
        - $0.2 million for Option 1A to provide general infrastructure due to being near the Japan Gulch Disinfection Facility.
        - $1.0 million for Option 2A to provide infrastructure for the watercourse that intersects with the Leech River Watershed.
    - Environmental Impacts:
        - General costs added to account for potential general environmental impacts.
        - $0.1 million for Option 1A based on its general length.
        - $0.5 million for Option 2A based on its general length.
    - Environmental Compensation
        - Costs added to provide environmental compensation lands due to impacts to sensitive areas.
        - $0.5 million for Option 1A to provide compensation for the Sooke Hills Wilderness Park.
    - Traffic Management
        - A general lump sum to account for traffic management during construction.
        - $0.1 million for Option 1A to manage pedestrian traffic on the trail.
        - $1.0 million for Option 2A to manage forestry trucking on the roadways.

The following rates were used in developing the cost estimates:

QUANTITY TYPE	RATE	UNIT	NOTES
Clear and Grub - Minor	$5	m^2	
Clear and Grub - Major	$10	m^2	
Cut - Earthwork	$20	m^3	
Cut - Rock	$45	m^3	
Fill	$35	m^3	
SGSB	$50	m^3	
CBC	$60	m^3	
Asphalt	$150	tonne	
Asphalt – linear metre, 75mm thickness	$201.87	m	8 m width * 75 mm thickness * density * $150 per tonne
Concrete Barrier	$150	m	$375 per unit, 2.5 m length
Lane Marking	$1.5	m	
Signage	$5	m	
Drainage	$10000	Culvert	
Lock Block Retaining Walls	$1000	m^2	
Bridge – Length 10-15 metres	$500	m^2	
Bridge – Length 20-30 metres	$6000	m^2	
Demolition of existing bridges	$500	m^2	

The following composite linear metre quantities and costs were used in developing the cost estimates:

CROSS SECTION	DESCRIPTION	TOTAL / M COST	QUANTITIES								
			CLEAR AND GRUB – MINOR (M^2)	CLEAR AND GRUB – MAJOR (M^2)	CUT – EARTHWORK (M^3)	CUT - ROCK (M^3)	FILL (M^3)	LOCK BLOCK RETAINING WALLS (M^2)	SGSB (M^3)	CBC (M^3)	SIGNAGE (M)
1	No Work	$0	0	0	0	0	0	0	0	0	0
2	No Work - Bridge Costs	$0	0	0	0	0	0	0	0	0	0
3	Widening, minimal slope, minor clearing	$237	5	0	2	0	1	0	1.2	1.2	1
4	Widening, minimal slope, major clearing	$262	0	5	2	0	1	0	1.2	1.2	1
5	Widening, slight fill slope, minor clearing	$565	7.5	0	2	0	10	0	1.2	1.2	1
6	Widening, slight fill slope, major clearing	$577	0	5	2	0	10	0	1.2	1.2	1
7	Widening, major fill slope, minor clearing	$732	10	0	1	0	15	0	1.2	1.2	1
8	Widening, major fill slope, major clearing	$782	0	10	1	0	15	0	1.2	1.2	1
9	Widening, slight cut slope, minor clearing	$417	8	0	12	0	0	0	1.2	1.2	1
10	Widening, slight cut slope, major clearing	$457	0	8	12	0	0	0	1.2	1.2	1
11	Widening, major cut slope, minor clearing	$612	15	0	20	0	0	0	1.2	1.2	1
12	Widening, major cut slope, major clearing	$687	0	15	20	0	0	0	1.2	1.2	1
13	Widening, rock cut, minor clearing	$1,062	5	0	0	20	0	0	1.2	1.2	1
14	Widening, rock cut, major clearing	$1,087	0	5	0	20	0	0	1.2	1.2	1
15	Widening, retaining fill, minor clearing	$4,887	10	0	0	0	20	4	1.2	1.2	1
16	Widening, retaining fill, major clearing	$4,937	0	10	0	0	20	4	1.2	1.2	1
17	New Road, Small Cut	$634	5	10	12	0	0	0	2.4	2.4	1
18	New Road, Small Fill	$784	5	10	2	0	10	0	2.4	2.4	1
19	New Road, Large Cut	$4,869	10	15	20	0	0	4	2.4	2.4	1
20	New Road, Large Fill	$5,919	10	15	20	0	30	4	2.4	2.4	1

Option 1A Cross Section Breakdowns

CHAINAGE		DISTANCE		DISTANCE	PAVING?	BARRIER SIDES	CROSS SECTION TYPE	CROSS SECTION RATE ($/M)	MONETIZATION
FROM	TO	FROM	TO						
98+800	99+300	98800	99750	950	No	0	1	$0.00	$0
99+300	100+000	99750	100000	250	No	0	1	$0.00	$0
100+000	100+050	0	50	50	No	0	1	$0.00	$0
100+050	100+200	50	200	150	No	0	9	$417.00	$62,550
100+200	100+250	200	250	50	No	0	1	$0.00	$0
100+250	100+500	250	500	250	No	0	3	$237.00	$59,250
100+500	100+600	500	600	100	No	1	12	$837.00	$83,700
100+600	100+700	600	700	100	No	0	9	$417.00	$41,700
100+700	100+850	700	850	150	No	0	3	$237.00	$35,550
100+850	100+900	850	900	50	No	0	7	$732.00	$36,600
100+900	101+250	900	1250	350	No	0	3	$237.00	$82,950
101+250	101+550	1250	1550	300	No	1	15	$5,037.00	$1,511,100
101+550	101+800	1550	1800	250	No	1	14	$1,237.00	$309,250
101+800	102+200	1800	2200	400	No	1	12	$837.00	$334,800
102+200	103+300	2200	3300	1100	No	0	3	$237.00	$260,700
103+300	103+400	3300	3400	100	No	0	9	$417.00	$41,700
103+400	103+600	3400	3600	200	No	0	10	$457.00	$91,400
103+600	104+000	3600	4000	400	No	0	9	$417.00	$166,800
104+000	104+400	4000	4400	400	No	0	10	$457.00	$182,800
104+400	104+600	4400	4600	200	No	0	9	$417.00	$83,400
104+600	104+800	4600	4800	200	No	0	12	$687.00	$137,400
104+800	105+000	4800	5000	200	No	1	10	$607.00	$121,400
105+000	105+400	5000	5400	400	No	0	9	$417.00	$166,800

CHAINAGE		DISTANCE		DISTANCE	PAVING?	BARRIER SIDES	CROSS SECTION TYPE	CROSS SECTION RATE ($/M)	MONETIZATION
FROM	TO	FROM	TO						
105+400	105+550	5400	5550	150	No	0	6	$577.00	$86,550
105+550	105+800	5550	5800	250	No	0	5	$564.50	$141,125
105+800	106+000	5800	6000	200	No	0	18	$784.00	$156,800
106+000	106+100	6000	6100	100	No	0	17	$634.00	$63,400
106+100	106+150	6100	6150	50	No	2	20	$6,219.00	$310,950
106+150	106+200	6150	6200	50	No	0	2	$0.00	$0
106+200	106+250	6200	6250	50	No	2	20	$6,219.00	$310,950
106+250	106+500	6250	6500	250	No	0	19	$4,869.00	$1,217,250
106+500	106+600	6500	6600	100	No	0	18	$784.00	$78,400
			Total	7800				Total	**$6,315,275**

Option 1A Bridge Structures

BRIDGE	OLD AREA (M^2)	NEW AREA (M^2)	TYPE	CONST RATE	DEMO RATE	ADDITIONAL COSTS	NOTES	COST	REPLACEMENT SCHEDULE
1	74.25	135	10-15m	$5,000	$500	$74,250	Cost for temp. bailey bridge	$786,375	Opening Day
2	0	300	15-30m	$6,000	$500	$0		$1,950,000	Opening Day

Option 2A Cross Section Breakdowns

CHAINAGE		DISTANCE		DISTANCE	PAVING?	BARRIER SIDES	CROSS SECTION TYPE	CROSS SECTION RATE ($/M)	MONETIZATION
FROM	TO	FROM	TO						
100+000	100+400	0	400	400	Yes	0	1	$201.87	$80,748
100+400	100+850	400	850	450	Yes	0	4	$463.87	$208,742
100+850	100+950	850	950	100	Yes	0	10	$658.87	$65,887
100+950	101+050	950	1050	100	Yes	0	12	$888.87	$88,887
101+050	101+100	1050	1100	50	No	0	2	$0.00	$0
101+100	101+150	1100	1150	50	Yes	2	1	$501.87	$25,094
101+050	1011+600	1150	11600	10450	Yes	0	10	$658.87	$6,885,192
101+100	1011+800	11600	11800	200	Yes	1	16	$5,288.87	$1,057,774
101+150	101+900	11800	1900	-9900	Yes	0	5	$766.37	-$7,587,063
101+900	102+100	1900	2100	200	Yes	1	14	$1,438.87	$287,774
102+100	103+100	2100	3100	1000	Yes	0	10	$658.87	$658,870
103+100	104+500	3100	4500	1400	Yes	1	12	$1,038.87	$1,454,418
104+500	105+000	4500	5000	500	Yes	0	10	$658.87	$329,435
105+000	106+000	5000	6000	1000	Yes	1	12	$1,038.87	$1,038,870
106+000	106+100	6000	6100	100	Yes	1	13	$1,413.87	$141,387
106+100	106+200	6100	6200	100	Yes	1	12	$1,038.87	$103,887
100+400	107+800	6200	7800	1600	Yes	0	10	$658.87	$1,054,192
100+850	107+900	7800	7900	100	Yes	0	12	$888.87	$88,887
100+950	107+950	7900	7950	50	Yes	0	14	$1,288.87	$64,444
101+050	108+300	7950	8300	350	Yes	0	9	$618.87	$216,605
101+100	108+400	8300	8400	100	Yes	0	6	$778.87	$77,887
101+150	108+500	8400	8500	100	Yes	1	14	$1,438.87	$143,887
101+900	108+900	8500	8900	400	Yes	0	5	$766.37	$306,548
102+100	109+200	8900	9200	300	Yes	0	3	$438.87	$131,661

CHAINAGE		DISTANCE		DISTANCE	PAVING?	BARRIER SIDES	CROSS SECTION TYPE	CROSS SECTION RATE ($/M)	MONETIZATION
FROM	TO	FROM	TO						
103+100	1011+000	9200	11000	1800	Yes	0	10	$658.87	$1,185,966
104+500	1011+650	11000	11650	650	Yes	0	12	$888.87	$577,766
105+000	1011+700	11650	11700	50	Yes	0	14	$1,288.87	$64,444
106+000	1012+350	11700	12350	650	Yes	0	10	$658.87	$428,266
106+100	1012+400	12350	12400	50	Yes	0	12	$888.87	$44,444
112+400	1012+600	12400	12600	200	Yes	0	10	$658.87	$131,774
112+600	1013+350	12600	13350	750	Yes	0	12	$888.87	$666,653
113+350	1013+500	13350	13500	150	Yes	0	14	$1,288.87	$193,331
113+500	1013+550	13500	13550	50	Yes	1	10	$808.87	$40,444
113+550	1013+600	13550	13600	50	Yes	1	14	$1,438.87	$71,944
113+600	1013+800	13600	13800	200	Yes	1	10	$808.87	$161,774
113+800	113+850	13800	13850	50	Yes	1	14	$1,438.87	$71,944
113+850	114+100	13850	14100	250	Yes	1	10	$808.87	$202,218
114+100	114+250	14100	14250	150	Yes	0	10	$658.87	$98,831
114+250	114+300	14250	14300	50	Yes	0	8	$983.87	$49,194
114+300	114+400	14300	14400	100	Yes	0	3	$438.87	$43,887
114+400	114+600	14400	14600	200	Yes	0	10	$658.87	$131,774
114+600	114+650	14600	14650	50	Yes	0	14	$1,288.87	$64,444
114+650	114+700	14650	14700	50	Yes	0	9	$618.87	$30,944
114+700	114+750	14700	14750	50	Yes	0	8	$983.87	$49,194
114+750	114+800	14750	14800	50	Yes	1	10	$808.87	$40,444
114+800	115+000	14800	15000	200	Yes	1	12	$1,038.87	$207,774
115+000	115+100	15000	15100	100	Yes	1	10	$808.87	$80,887
115+100	115+300	15100	15300	200	Yes	0	10	$658.87	$131,774
115+300	200+500	0	500	500	Yes	0	9	$618.87	$309,435
200+500	200+600	500	600	100	Yes	0	5	$766.37	$76,637

CHAINAGE		DISTANCE		DISTANCE	PAVING?	BARRIER SIDES	CROSS SECTION TYPE	CROSS SECTION RATE ($/M)	MONETIZATION
FROM	TO	FROM	TO						
200+600	200+750	600	750	150	Yes	0	9	$618.87	$92,831
200+750	200+850	750	850	100	Yes	0	11	$813.87	$81,387
200+850	200+900	850	900	50	Yes	1	13	$1,413.87	$70,694
200+900	201+200	900	1200	300	Yes	1	9	$768.87	$230,661
201+200	201+300	1200	1300	100	Yes	0	5	$766.37	$76,637
201+300	201+600	1300	1600	300	Yes	0	9	$618.87	$185,661
201+600	202+000	1600	2000	400	Yes	0	5	$766.37	$306,548
202+000	202+550	2000	2550	550	Yes	0	9	$618.87	$340,379
202+550	202+700	2600	2700	100	Yes	0	3	$438.87	$43,887
202+700	203+100	2700	3100	400	Yes	0	9	$618.87	$247,548
203+100	203+450	3100	3450	350	Yes	0	10	$658.87	$230,605
203+450	203+600	3450	3600	150	Yes	0	5	$766.37	$114,956
203+600	203+800	3600	3800	200	Yes	0	9	$618.87	$123,774
203+800	204+000	3800	4000	200	Yes	0	10	$658.87	$131,774
204+000	204+500	4000	4500	500	Yes	0	9	$618.87	$309,435
204+500	205+200	4500	5200	700	Yes	0	3	$438.87	$307,209
205+200	206+000	5200	6000	800	Yes	1	9	$768.87	$615,096
206+000	206+500	6000	6500	500	Yes	1	9	$768.87	$384,435
206+500	206+600	6500	6600	100	Yes	1	3	$588.87	$58,887
206+600	207+100	6600	7100	500	Yes	1	9	$768.87	$384,435
207+100	207+400	7100	7400	300	Yes	1	10	$808.87	$242,661
207+400	207+800	7400	7800	400	Yes	0	9	$618.87	$247,548
207+800	208+100	7800	8100	300	Yes	0	6	$778.87	$233,661
208+100	208+400	8100	8400	300	Yes	0	3	$438.87	$131,661
208+400	208+500	8400	8500	100	Yes	0	9	$618.87	$61,887
208+500	208+600	8500	8600	100	Yes	0	9	$618.87	$61,887

CHAINAGE		DISTANCE		DISTANCE	PAVING?	BARRIER SIDES	CROSS SECTION TYPE	CROSS SECTION RATE ($/M)	MONETIZATION
FROM	TO	FROM	TO						
208+600	208+900	8600	8900	300	Yes	0	5	$766.37	$229,911
208+900	209+200	8900	9200	300	Yes	0	3	$438.87	$131,661
209+200	209+950	9200	9950	750	Yes	0	9	$618.87	$464,153
209+950	210+000	9950	10000	50	Yes	0	11	$813.87	$40,694
210+000	300+850	0	850	850	Yes	0	10	$658.87	$560,040
300+850	300+950	850	950	100	Yes	0	13	$1,263.87	$126,387
300+950	301+200	950	1200	250	Yes	0	3	$438.87	$109,718
301+200	301+400	1200	1400	200	Yes	0	10	$658.87	$131,774
301+400	303+550	1400	3550	2150	Yes	0	10	$658.87	$1,416,571
303+550	303+600	3550	3600	50	Yes	0	14	$1,288.87	$64,444
303+600	303+950	3600	3950	350	Yes	0	10	$658.87	$230,605
303+950	304+050	3950	4050	100	Yes	0	3	$438.87	$43,887
304+050	304+500	4050	4500	450	Yes	0	10	$658.87	$296,492
304+500	304+700	4500	4700	200	Yes	0	3	$438.87	$87,774
304+700	304+900	4700	4900	200	Yes	0	10	$658.87	$131,774
304+900	304+950	4900	4950	50	Yes	0	12	$888.87	$44,444
304+950	305+000	4950	5000	50	Yes	0	14	$1,288.87	$64,444
305+000	305+350	5000	5350	350	Yes	0	10	$658.87	$230,605
305+350	305+450	5350	5450	100	Yes	0	3	$438.87	$43,887
305+450	305+500	5450	5500	50	Yes	0	2	$201.87	$10,094
305+500	305+550	5500	5550	50	Yes	0	3	$438.87	$21,944
305+550	306+000	5550	6000	450	Yes	0	10	$658.87	$296,492
306+000	400+250	0	250	250	Yes	0	10	$658.87	$164,718
400+250	400+500	250	500	250	Yes	0	12	$888.87	$222,218
400+500	400+550	500	550	50	Yes	0	14	$1,288.87	$64,444
400+550	400+800	550	800	250	Yes	0	10	$658.87	$164,718

CHAINAGE		DISTANCE		DISTANCE	PAVING?	BARRIER SIDES	CROSS SECTION TYPE	CROSS SECTION RATE ($/M)	MONETIZATION
FROM	TO	FROM	TO						
400+800	401+300	800	1300	500	Yes	0	12	$888.87	$444,435
401+300	401+600	1300	1600	300	Yes	0	14	$1,288.87	$386,661
401+600	402+400	1600	2400	800	Yes	0	10	$658.87	$527,096
402+400	402+650	2400	2650	250	Yes	0	3	$438.87	$109,718
402+650	402+800	2650	2800	150	Yes	0	4	$463.87	$69,581
402+800	403+000	2800	3000	200	Yes	0	3	$438.87	$87,774
403+000	403+050	3000	3050	50	Yes	0	5	$766.37	$38,319
403+050	403+100	3050	3100	50	No	0	2	$0.00	$0
403+100	403+250	3100	3250	150	Yes	0	4	$463.87	$69,581
403+250	403+500	3250	3500	250	Yes	0	3	$438.87	$109,718
403+500	403+650	3500	3650	150	Yes	0	9	$618.87	$92,831
403+650	407+500	3650	7500	3850	Yes	0	10	$658.87	$2,536,650
407+500	407+550	7500	7550	50	Yes	0	12	$888.87	$44,444
407+550	407+650	7550	7650	100	Yes	0	10	$658.87	$65,887
407+650	409+100	7650	9100	1450	Yes	0	9	$618.87	$897,362
409+100	409+800	9100	9800	700	Yes	0	10	$658.87	$461,209
409+800	410+000	9800	10000	200	Yes	0	6	$778.87	$155,774
410+000	410+200	10000	10200	200	Yes	0	4	$463.87	$92,774
410+200	410+450	10200	10450	250	Yes	0	10	$658.87	$164,718
410+450	410+700	10450	10700	250	Yes	0	9	$618.87	$154,718
410+700	411+250	10700	11250	550	Yes	0	6	$778.87	$428,379
411+250	411+350	11250	11350	100	Yes	0	10	$658.87	$65,887
411+350	411+450	11350	11450	100	Yes	0	12	$888.87	$88,887
411+450	411+800	11450	11800	350	Yes	0	6	$778.87	$272,605
411+800	500+100	0	100	100	Yes	0	6	$778.87	$77,887
500+100	500+400	100	400	300	Yes	0	10	$658.87	$197,661

CHAINAGE		DISTANCE		DISTANCE	PAVING?	BARRIER SIDES	CROSS SECTION TYPE	CROSS SECTION RATE ($/M)	MONETIZATION
FROM	TO	FROM	TO						
500+400	500+650	400	650	250	Yes	0	9	$618.87	$154,718
500+650	501+000	650	1000	350	Yes	0	5	$766.37	$268,230
501+000	501+200	1000	1200	200	Yes	0	9	$618.87	$123,774
501+200	503+200	1200	3200	1500	Yes	0	17	$835.87	$1,253,805
503+200	503+450	3200	3450	250	Yes	0	5	$766.37	$191,593
503+450	503+600	3450	3600	150	Yes	0	6	$778.87	$116,831
503+600	504+000	3600	4000	400	Yes	0	4	$463.87	$185,548
504+000	504+100	4000	4100	100	Yes	0	5	$766.37	$76,637
504+100	504+850	4100	4850	750	Yes	0	9	$618.87	$464,153
504+850	505+050	4850	5050	200	Yes	0	10	$658.87	$131,774
505+050	505+200	5050	5200	150	Yes	0	9	$618.87	$92,831
505+200	505+300	5200	5300	100	Yes	0	5	$766.37	$76,637
505+300	506+000	5300	6000	700	Yes	0	9	$618.87	$433,209
506+000	506+150	6000	6150	150	Yes	0	10	$658.87	$98,831
506+150	507+700	6150	7700	1550	Yes	0	9	$618.87	$959,249
507+700	508+650	7700	8650	950	Yes	0	10	$658.87	$625,927
508+650	508+850	8650	8850	200	Yes	0	6	$778.87	$155,774
508+850	509+050	8850	9050	200	Yes	0	12	$888.87	$177,774
509+050	509+150	9050	9150	100	Yes	0	9	$618.87	$61,887
509+150	509+300	9150	9300	150	Yes	0	1	$201.87	$30,281
509+300	509+350	9300	9350	50	Yes	0	10	$658.87	$32,944
509+350	509+500	9350	9500	150	Yes	0	12	$888.87	$133,331
509+500	509+550	9500	9550	50	Yes	0	10	$658.87	$32,944
509+550	509+700	9550	9700	150	Yes	0	4	$463.87	$69,581
509+700	509+850	9700	9850	150	Yes	1	12	$1,038.87	$155,831
509+850	510+250	9850	10250	400	Yes	1	10	$808.87	$323,548

CHAINAGE		DISTANCE		DISTANCE	PAVING?	BARRIER SIDES	CROSS SECTION TYPE	CROSS SECTION RATE ($/M)	MONETIZATION
FROM	TO	FROM	TO						
510+250	510+300	10250	10300	50	Yes	0	6	$778.87	$38,944
510+300	510+500	10300	10500	200	Yes	1	8	$1,133.87	$226,774
510+500	510+600	10500	10600	100	Yes	0	4	$463.87	$46,387
510+600	511+100	10600	11100	500	Yes	0	4	$463.87	$231,935
511+100	511+150	11100	11150	50	Yes	0	6	$778.87	$38,944
511+150	511+400	11150	11400	250	Yes	0	12	$888.87	$222,218
511+400	511+600	11400	11600	200	Yes	1	16	$5,288.87	$1,057,774
511+600	511+900	11600	11900	300	Yes	0	12	$888.87	$266,661
511+900	512+050	11900	12050	150	Yes	0	6	$778.87	$116,831
512+050	512+200	12050	12200	150	Yes	0	12	$888.87	$133,331
512+200	512+300	12200	12300	100	Yes	0	4	$463.87	$46,387
512+300	512+400	12300	12400	100	Yes	1	8	$1,133.87	$113,387
512+400	512+700	12400	12700	300	Yes	0	6	$778.87	$233,661
512+700	512+800	12700	12800	100	Yes	0	3	$438.87	$43,887
512+700	512+800	12700	12800	100	Yes	0	3	$778.87	$155,774
512+800	513+000	12800	13000	200	Yes	0	6	$438.87	$219,435
513+000	513+500	13000	13500	500	Yes	0	3	$778.87	$155,774
513+500	513+700	13500	13700	200	Yes	0	6	$438.87	$131,661
513+700	514+000	13700	14000	300	Yes	0	3	$463.87	$46,387
514+000	514+100	14000	14100	100	Yes	0	4	$778.87	$155,774
			Total	56850				Total	$41,080,323

Option 2A Bridge Structures

BRIDGE	OLD AREA (M^2)	NEW AREA (M^2)	TYPE	CONST RATE	DEMO RATE	ADDITIONAL COSTS	NOTES	COST	REPLACEMENT SCHEDULE
1	66	120	10-15m	$5,000	$500	$66,000	Cost for temp. bailey bridge	$699,000	Future as required
2	81	135	10-15m	$5,000	$500	$81,000	Cost for temp. bailey bridge	$796,500	Future as required
3	55	100	10-15m	$5,000	$500	$55,000	Cost for temp. bailey bridge	$582,500	Opening Day
4	68.75	125	10-15m	$5,000	$500	$10,000	Cost for diverting to other roads	$669,375	Opening Day
5	71.5	130	10-15m	$5,000	$500	$10,000	Cost for diverting to other roads	$695,750	Opening Day
6	82.5	150	10-15m	$5,000	$500	$82,500	Cost for temp. bailey bridge	$873,750	Opening Day
7	99	180	15-30m	$6,000	$500	$99,000	Cost for temp. bailey bridge	$1,228,500	Future as required
8	104.5	190	15-30m	$6,000	$500	$10,000	Cost for diverting to other roads	$1,202,250	Future as required
9	55	100	10-15m	$5,000	$500	$55,000	Cost for temp. bailey bridge	$582,500	Opening Day
10	144	240	15-30m	$6,000	$500	$144,000	Cost for temp. bailey bridge	$1,656,000	Opening Day
11	71.5	130	10-15m	$5,000	$500	$10,000	Cost for diverting to other roads	$695,750	Opening Day
12	78	130	10-15m	$5,000	$500	$78,000	Cost for temp. bailey bridge	$767,000	Opening Day
13	88	160	15-30m	$6,000	$500	$10,000	Cost for diverting to other roads	$1,014,000	Opening Day
14	66	120	10-15m	$5,000	$500	$10,000	Cost for diverting to other roads	$643,000	Opening Day
15	55	100	10-15m	$5,000	$500	$10,000	Cost for diverting to other roads	$537,500	Opening Day
16	137.5	250	15-30m	$6,000	$500	$137,500	Cost for temp. bailey bridge	$1,706,250	Future as required

Appendix D

Full Scale Alternative Route and Area Graphics

(Bound Separately)

Appendix E

Conceptual Design Drawings

(Bound Separately)

Appendix F

Environmental and Geotechnical Features

(Bound Separately)