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July 23, 2021

Mr. Patrick Wruck
Commission Secretary and Manager
Regulatory Support
British Columbia Utilities Commission
Suite 410, 900 Howe Street
Vancouver, BC V6Z 2N3

Dear Mr. Wruck:

RE: British Columbia Utilities Commission (BCUC or Commission)
British Columbia Hydro and Power Authority (BC Hydro)
Bridge River Projects

BC Hydro is filing the attached application to the BCUC, pursuant to sections 45 and 46 of the *Utilities Commission Act*, for Certificates of Public Convenience and Necessity (**CPCN**) for the Bridge River 1 Units 1 to 4 Generator Replacement Project and the Bridge River Transmission Project.

BC Hydro is providing the Application as follows:

- Application;
- Application – Chapters 5 and 11 (Confidential Version);
- A Appendices;
- Appendices A-6-2 to A-6-5, A-6-8 (Confidential Version);
- B Appendices;
- Appendices B-2, B-3, B-5 to B-10, B-11, B-13 (Confidential Version);
- C Appendices; and
- Appendices C-1, C-3, C-4, C-9 (Confidential Version).

BC Hydro requests that certain information in the following chapters and appendices be held confidential in accordance with Part IV of the BCUC's Rules of Practice and Procedure.

- Chapter 5 – BR1 Project Description and Impacts;
- Chapter 11 – BRT Project Indigenous Nations Consultation & Public Engagement;

- Appendix A-6-2 to Appendix A-6-5 – Settlement Agreements;
- Appendix A-6-8 - Example of Consultation Material;
- Appendix B-2 – Bridge River System Studies;
- Appendix B-3 – Facility Asset Plans;
- Appendix B-5 – BR1 Alternative Assessment Financial Model;
- Appendix B-6 – BR1 Summary of Power Benefits Study;
- Appendix B-7 – BR1 Preliminary Design Report;
- Appendix B-8 – BR1 Project Procurement Decision;
- Appendix B-9 – BR1 Preliminary Cost Estimate;
- Appendix B-10 – BR1 Project Expenditure Breakdown by Year;
- Appendix B-11 - BR1 Rate Impact Models
- Appendix B-13 – BR1 Environmental Impact Statement;
- Appendix C-1 – Transmission Studies;
- Appendix C-3 – Bridge River Transmission Project Alternative Assessment Financial Model;
- Appendix C-4 – Bridge River Transmission Project Conceptual Design Report; and
- Appendix C-9 – Bridge River BRT Project Stakeholder Engagement Materials

In these chapters and appendices, BC Hydro has redacted commercially sensitive information related to BC Hydro's cost estimates and past settlements which could prejudice BC Hydro's position in future negotiations.

For the purpose of this proceeding and on appropriate undertakings, as contemplated by the BCUC's Rules of Practice and Procedure, BC Hydro can make this information available to registered interveners. BC Hydro reserves the right to object to a request for access to confidential information on a case-by-case basis.

Communications on the Application should be directed to:

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Yours sincerely,

Chris Sandve
Chief Regulatory Officer

tl/rh

Enclosure

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BC Hydro Bridge River Projects

Bridge River Transmission Project

Appendix C-1

Transmission Studies

PUBLIC

BRIDGE RIVER TRANSMISSION SYSTEM UPGRADE

NITS STUDY

REPORT NO: T&S PLANNING 2017-001

MARCH 2018

British Columbia Hydro and Power Authority

This NITS Study report was

Prepared by: ______________________________

Kai C. Lee, Growth Capital Planning (GCP)

Reviewed by: ______________________________

Ming Zou, Growth Capital Planning

Accepted by: ______________________________

Wah Shum, Manager Growth Capital Planning

Professional Seal, Signature and Date

EXECUTIVE SUMMARY

The Bridge River Area (BR) located in north of the Sunshine Coast has surplus generation over load to be transferred to the BC Hydro system via three transmission paths--- BR to South Interior West (SIW) via 2L90, BR to Fraser Valley via 3L2 and BR to North Shore (NS) - Sunshine Coast (SC) via 2L1/ 2L2. There are recently completed and on-going generation projects with a total increase of 480 MW in surplus BR generation. Transmission capacity will also be reserved for full BR1/ BR2 (BRR) output at all times upon completion of the BRR Generator Upgrade projects in 2021/ 2025. BRR generation curtailment is unacceptable due to the high potential for additional spill and the ensuing costs and risks.

The original SIW transmission path consisted of two circuits 2L90 and 2L91. Both 2L90 and 2L91 were destroyed by a forest fire in 2002 and restored. However, both were again destroyed by a 2004 forest fire. Subsequently, only 2L90 was restored and is now characterized in the Asset Heath Index as in poor condition.

Options to alleviate the future BR Transmission System overload that were studied include upgrading 2L90, expanding ROS substation, and curtailing local surplus IPP generation. Net present values (NPV) analysis will be performed by Commercial Management in Conceptual Design stage of the continuing Capital Project TM-0287.

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1. INTRODUCTION

The Bridge River Area (BR) is located in north of the Sunshine Coast (SC) in south-west BC. The BR Transmission System is shown in Figure 1.

[redacted]

Figure 1 Bridge River Transmission System.

The BR and neighbouring Sunshine Coast/ North Shore/ Fraser Valley East areas have 300 MW local load demand, and 1680 MW generation in 2025. There are several completed and under construction generation projects with a total addition of 480 MW in surplus generation as follows:

- BCH BR2/ BR1 (BRR) Upgrades--- 43 MW increase from 486 MW to 529 MW in 2025;
- BCH CMS Upgrade--- 23 MW increase from 157 MW to 180 MW in 2018;
- [redacted]

  *(*** These IPPs are run-of-river (ROR) projects with generation output depending on prevailing water inflow hydrology conditions.)*

2. BRIDGE RIVER TRANSMISSION PATHS

There are three existing transmission paths (TP) in the Bridge River (BR) area to transfer local surplus generation to the BC Hydro system:

- TP1--- BR to South Interior West (SIW) (via 2L90, rated at 50°C);
- TP2--- BR to Fraser Valley (FV) (via 3L2); and
- TP3[1]--- BR to Sunshine Coast (SC)-North Shore (NS)-Metro (MT) (via 2L1 and 2L2).

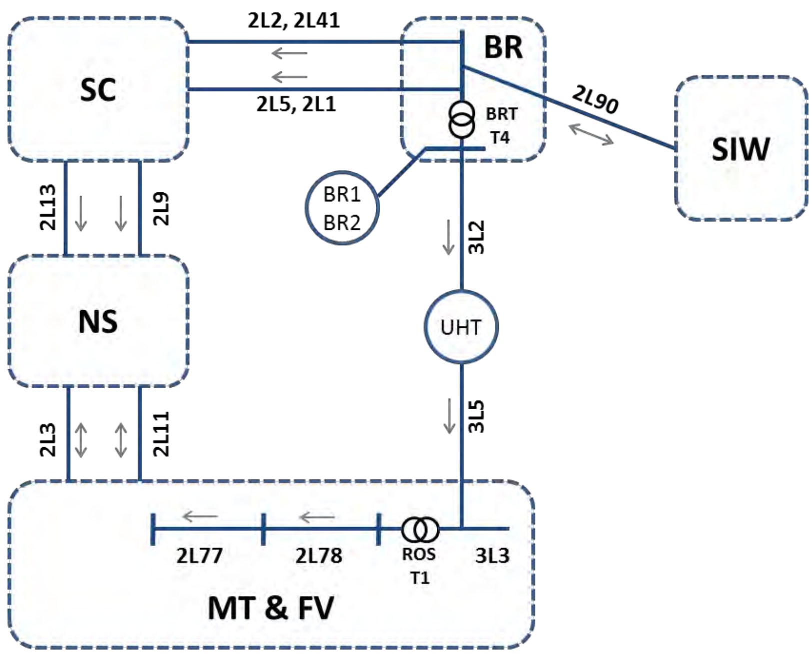


Figure 2 Three main BR transmission paths.

The original TP1 consisted of two circuits 2L90 and 2L91 connecting the two major areas: SIW and BR. Both circuits were destroyed a forest fire in 2002 and restored. However, both were again destroyed by a 2004 forest fire. Subsequently, only 2L90 was restored and is now characterized in the Asset Heath Index as in poor condition.

Upon completion of the BRR Upgrade projects, transmission capacity will be required for full output of BRR units (529 MW). The overloading of the BR Transmission System will become more severe. For overload protection, 2L90 is equipped with thermal protection module. If the 2L90 conductor temperature

[1] Upgrading the sunshine coast transmission path (TP3) is not effective to alleviate 2L90 overload.

exceeds 50° C, overload will be relieved by generation curtailment remedial action schemes (RAS) as described in BCH OO 7T-14.

3. SYSTEM STUDIES

3.1 ASSUMPTIONS AND METHODOLOGY

Assumptions

- Load Forecast---The BC Hydro substation loads used in the study are based on the BC Hydro 10-year Distribution Substation Load Forecast dated August 2016 (See Appendix 1); and

- Generation Resource---The latest available version of the BCH Base Resource Plan (BRP) dated October 3, 2016 was employed (See Appendix 2).

Methodology

The BR Transmission System overload is the combined effect of two highly variable phenomena. Firstly, the 2L90 loading is strongly dependent on ROR IPP generation that is affected by water inflow hydrology. Secondly, the 2L90 rating is also strongly dependent on various environment conditions including ambient temperature, solar heating, wind speed and direction and other environmental effects. These factors are included in the evaluation of frequency, duration, and amount of generation curtailment for all overload events.

3.2 STANDARDS AND CRITERIA

The IEEE Std. 738-2006 was employed for analyzing transmission line quasi-dynamic rating that is dependent on various environment and conductor surface conditions (See Appendix 3 for 2L90 rating). The NERC/WECC Planning Standards, and BCH Transmission Planning Standards including System Operating Limits Methodology, Operating Orders, and facility rating criteria were applied. Credible normal and first contingency conditions for various system conditions have been analyzed.

The 2L90 thermal overload issue has been identified in the previous 2013 and 2014 TPL Assessment. This issue is addressed by operations means through generation re-dispatch and 2L90 line opening until 2L90 upgraded to 90° C operation.

Under normal system conditions, no generation restriction is allowed. Transmission capacity will also be reserved for full BR1/ BR2 (BRR) output at all times upon completion of the BRR Generator Upgrade projects in 2021/ 2025. BRR generation curtailment is unacceptable due to the high potential for additional spill and the ensuing costs and risks. Under single contingency conditions, generation shedding at Bridge River area is allowed.

3.3 SYSTEM CONDITIONS

The system condition is most stringent in light summer because the line rating is reduced due to environment (ambient temperature) conditions, and increased surplus generation in the ROR IPP plants caused by high water in-flow conditions. Detailed assessment of system overload used the 2028 Light Summer (LS) base case with the following conditions:

- Peace generation is set to various levels in order to represent expected variation in the flow into KLY from the north.

- BRR generation--- All BRR units are set at Maximum Power Output (MPO) (with a 5% reduction to account for an actual expected level described by Generation Asset Management) for all times as required by the BCH Generation Asset Management for flood control. BRR generation curtailment is unacceptable due to the high potential for additional spill and the ensuing costs and risk

- IPP generation--- All IPPs in BR and neighbouring areas will adopt the [redacted] were retrieved from the BCH PI System. In August, generation level drops significantly to one third of maximum level due to reduced seasonal water inflow hydrology; and

- Ambient temperature and seasonal environment conditions--- The BRT ambient temperature data for the past 6 years (2011- 2016) were retrieved from the BCH PI System. In May, the BRT ambient temperature is low (16°C average, 29°C maximum). With reduced solar radiation due to lower angle of elevation of sun and other weather conditions including wind and overcast, BR Transmission System overload is unlikely. However, in June and July, the average temperature is 21°C and can reach 40°C maximum around mid-June to mid-July. Solar radiation heating of line conductors also reaches its seasonal peak, so line rating can be significantly reduced. [redacted] hus, June-July is the period for BR Transmission System overload concern.

3.4 2L90 LOADING DURING SUMMER

BR Transmission System will be stressed in light summer, a system condition with maximum local surplus generation and minimum local load. A typical BR Transmission System heavy loading condition that occurred on the hottest days of 2016 (June 28-30) was examined (See Figure 3). In 2016, 2L90 did not exceed its present 50°C rating. However, if similar conditions occur in future upon completion of the various generation projects including the 43 MW BRR Upgrade, the BR Transmission System capability will be exceeded. 2L90 will exceed its present 50°C rating and overload will occur in future. With additional generation in the area in the future, the overloading of 2L90 will be more severe--- last longer duration, occur more frequently with increased amount. If 2L90 is refurbished to the present 50°C rating only, one option is curtail IPP generation to relieve overload. Upgrading 2L90 to 90°C rating is sufficient to accommodate the surplus generation without curtailment.

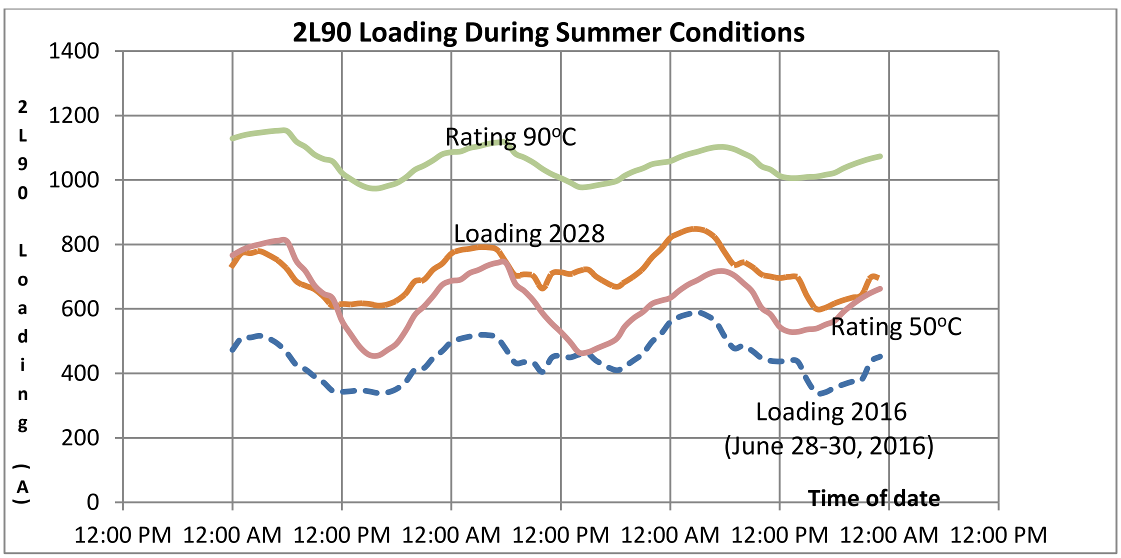


Figure 3- Typical present and future 2L90 severe light summer system conditions

3.5 [redacted] ANALYSIS

Data for the BRT Ambient Temperature in past 6 years, [redacted] IPP generation in past [redacted] since commissioning [redacted] were retrieved from the BCH PI system to assess and forecast the amount of IPP curtailment. Details of the analysis are outlined below:

<u>Step 1--- Expected IPP output and 2L90 loading levels</u>

Historical [redacted] generation patterns since the initial commissioning stage were assessed. The average IPP output for summer conditions was determined to be 0.56* MPO by using the average ratio of [redacted] to Maximum Power Output (MPO) of the IPP for June and July in the past 3 years [redacted] (See Appendix 4). The corresponding average 2L90 loading was thus determined to be 618 A in the load flow study using BRR at 503 MW, 95% of MPO.

<u>Step 2--- Frequency and duration IPP Curtailment</u>

T_{crit}, is the ambient temperature that 2L90 overload condition will occur. The expected 2L90 loading of 618 A corresponds to an ambient temperature (T_{crit}) of 26.2^{o}C. From the recorded BRT Ambient Temperature ($T_{ambient}$) PI data, the average frequency and duration of ambient temperatures exceeding T_{crit} for June- July in the past 6 years (2011- 2016) were obtained. Curtailment is required to reduce the 2L90 loading to its 50^{o}C rating. These frequency and duration correspond to the curtailment events.

<u>Step 3--- Expected IPP Generation curtailment amount</u>

To alleviate overload on 2L90, IPP generation needs to be curtailed excessively. However, opening 2L90 would lower the curtailment to 48 MW because the constraint is now ROS T1 instead of 2L90. The approach to lower curtailment requirement by opening 2L90 upon overload is employed.

The expected annual IPP curtailment can then be obtained from the product of expected curtailment amount and period of overload. The cost can also be estimated in the Conceptual Design stage based on cost information available from BCH Business and Economic Development.

Step 1	Average 2L90 Loading for patterned IPP generation	618 A
Step 2	Critical temperature (T_{crit})	26.2°C
	Curtailment Frequency per year for $T_{ambient}$>T_{crit} from on PI data	28 times
	Curtailment Duration per year for $T_{ambient}$>T_{crit} from PI data	255 h
Step 3	Expected [redacted] curtailment (2L90 open--- ROS T1 overload constraint)	48 MW
	Expected total [redacted] curtailment per year (2L90 open)	12,240 MWh

Note:-

1. *Overload will not occur in late spring (May) due to low ambient temperatures and reduced solar radiation heating on line conductors;*
2. *Overload will not occur in late summer (August) due to generation reduced to 0.29*MPO for seasonal low water inflow condition;*
3. *BRR at maximum output at all times; and*
4. *All effective generation curtailment schemes to alleviate 2L90 overload conditions have been analyzed.*

Table 2- Analysis of [redacted] Generation curtailment

4. SYSTEM UPGRADE OPTIONS

Various reinforcement options have been identified to alleviate overload conditions of the BR Transmission System as follows:

Option 1--- Increase 2L90 rating to 90°C from 50°C

Upon upgrading to 90°C operation, 2L90 rating will be increased to 1014 A at 30°C, and 921 A at 40°C summer ambient temperature (see Appendix 3). This will provide sufficient capacity for the future system conditions.

Option 2--- Increase ROS 360/230 kV T1 transformer capacity by 150 MVA and operate with 2L90 open

The present practice is to open 2L90 when 2L90 is overloaded in order to maximize the transfer of surplus generation from the BR area. Upon opening of 2L90, ROS T1 can be overloaded. Additional 150MVA 360/230kV transformation capacity at ROS[2] is required with 2L90 opened.

Also, remove protection limitations on 3L5, 2L77 (CBN-ALZ) caused by relay or CT (re: BCH OO 5T-10) so that line ratings can be fully utilized.

With this option, 2L90 can be decommissioned, but the operating flexibility would be reduced and would require acceptance from internal stakeholders such as Performance Planning and FVO.

Option 3--- Generation curtailment at [redacted] with 2L90 open

To accommodate full generation output of BRR, the technically viable generation curtailment option is to curtail [redacted] generation to relieve overloading ROS T1. With this option, 2L90 can be decommissioned, but the operating flexibility would be reduced and would require acceptance from internal stakeholders such as Performance Planning and FVO.

Dismissed Option--- Rebuild 2L91 (50°C) **to operate in parallel with 2L90 (**existing 50°C rating)

This option was dismissed because 2L90 will still be overloaded under normal conditions and IPP generation curtailment will be required. Combined rating of 2L90 and 2L91 both rated at 50°C is less than 2L90 uprated to 90°C in the high temperature zone (30° to 40°C) in which 2L90 overload will occur more frequently.

The Capital Project TM-0287 design team is proposing to partially parallel 2L90 and 2L91 due to First Nation territories and cost saving issues. Since there will be no adversative effect on the BR Transmission System from a Transmission Planning point of view, GCP have no issue with this scheme.

[2] In this situation, Transmission Planning does not require N-1 firm capacity because no load would be at risk. In the event of a transformer fault on ROS T1, the new ROS transformer can be tripped as well due to the existing RAS at ROS.

5. LOSS EVALUATION

The existing practice using the in-house PLOSS program to evaluate system losses was adopted. This includes loss in all the transmission elements under various system operating conditions at different specified time of the year. Net present values (NPV) analysis will be performed in the Conceptual Design stage of the continuing Capital Project TM-0287.

6. COST ESTIMATE

Pre-conceptual cost estimate for Options 1 and 2 were also obtained from the BCH Estimating and Project Engineering. The Sustain and GCP cost of restoring and upgrading 2L90 to 50^{o}C and 90^{o}C are 79% and 21% respectively (See Appendix 5). GCP initially planned to de-commission 2L90. However, Performance Planning and FVO do not agree with this approach. The 2L90 restoration cost is thus included in the all three options. NPV analysis will be performed in the Conceptual Design stage of the continuing Capital Project TM-0287.

7. CONCLUSION

BR Transmission System overload will occur in future due to increased generation in the area. Options to alleviate overload have been identified. For this study stage, all technically viable and feasible options have been investigated. Project was handed over to Capital Project TM- 0287 (See Appendix 6). Net present values (NPV) analysis will be performed by Commercial Management in the Conceptual Design stage of the continuing Capital Project TM-0287.

Appendix 1: BCH Distribution Substation Load Forecast- 2016

Load Forecast (MVA)- Peak Winter Non-coincidental (High with DSM)

	F15	F17	F18	F19	F20	F21	F22	F23	F24	F25	F26
BR Sub Total-Distribution	48	48	48	48	48	48	48	48	49	49	50
BR Sub Total-Transmission	9	9	9	9	9	9	9	9	9	9	9
BR Grand Total	57	57	57	57	57	57	57	57	58	58	59
FVE Sub Total-Distribution	268	271	238	241	243	245	249	253	258	263	269
FVE Sub Total-Transmission	15	14	14	17	13	13	13	13	13	13	13
FVE Grand Total (D+T)	282	285	252	257	256	258	261	266	271	276	282
NS-HS Sub Total-Distribution	546	545	550	558	562	567	576	584	593	603	613
NS-HS Sub Total-Transmission	161	182	185	185	185	185	185	185	185	186	186
NS-HS Grand Total (D+T)	707	727	735	742	747	752	761	769	778	789	799

Table A1- BCH load forecast

Appendix 2: BCH Base Resource Plan (2013-2016)

The major BR generation projects completed in 10 year horizon extracted from NITS Data Update on Oct 3, 2016 are shown in Table A2:-

	2013	2014	2015	2016
BCH BRR Upgrade (MW)	486	486	486	529
BCH CMS Upgrade (MW)	184	180	180	180

[redacted]

Table A2- Major BR generation projects (MW) in Base Resource Plan for 10 year horizon

Appendix 3: 2L90 RATING

PLSCADD results based on IEEE Std 738--- by BCH Transmission Design

Basic Data or Assumptions

For the purpose of this study, following parameters are used or assumed:

- Conductor: ACSR Drake.
- Wind: 0.61m/s of wind speed perpendicular to the conductor.
- Elevation: 2500ft (762m).
- Representative summer date and time: July 15, 6pm.
- Representative winter date and time: Dec.21, 6pm.
- Atmosphere: Clear.
- Conductor latitude: 50.8°N.
- Line direction: perpendicular to solar azimuth for maximum solar heating.
- Absorptivity: 0.5
- Emissivity: 0.5
- Maximum allowable conductor temperature: 50°C.

Temp (°C)	Summer Rating (A) 50°C Operating Temp (old IEEE Std-738)	Summer Rating (A) 50°C Operating Temp (new IEEE Std-738)	Summer Rating (A) 90°C Operating Temp (new IEEE Std-738)
0	917	954	1253
5	863	898	1214
10	806	838	1175
15	744	774	1136
20	675*	707	1097
25	598*	632	1057
30	509	546	1014
35	399	443	969
40	242**	305	921

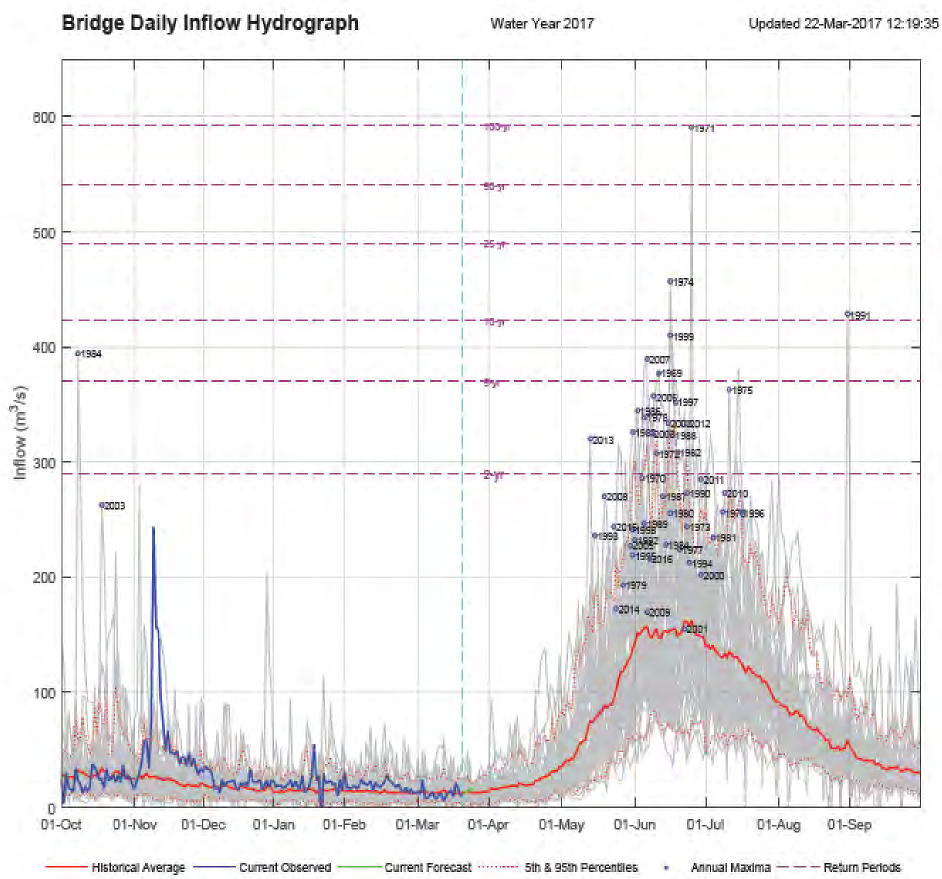
(Winter rating can increase by 11- 13% in applicable temperature range.)

* **Average 2L90 loading of 618A corresponds to critical temperature T_{crit} of 26.2°C by linear interpolation.**

**** Sharp decrease in rating above 35°C--- major temperature range for overload.**

Appendix 4: IPP GENERATION PATTERN WITH DAILY INFLOW HYDROGRAPH

(by BCH Generation Resource Management)



[redacted] **GENERATION OUTPUT AVERAGE= 0.56*MPO (June- July); 0.40*MPO (Jan- Dec)**

Appendix 5: Pre-conceptual Cost Estimate (extracted)

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Engineering Memorandum

Inter-office memo

TO:	Wah Shum	**DATE:**	May 10, 2017
FROM:	Qaiser Iqbal	**Project #:**	FI-01074.0013 FI-01077.0008
SUBJECT:	**Bridge River (BR) Transmission Study – pre-Conceptual Cost Estimate (Not for Implementation Funding)**		

The purpose of this estimate is to provide pre-Conceptual level cost estimates for capital planning and for discussion purposes only. This estimate should not be used for implementation funding request. The accuracy of these cost estimate are judged to be approximately +100 per cent/-35 per cent*. Included are the estimate details and cash flows for the Bridge River (BR) Transmission Study.

*Accuracy range for pre-Conceptual estimate is currently not defined in the PPM practices. The accuracy range for these cost estimates are a reflection of the scope information provided and the estimating assumptions being used. If scope is not clearly defined, the accuracy range for pre-Conceptual estimate could vary greatly.

Study Description

There is a series of recently completed and on-going generation projects ([redacted] with a total increase of 468 MW surplus generation in the Bridge River area. The following alternatives for Transmission reinforcements have been identified to alleviate overload conditions due to increased level of power export to rest of the BCH system.

The planning team is considering the following Alternatives:

Alternative 1 - Option 1: Increase Overhead Transmission Circuit 2L090 Rating to 90°C Operation using Current Alignment.

Alternative 1 - Option 2: Increase Overhead Transmission Circuit 2L090 Rating to 90°C Operation using Original Alignment (Burnt Section).

Alternative 2: Operate with Overhead Transmission Circuit 2L090 open and add Rosedale Substation (ROS) 360/230kV transformation capacity.

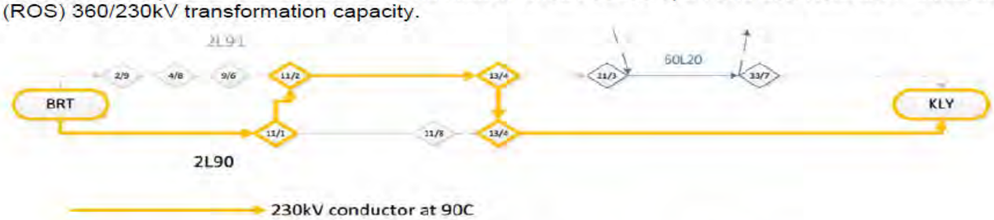

Figure 1: 2L090 alignment for Alternative 1 - Option 1

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Release Date: May 2017

Version: 1.00
Page: 1

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Engineering Memorandum

Bridge River Transmission Study Costs

The project costs are summarized as follows:

Description	Alt.1 Option1 Total Cost ($ M)		Alt.1 Option 2 Total Cost ($ M)		Alt. 2 Total Cost ($ M)
	Rating Restoration for 2L090 to 55°C	Thermal Upgrade 2L090 to 90°C (Incremental Cost)	Rating Restoration for 2L090 to 55°C	Thermal Upgrade 2L090 to 90°C (Incremental Cost)	
Total Construction Cost without contingency	16.6	4.3	18.1	4.1	35.8
Contingency	5.0	1.5	5.5	1.4	8.1
Total Construction Cost (with contingency)	**21.6**	**5.8**	**23.6**	**5.5**	**43.9**
Inflation	1.0	0.3	1.3	0.3	2.1
Total Construction Cost (inflated)	**22.6**	**6.1**	**24.9**	**5.8**	**46.0**
Capital Overhead (COH)	0.5	0.2	0.6	0.1	1.1
Interest During Construction (IDC)	1.1	0.2	1.1	0.2	2.8
Subtotal COH and IDC	**1.6**	**0.4**	**1.7**	**0.3**	**3.9**
Total Construction Cost with COH and IDC	**24.2**	**6.5**	**26.6**	**6.1**	**49.9**
Total Asset Retirement Cost without contingency	1.5	0.5	1.6	0.4	-
Contingency	0.5	0.2	0.6	0.2	-
Total Asset Retirement Cost (with contingency)	**2.0**	**0.7**	**2.2**	**0.6**	**-**
Inflation	0.1	0.0	0.1	0.0	-
Total Asset Retirement Cost (inflated)	**2.1**	**0.7**	**2.3**	**0.6**	**-**
Total Cost Estimate (loaded) (+100 % / -35 %) In-Service Date (ISD)	33.5 67 ~ 22 Oct 2020		35.6 71 ~ 23 Oct 2020		49.9 100 ~ 32 Oct 2020

Appendix 6: T&D Capital Project Summary

T&D Capital Project Summary - **Date:**
03-Aug-2017

IPID number:	92423	**In Capital/Management Plan:**	YesYesYes
EAR number:	TM-0287	**T/D Sustain/Growth:**	T GrowthT GrowthT Growth
Project Title	**Bridge River Transmission System Reinforcement**		
Location:	2L90	**Region:**	SI
Planner:	K C Lee	**Initiator:**	Ajay Kumar
Project Manager:	Sue Foster	**Sponsor:**	Chris O'Riley
Required ISD:	October 2020. The target in-service date is October 2020 to align with the BR2 generation upgrade project. For Alternative 1, it is likely the project will have to extend until 2022 for proper aboriginal engagement and environment assessment. The cash flow reflects ISD of October 31, 2022.		

Costs Estimate:

	F17	F18	F19	F20	F21	F22	F23	F24	Total
Capital ($M)		0.5	1.0	1.1	2.5	11.7	16.8		33.6

**The cost estimate shown is for Alternative 1.*

Project Description:
Bridge River generation is currently curtailed or restricted when the transmission system is constrained during the summer period (June-August). With the generation increase in the Bridge River area (480 MW) because of the addition of IPPs and Bridge River unit replacements to restore capacity, Generation Resource Management no longer believes it as appropriate to restrict BRR to control overload on 2L90 because (1) the increased probability of spill is higher, and (2) the generation curtailment cost is estimated to average $2.6M per year.

A NITS study was undertaken to identify the solutions to accommodate the generation increase in the Bridge River area.

Alternatives to Be Considered:

Alternative 1: Restore 2L90 to 55° C and upgrade to 90° C
- Increasing 2L90 rating to 90° C will provide sufficient capacity for various system conditions.

Alternative 2: Add a 360/ 230 kV transformer in ROS
- This requires major upgrade in the ROS substation. For this alternative, there is a preference to keep 2L90 for operational flexibility. Therefore, additional cost is needed to restore 2L90 to 55° C. This alternative will not be cost effective compared to Alternative 1.

Alternative 3:
- Curtail IPP generation, [redacted]. IPPs would need to be paid for their deemed generation if they were curtailed. For this alternative, there is a preference to keep it for operational flexibility. Therefore, additional cost is needed to restore 2L90 to 55° C.

Other Alternatives Rejected:
The "Deferral" and "Do Nothing" alternatives were rejected because Generation no longer believes it as appropriate to restrict BRR to control overload on 2L90 because of the increased probability of spill at Terzaghi Dam into Lower Bridge River and at Seton River. BC Hydro is in discussions with the Stat'im'c Nation regarding the increased spill risk and potential impacts to the Lower Bridge River and Seton River. The impact of spill, especially on First Nations interests, is considered high.

Other Project Dependencies:
None

Other Information:
None

Bridge River Transmission System Upgrade

NITS Study Addendum

Report #: T&S Planning 2018-073

December 2018

This is an addendum to the NITS Study Report, "Bridge River Transmission System Upgrade", T&S Planning 2017-001, March 2018.

This NITS Study report was

Prepared by: ______________________________

Kai C. Lee, Transmission Planning

Reviewed by: ______________________________

Ming Zou, Transmission Planning

Accepted by: ______________________________

Wah Shum, Manager Transmission Planning

Professional Seal, Signature and Date

Introduction

As part of the Conceptual Design stage of project TM-0287---"Bridge River Transmission System Upgrade", the Independent Power Producer (IPP) generation curtailment alternative was further investigated and updated by Transmission Planning (TP). It is standard process for TP to define alternatives at a high level in the Initiation stage, further investigate them in the Conceptual Design stage and later refine the requirements of the alternatives. The information shown below was provided by various BC Hydro departments and used to update the IPP generation curtailment alternative.

New Inputs

1. BC Hydro Stations Design was requested to confirm the loading capability of the Rosedale transformer (ROS T1), which includes the winding hottest spot and top oil temperature (See Attachment A). This information was based on the equipment design, factory and field test data and is shown in the Table A1 below:

Table A1: ROS T1 loading and temperature characteristics

ROS T1 Loading Limit (MVA/ %)	Allowable loading period (h)	Temperature (°C)- Winding hottest spot/ top oil
450 (100%)	continuous	93/73
473 (105%)	continuous	97/76
495 (110%)	continuous	102/79
518 (115%)	5.0	105/80
540 (120%)	2.0	105/78
563 (125%)	0.9	105/76
585 (130%)	0.4	105/75

- *ROS T1 transformer top oil thermal time constant (t_{to}) is 3.8 hours. Settling time= 4* t_{to}.*

2. IPP total units ramping up and down times will be approximately 5 hours total. This is based on discussions with the IPP and confirmed by PI records.

3. BCH control center responding time for IPP curtailment process will be approximately 2 hours (See Attachment B).

Outcome

Design of the IPP generation curtailment scheme was formulated in July 2018 and was documented in ScopeNotes 3286 Rev 5 (TM-0287 Conceptual Design stage). This scheme employs the existing ROS T1

Electronic Temperature Monitor (ETM) device for top oil temperature rise measurement. The overload alarm of ROS T1 was then set at 76°C top oil temperature.

The implementation of the IPP generation curtailment scheme would result in a lower occurrence of curtailment events and each curtailment event will be longer. Because of transformer top oil thermal time constant identified by Stations Design, units ramping and BCH control centre responding times, the IPP curtailment events can no longer be considered independently. Instead, consecutive IPP curtailment events within a short period (say, within one day) have the impact of a single event. The anticipated IPP generation curtailment events with this new formulated scheme are shown in Table A2 below:

Table A2: Frequency and duration of IPP curtailment events

	Minimum	Maximum	Expected (average)
Frequency rate (events/ year)	0	19	7
Duration per event (hour)	16	72	25[1]

[1] *Expected duration= IPP curtailment time+ FVO time+4* t_{to}= 8h+2h+15h=25h.*
Notes:- IPP units ramping times are additional.

The detailed curtailment requirements based on the formulated curtailment scheme and alarm settings are shown below in Table A3. The previous high level requirements are shown for comparison purposes:

Table A3: Analysis of [redacted]

Step	Description	NITS Planning Study project initiation Stage[1] (August 2017)	TM-0287 Conceptual Design Stage[2] (July, 2018)
Step 1	Average 2L90 Loading for patterned IPP generation	618 A	618A
Step 2	Critical temperature (T_{crit})	26.2°C	26.2°C
	Curtailment Frequency per year for $T_{ambient}$>T_{crit} from on PI data	28 times	7 times
	Curtailment Duration per year for $T_{ambient}$>T_{crit} from PI data	255 h	175 h[3]
Step 3	Expected [redacted] (2L90 open---ROS T1 overload constraint)	48 MW	48 MW
	Expected total [redacted] per year (2L90 open)	12,240 MWh	8,400 MWh

[1] Transformer Data Book System- ROS T1 loading characteristics not available
[2] ROS T1 loading characteristics included and ROS T1 overload alarm set at 76°C top oil temperature
[3] IPP units ramping times are additional

Notes:

1. *Overload will not occur in late spring (May) due to low ambient temperatures and reduced solar radiation heating on line conductors;*
2. *Overload will not occur in late summer (August) due to reduced generation for seasonal low water inflow condition;*
3. *BRR at maximum output at all times;*
4. *All effective generation curtailment schemes to alleviate 2L90 overload conditions have been analyzed;*
5. *Above information is highly statistical due to inherent characteristics of environment conditions including ambient temperature, and IPP hydrological conditions;*
6. *Heat transfer and cooling phenomena of transformer are complicated and dependent on individual design;*
7. *No further field test and thus data update of the ROS T1 has been planned. There is further change in the IPP curtailment requirements expected in the foreseeable future; and*
8. *IPP curtailment requirement is based on ROS T1 loading at 450 MVA nameplate rating (re: ScopeNotes 3286, Rev 5).*

Attachment A

From: Zhu, Hanxin
Sent: 2018, May 24 3:24 PM
To: Lee, Kai Chung; Yu, Alex
Cc: Horan, Paul; Zou, Ming
Subject: RE: BRTP- ROS T1 load profile

The (top) oil temperature as provided in the table is the sum of the oil rise and the ambient.
Winding hot spot as provided is the sum of the top oil temperature and the winding hot spot gradient.

ROS T1 Loading Limit (MVA/ %)	Allowable overload period (hr)**	Temperature Winding hot spot/ oil (°C)
450 (100%)	continuous	93/73
473 (105%)	continuous	97/76
495 (110%)	continuous	102/79
518 (115%)	5.0	105/80
540 (120%)	2.0	105/78
563 (125%)	0.9	105/76
585 (130%)	0.4	105/75

Time constant for copper is 6-9 minutes.
Oil time constant, however, is much longer. For this unit, it is about 3.8 hours. It would take 4x the oil time constant to get the ultimate oil rise (temperature).

Please let me know if you have any further questions.

Regards!

Attachment B

From: Lee, Kai Chung
Sent: 2018, December 19 4:06 PM
To: Cullen, Steven (SC)
Cc: Zou, Ming; Horan, Paul; Bu, Lili
Subject: BRTP - revision to the NITS study by Dec. 11, 2018

Steven,
Have you confirmed the 2 hours responding time with the Control room. Could you please confirm that:-

1. The responding time for FVO to request IPP to curtail is 2 hours. The FVO operator will request IPP curtailment by phone after receiving alarm- "*YES, the 2hr time period to contact the IPP is acceptable*"--- *(SC).*
2. It is acceptable to attach following e-mail to Addendum as shown in Attachment B– "*Yes, as I do not see any issues in attaching this as email to the NIS*"--- *(SC).*

Thanks.

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Appendix C-2

IPP Generation Curtailment Description and Cost Estimate Assessment Methodology

Description and Cost Estimate Assessment Methodology of Alternative 3

Alternative Description

In this alternative, BC Hydro obtains new curtailment rights to reduce the output of regional IPP(s) to manage the loading along 2L90 transmission line during system normal operations to ensure that the transmission system is operated within normal system operating limits. These new rights, described in more detail later, are required as current contract provisions are not sufficient to allow BC Hydro to curtail in a manner which meets the project objective.

An operating procedure would be set up such that on a day-ahead basis, an evaluation would be made to determine if curtailment appears necessary. If so, the IPP(s) would be contacted, and curtailment executed, per the new rights. The envisioned operating procedures are:

Day 0 (“today”):

- GSO evaluates temperature and generation forecasts for tomorrow (Day 1) to see if there may be too much generation in the BRR region;
- If yes, then GSO evaluates duration of curtailment needed, taking into account contract provisions re. minimum curtailment duration and minimum time between curtailments;
    - ▶ This may mean multi-day curtailment is needed if a multi-day hot spell is forecast
- GSO also conservatively estimates MW curtailment required to ensure ROS T1 stays within limit for worst forecast temperature and generation patterns, assuming TDSO willing to switch 2L90 out for the worst part of day;

- GSO provides “heads up” notice to the IPP(s) of expected size & duration of curtailment and also notifies TDSO.

Day 1:

- If conditions forecast on Day 0 (yesterday) do not materialize, GSO notifies IPP(s) curtailment not needed, or fine tunes timing/MW as needed;
- Assuming conditions forecast on Day 0 materialize, GSO formally notifies IPP(s) with appropriate lead time for notification and ramp requirements;
- TDSO keeps 2L90 in-service as much as possible (which may generally be achievable given conservatism in curtailment MW), and only switches out 2L90 when the circuit becomes thermally overloaded, if appropriate. TDSO will restore 2L90 once the ambient temperature falls below 25 C or when determined necessary by TDSO.

Day X:

- Operation continues as per third bullet in Day 1 until the last day of curtailment is reached;
- GSO notifies the IPP(s) of the anticipated curtailment end time, with appropriate lead time for notification and ramp requirements.

Curtailment Size, Duration, and Frequency Estimate

TDSO carried out analysis to estimate the expected curtailment size (MW), duration (days), and frequency (times per year). In this analysis, curtailments were expected to be necessary anytime the ambient temperature at the Bridge River Substation (near Lillooet) is at or above 30^{o}C and BRR regional generation is high.

TDSO first reviewed historical temperature trends to determine the duration and frequency for when temperatures equal or exceed 30^{o}C. A sample of this analysis is shown below.

The linked image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the link points to the correct file and location.

TDSO also carried out power load flow analysis to determine the amount of curtailment required to keep system within its normal operating limits during periods of high local generation or when the local ambient temperatures became greater than 30 C and 2L90 became thermally overloaded.

This involved reviewing historical generation patterns, appropriately scaled for expected changes in resources (e.g., additional IPPs expected to be built in the region), and assuming that BC Hydro's Bridge River facilities (BR1 and BR2) would be run at maximum output.

From these analyses, the expected/average curtailment is estimated to be 114 MW, be seven days long, and occur five times per year, generally in the months of May, June, and July.

A brief investigation of how future climate change may influence this estimate was carried out by GSO. This showed that while temperatures are expected to increase in these months, water flows are expected to decrease. Given these offsetting trends, no adjustment to the curtailment estimate was made.

Curtailment Rights and Preliminary Cost Estimate

Contract Management held discussions to determine if the IPP(s) were amenable to negotiating suitable curtailment rights and determined they were. Contract Management also determined, using TDSO's results, the total expected cost of this option. Given the correlation between temperature and Mid-C prices, historic prices were adjusted for >30°C and escalated in line with standard corporate Mid-C forecasts. Using the corporate standard return of 6%, the present value of the total costs amount to ~$65 million in $2019, or ~$3.5 million for the first year, growing annually.

BC Hydro Bridge River Projects

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Appendix C-3

BRT Project Alternative Assessment Financial Model

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Appendix C-4

BRT Project Conceptual Design Report

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BRTP

Conceptual Design Report

TM-0287

Prepared for: Jason Lee – Project Manager

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Accepted by:

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Title:	PE Team Lead
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Revisions

Revision Number	Date	Description

Contributors

The following have contributed to the content of this report for the specified sections and technical matter. The Professional of Record has applied their seal to accept professional responsibility for that portion of the report.

Sections: Overhead line design sections 2 and 3.2.4 and Appendix B

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Aug 25, 2020

Sections: Substation Electrical design section 3 (excluding section 3.2.4) and appendix E

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Sept 09, 2020

Sections: Executive Summary and sections 1, 4, 5, 6, 7, 8 and 9 (excluding associated appendices)

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21 Aug 2020

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Acronyms

The following are acronyms, abbreviations and codes used in this report.

2L90 - 230kV transmission line

2L91 - 230kV transmission line from

AACE - Association for the Advancement of Cost Engineering

BR - Bridge River Area

BRT - Bridge River Terminal substation

BRTP - Bridge River Transmission Project

ISD - In Service Date

IPP - Independent Power Producer

KLY - Kelly Lake Substation

LiDAR - Light Detection And Ranging

PLS CADD - Power Line Systems Computer Aided Design and Drafting

ROS - Rosedale substation

SCK - Soda Creek substation

SOO - Standard Operating Order

STARR - System for Transmission Asset Recording & Reporting

TDSO - Transmission and Distribution System Operation

Executive Summary

Bridge River generation is currently curtailed or restricted when the transmission system is constrained during the summer period (June-August). Transmission reinforcement or IPP (Independent Power Producer) generation curtailment is required to ensure Bridge River generation can be delivered at all times of the year without additional high water flows at Terzaghi Dam into the Lower Bridge River and the Seton River.

In addition to the transmission constraint discussed above, transmission line 2L90 in the Bridge River system is in a very poor state. This transmission line is an essential asset for transmission system flexibility during outages in the Bridge River system.

There are 3 alternatives being considered to accommodate the generation excess in the Bridge River area; the first is an upgrade of the 230kV transmission line 2L90 which runs between Bridge River Terminal substation (BRT) and Kelly Lake substation (KLY); the second is an additional transformer at Rosedale substation (ROS) plus refurbishment of 2L90; and the third is to curtail IPP generation plus refurbishment of 2L90.

The preferred alternative selected through a Structured Decision Making (SDM) process is alternative 1, an upgrade of 2L90 to 90degC operation including addressing all reliability related defects.

1 Introduction

The Bridge River Area (BR) is located in north-east of Pemberton. Generation is being transferred to the BC Hydro system via three transmission paths - BR to South Interior West via 2L90, BR to Fraser Valley via 3L2 and BR to North Shore - Sunshine Coast via 2L1/ 2L2.

Bridge River 1 and 2 Generation was designed for approximately 500MW. Due to equipment health and rating reduction caused by equipment failures and due to safety issues, the generation was de-rated to 396MW. This curtailment of generation results in loss of water conveyance capability. This issue will be resolved by a number of generation projects currently underway to restore historical operating capacity in late 2024 / early 2025.

On the transmission BR to South Interior West path the system was designed to deliver the full power from the generation using both 2L90 and 2L91. Both of these lines were destroyed by a fire in 2002 and were restored. In 2004 another fire damaged both lines and only 2L90 was restored with sections utilizing 2L91. This restricted the transmission capacity of this transmission path and the asset health rating of 2L90 is poor.

In 2010 through the Clean Power Call a number of Independent Power Producers (IPP) were procured and they contribute surplus generation power to the Bridge River system during Spring and early Summer beyond the existing transmission system capacity. Therefore, the transmission system restrictions are most stringent in the summer months due to higher ambient temperatures and increased surplus generation in the run-of-river IPP plants caused by high water in-flow conditions.

With the need to restore the loss of operating capacity within the Bridge River system and thereby restoring the lost water conveyance, Generation

System Operations no longer believes it as appropriate to restrict BR to control overload on 2L90 due to the high potential for additional high water flows at Terzaghi Dam into the Lower Bridge River and the Seton River.

Three different alternatives have been identified for this project to-date as follows:

Alternative 1: Upgrade 2L90 to 90ºC operation and address all reliability related defects.

Alternative 2: Increase Rosedale substation transformer capacity to 600MVA and address all reliability related defects.

Alternative 3: Curtailment of IPP generation and address all reliability related defects.

The conceptual designs for each alternative have been developed to a sufficient level to produce a conceptual design level estimate, AACE (Association for the Advancement of Cost Engineering) Class 5 with a +100%/-35% expected accuracy.

2 Alternative 1 – Uprate 2L90

2.1 Background

2L90 is a 230 kV circuit that connects Bridge River Terminal (BRT) to Kelly Lake Substation (KLY). The line was originally constructed in the early 1960's (1963-65) using wood pole type structures and initially went all the way to Prince George. When KLY was completed in the late 60's, 2L90 was terminated into KLY, creating 2L94 from KLY to Soda Creek substation (SCK). 2L91 was built shortly after 2L90 and runs in parallel for the entire alignment.

2L90 starts at the North end of Seton Lake at Bridge River generating station and runs east along the south side of Seton Lake to Lillooet, BC. From Lillooet the circuit continues northeast following highway 99 until Pavilion where it joins 5L41 and 5L42 in a right-of-way (ROW) all the way to KLY.

The circuit is 76.5 km in length, traversing through coastal mountainous terrain that is highly susceptible to wildfires. The majority of the ROW is through Crown land but a significant section of the circuit does cross Indian Reserve (IR) lands. The circuit alignment also traverses some very steep terrain with very limited access, particularly on the south side if Seton Lake. Throughout the circuit's history there have been a few geotechnical issues in this area including major rock and earth slides in the 1990's which destroyed the lattice steel masts of structure 9/6 on 2L90.

A Google Earth image of the circuit alignment is provided in figure 1.

Figure 1: Google Earth image of circuit alignment

In 2004 a forest fire burnt down sections of 2L90 and 2L91 resulting in parts of the circuits being spliced together and now only 2L90 is energized. In 2012 there was a project initiated to uprate 2L90 to 90°C. The construction contract was awarded and materials were ordered however the project was cancelled due to the inability to obtain the necessary outages and difficulty in obtaining access on existing First Nations lands.

2.2 Scope of Work

At present 2L90 is rated for operation at 55°C as per SOO (Standard Operating Order) 5T-10. However, it has multiple clearance deficiencies for this operating temperature and also has significant defects which could affect its reliability (as logged in STARR (System for Transmission Asset Recording & Reporting)). The objective of alternative 1 is to carry out work on the line (structure replacements, ground re-contouring etc.) to allow the line to be operated at 90°C (1,014A) with no clearance violations. In addition, all major STARR defects which could cause reliability issues (categorized as D and E in STARR) will be addressed.

To determine the scope of work, desktop thermal analyses have been carried out using PLS CADD (Power Line Systems Computer Aided Design and Drafting) software and LiDAR (Light Detection And Ranging) data gathered in 2010 to identify all the clearance violations at the higher temperature. These violations have then been resolved by proposed pole height increases, ground re-contouring or other measures.

The STARR defects have then been reviewed to identify work required to address the reliability concerns (categorized as level C, D and E in STARR). In many cases, the same pole has been identified for clearance violations and STARR defects. The vast majority of the STARR defects require the complete replacement of the structure, however, in some cases the poles will remain and cross-arms / insulators / guys / etc. will be replaced.

In addition to the major STARR defects there are a considerable number of minor STARR defects such as missing guy guards, broken number plates etc. These defects do not affect the reliability of the line. The cost of addressing this work is small relative to the overall project costs, however, the practicality of including this work in the project (due to access requirements on First Nation lands etc.) may preclude the work from the project. The conceptual level cost estimates have included this work but its inclusion in the final scope of the project will be determined during the Feasibility / Definition stages of the project based on accessibility etc.

It is recognized that the STARR data is not up to date and hence represents the minimum amount of work required. It is inevitable that the condition of the line will have further deteriorated since the STARR data was collected. To compensate for this, the costs associated with the STARR work have been increased by 30%. This factor has been proposed by Transmission Line Design based on experience from previous similar projects.

In selecting the materials for the replacement structures, consideration has been given to the wildfire risk. The line has suffered from damage due to wildfires on multiple occasions. Below is a summary of the forced outages 2L90 has suffered in the past as a result of wildfires:

- 2002 Fire caused about 3-month outage (2010 hr 51 min)
- 2004 Fire caused about 4.5-month outage (3363 hr 46 min)
- 2006 Fire caused one week outage (145 hr 49 min)
- 2009 Fire caused about 2.5-month outage (1869 hr 46 min)
- 2016 Fire caused about 3 day outage (64 hr 5 min)

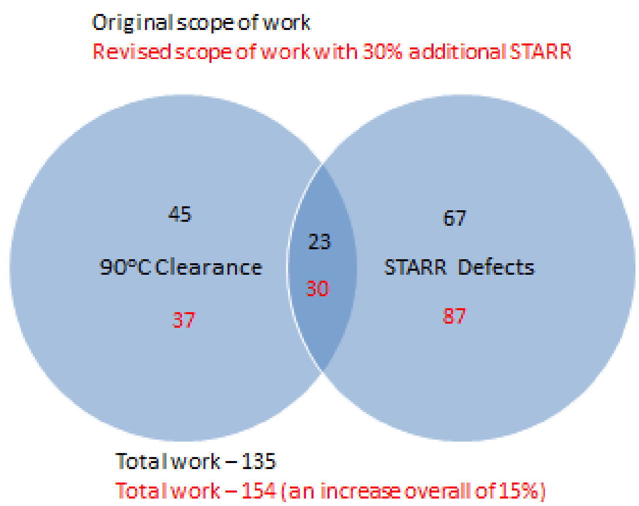
Due to the high fire risk in this region the project engaged Bruce Blackwell (B.A. Blackwell &Associates Ltd.) to perform a wildfire risk assessment on the circuit and provide recommendations to consider in the conceptual design stage. A copy of the Transmission Circuit 2L90 Wildfire risk Assessment report is provided in appendix A. To address the future wildfire risks, fibre reinforced plastic (FRP) poles have been proposed for replacement structures in the high wildfire risk sites identified in the report. The manufacturers of FRP poles claim that this material has a superior resistance to wildfire damage compared to wood poles. FRP poles have also been selected in areas with restricted access due to their lower weight which will facilitate easier helicopter work procedures.

As a further measure to enhance wildfire resiliency, where new structures will be installed adjacent to existing structures that are being replaced, the new structure will be located on the side furthest away from the edge of the ROW where feasible. This will result in increased distance between wildfire fuel sources (trees and vegetation) and the line. This can be achieved without concerns about circuit to circuit spacing as there is no plan to reinstate both 2L90 and 2L91 to operational service.

A detailed list of the work is provided in appendix B. The major work is summarised as follows:

Work Description	Quantity
Structure replacements due to clearance violations	64
Ground re-contouring sites due to clearance violations	4
Structure replacements due to STARR defects	34
Cross-arm etc. replacements due to STARR defects	33
Total scope items	135

The 30% allowance for the un-reported / ongoing deterioration STARR defects has been applied to the scope as follows:



In one section the de-energised 2L91 is currently used as a by-pass for damaged parts of 2L90. The transition is from 2L90 structure 11/01 to 2L91 structure 11/02 and presently extends to a flying tap at the back of 2L90 structure 13/05 and 2L91 structure 13/05. The proposal is to extend the use of 2L91 to structure 14/08 with a new dead-end structure on 2L090 as structure 14/08A installed in the alignment of 2L090.

Due to the difficult access and limitations of guying, structure 9/8A may need special design, for example, a self-standing steel pole or special wood pole H-frame may be required.

The removal of de-energised structures on 2L91 is not included in the scope of work.

2.3 Further Work

No site investigations have taken place in the Conceptual stage of the project due to sensitivity regarding access to First Nation areas. If the 2L90 uprating alternative is selected a complete field review should take place to confirm the condition of the existing structures. The field review will also confirm the preferred access for each structure and update the crossing list. As the current LiDAR is dated 2010, it is recommended that updated data is obtained.

Based on the updated data the design will be further developed and a more accurate scope of work will be produced.

3 Alternative 2 – Add Transformer Capacity to ROS

3.1 Background

Rosedale was constructed in 1955 to 1958 as a 360/69kV substation. It is located in the Fraser Valley close to Highway 1 at end of Thompson Road, East of Rosedale Village. Figure 2 shows a Google Earth view of the substation.

Figure 2 – Satellite view of the Rosedale substation

Transformer T1 consists of three single-phase autotransformers and one spare phase (T1SP). Each are rated 345kV/238kV/12.5kV, 150MVA per phase. All four units are from CGE, built and installed at ROS in 1956. None of the units are equipped with oil containment pits and there are no fire walls installed between the phases. Additional information regarding the transformer and the rest of the assets at ROS is available in the ROS Asset Plan provided in appendix C.

3.2 Scope of Work

The basic scope of work for ROS is to increase the transformer capacity for the existing 400MVA to 600MVA. This will be achieved by replacing the existing 400MVA 360/230kV transformer T1 and replacing it with a new 600MVA 360/230kV transformer. No requirements to provide redundancy (N-1) by installing two parallel transformers at ROS have been specified although this was considered early on in the project.

In addition to the transformer capacity increase, 2L90 is to be restored to is full operating temperature of 55°C by addressing all clearance violations for this operating temperature and all major STARR defects affecting the circuit's reliability are to be addressed. The driver for this additional work is system flexibility for dealing with forced and planned outages in the Bridge River area. This is a major consideration for TDSO (Transmission and Distribution System Operations) especially as the Bridge River system is designed with no redundancy (system normal N-0).

Three options have been identified to achieve the required transformer capacity. One-line diagrams and provisional station layout drawings are provided in appendices E and F respectively. In all three options, no expansion of the substation fence-line or the control building are required.

The transformers proposed in all three options will be unique to BC Hydro. This is a result of the small amount of 360kV equipment that BC Hydro has on its transmission system. As a result of this, measures to mitigate the risk of a transformer failure are provided for in each option. (NOTE – a spare transformer to match the existing transformers at ROS is already present on site.)

A desktop geotechnical assessment for ROS has been carried out to and the results of this are provided in appendix F. This assessment considered both geohazard risks (such as river erosion and landslides) and geotechnical risks (related to foundation requirements). The major finding of this analysis is that the soils in ROS may be subject to liquefaction and mitigation measures such as deep soil mixing should be used during construction. These requirements have been taken into account in the cost estimate for this alternative.

The existing transformer units do not have any oil containment pits or firewalls. When installing the new transformers oil containment pits will be included and firewalls will be constructed as required (as shown on the provisional layout drawings in appendix E).

3.2.1 Alternative 2 – Option A

Under option A, the existing transformer will be replaced by three 200MVA 360/230kV single phase transformers. The scope of work is summarised as follows:

1. Add three 200 MVA 360/230kV single phase transformers plus one spare unit (T2: A, B, C, plus a spare one, 4 CTs per bushing);
2. Relocate the 360kV circuit breaker 3CB1 and rename as 3CB4. At 3CB1 location add bus through
3. Add a manually operated 360kV disconnect switch 3D2CB4 (2000A), a motor operated 360kV disconnect switch 3D2 (1500A) and associated buswork (2000A) including tertiary buswork
4. Relocate 3SAB3 and rename as 3SAB4;
5. Add a motor operated 230kV disconnect switch 2D22 (2000A) and associated buswork (3000A);
6. Add a 230kV line terminal tower and re-terminate 2L78;
7. Add 3SA2, 2SA2, 2CVT2;
8. Add new SS1, 12VTT2, 12SA2, 12DSS1 and associated buswork and connection cables;

9. Remove T1 and associated equipment including buswork, DSs, CVTs, SAs, tertiary equipment and tower of 2L78 after the new installation.

3.2.2 Alternative 2 – Option B

Under option A, three new 200MVA 360/230kV single phase transformers will be installed and the existing transformer will be retained as a cold standby transformer. The scope of work is summarised as follows:

1. Add three 200 MVA 360/230kV single phase transformers plus one spare unit (T2: A, B, C, plus a spare one, 4 CTs per bushing);
2. Add a 360kV breaker 3CB4(2000A) and a disconnect switch 3D2CB4(2000A);
3. Add a motor operated 360kV disconnect switch 3D2(1500A);
4. Add a motor operated 230kV disconnect switch 2D22(2000A);
5. Add associated 360kV bus work (2000A) and 230kV bus work (3000A);
6. Relocate 3SAB3 and rename as 3SAB4;
7. Add 3SA2 and 2SA2;
8. Relocate 2D21
9. Relocate 2CVT1 to common bus;
10. Add new SS1, 12VTT2, 12SA2, 12DSS1 and associated busworks and connection cables
11. Relocate existing T1 spare on new foundation with oil containment pit to provide space for tie bus to T2;
12. The existing T1 will be a cold standby transformer, build an oil containment pit for T1;
13. Add new gantry tower and re-terminate 2L78 to avoid energized transmission line above the transformer T1;
14. Remove T1 tertiary equipment, 12SA1 and 12VTT1 after the new installation.

3.2.3 Alternative 2 – Option C

Under option C, the existing transformer will be replaced by a single 600MVA 360/230kV three phase transformer. The scope of work is summarised as follows:

1. Add one three phase 600 MVA 360/230kV transformer plus one three phase 600 MVA 360/230kV spare transformer
2. Relocate 360kV circuit breaker 3CB1 and rename as 3CB4. At 3CB1 location add bus through;
3. Add a manual operated 360kV disconnect switch 3D2CB4 (2000A), a motor operated 360kV disconnect switch 3D2 (1500A) and associated buswork (2000A)
4. Relocate 3SAB3 and rename as 3SAB4;
5. Add a motor operated 230kV disconnect switch 2D22 (2000A) and associated buswork (3000A);
6. Add a 230kV line terminal tower and re-terminate 2L78;
7. Add 3SA2, 2SA2, 2CVT2;
8. Add new SS1, 12VTT2, 12SA2, 12DSS1 and associated buswork and connection cables;
9. Remove T1 and associated equipment including buswork, DSs, CVTs, SAs, tertiary equipment and tower of 2L78 after the new installation.

3.2.4 Alternative 2 – 2L90 Rating Restoration

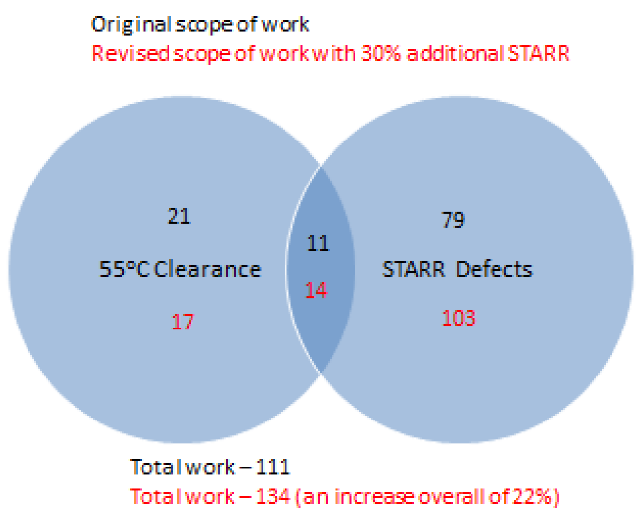
The work to restore the rating of 2L90 and address the STARR defects is the same for each of the options under alternative 2. The approach to determining the scope of work on 2L90 for alternative 2 and the corresponding cost estimate is exactly the same as for alternative 1A with a different temperature rating (55°C as opposed to 90°C).

Where clearance violations at this lower temperature have been identified, the solution has been designed to the higher temperature of 90°C. This approach is consistent with Asset Investment Management's structure replacement policy and ensures that any future uprating of the circuit will not result in virtually new structures being replaced by slightly taller structures. The cost impact of this approach to the project is minimal.

A detailed list of the work is provided in appendix B and is summarised as follows:

Work Description	Quantity
Structure replacements due to clearance violations	31
Ground re-contouring sites due to clearance violations	1
Structure replacements due to STARR defects	46
Cross-arm etc. replacements due to STARR defects	33
Total scope items	111

The 30% allowance for the un-reported / ongoing deterioration STARR defects has been applied to the scope as follows:



As with alternative 1, in addition to the major STARR defects there are a considerable number of minor STARR defects such as missing guy guards, broken number plates etc. These defects do not affect the reliability of the line. The cost of addressing this work is small relative to the overall project costs, however, the practicality of including this work in the project (due to access requirements on First Nation lands etc.) may preclude the work from the project. The conceptual level cost estimates have included this work but its inclusion in the final scope of the project will be determined during the Feasibility / Definition stages of the project based on accessibility etc.

4 Alternative 3 – IPP Curtailment

The fundamental driver for this project is the inability of the transmission system to transmit the increased generation in the Bridge River area. A simple solution to this problem would be to reduce the generation during those times when the transmission system is over stressed. This can be achieved without reducing the output of the Bridge River generating facility by curtailing the IPPs in the area. This approach avoids the need for higher water flows at Terzaghi Dam into the Lower Bridge River and the Seton River.

The details of this curtailment is outside of the scope of this document. However, in addition to this generation curtailment, alternative 3 includes the refurbishment of 2L90. The scope of this refurbishment work is identical to that for alternative 2 and is described in the preceding sections of this report.

5 Construction Schedule

A constructability review which includes construction schedule considerations was carried out for all of the alternatives and options and is provided in appendix G.

5.1 2L90 Work

Work on 2L90 is severely constrained by the outage availability which increases the overall duration and cost of the project. Some of these impacts can be mitigated by the use of live-line techniques where applicable. The optimal solution to the outage constraints is to use the 2L91 alignment as per alternative 1B. This does not entirely eliminate the need for outages on 2L90 but it significantly increases the amount of work that can be completed without outages.

5.2 ROS Work

Work at ROS is far less constrained by outages. All of the options for the transformer work can easily be completed within the project ISD (in service date) timescale.

6 Cost Estimates

Based on the scope of work for each alternative described within this report, a conceptual design level estimate, AACE Class 5 with a +100%/-35% expected accuracy has been produced. The details of the cost estimates are provided in appendix H. The cost estimates are summarized as follows:

Alternative 1: $66.2M

Alternative 2

- Option A: $115.4M
- Option B: $117.2M
- Option C: $105.0M

Alternative 3

- 2L90 work only: $57.1M

7 Alternatives Analysis

Transmission Asset Management and System Planning were engaged to assist with identifying a leading alternative as Structured Decision Making (SDM) analysis of the three alternatives created a challenge. Alternative 1 has been identified as the leading alternative for the project because 2L090 is a strategically important transmission path and it provides needed operational flexibility for the power system. In addition, the cost model developed to evaluate the alternatives indicates that the total costs, on a present value basis for Alternative 1 are superior to the competing Alternatives.

Alternative 1 involves the 2L90 Uprate Scope, which is incremental to either of the competing alternatives. Because of the incremental work along the 2L90 corridor there is a risk of additional impact to terrestrial species and habitat and heritage sites with this alternative. However, based on the investigation completed throughout the conceptual stage of the project these impacts are not considered to be significant and mitigation strategies are expected to developed throughout the project's feasibility stage.

The full output of the SDM process is provided in appendix I.

8 Conclusions

Sufficient conceptual design work has been completed to allow the project team to carry out a full comparison of the project alternatives using SDM techniques. The best solution to address the project objectives is the upgrading of 2L90 to 90degC operation including the mitigation of all reliability related defects.

9 Recommendations

It is recommended that the project proceed into the feasibility design stage to further develop the scope of alternative 1 as the leading alternative. An area to be examined in the feasibility design stage is the option to use the alignment of 2L91 to replace 2L90. This should reduce the amount of work required under outages and may both shorten the construction duration and reduce costs. This may not be possible for the entire route due to the utilisation of parts of 2L91 for other circuits but it may allow an optimization of this alternative.

Appendix A
Transmission Circuit 2L90 Wildfire Risk Assessment

Transmission Circuit 2L90

Wildfire Risk Assessment

February 2019

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1.0 IDENTIFICATION

The opinions contained in this report are those of Bruce A. Blackwell RPF of B.A. Blackwell & Associates Ltd. at 270-18 Gostick Place, North Vancouver, British Columbia. Mr. Blackwell is a recognized expert in fire science and fire management within the Province of British Columbia. This report provides a review and an unbiased opinion on wildfire risk associated with Transmission Circuit 2L90.

2.0 STATEMENT OF QUALIFICATIONS – BRUCE BLACKWELL

The opinions and discussion contained in the enclosed report are based on 30 years of experience as a practicing Forest Professional in British Columbia. I am the individual responsible for the opinions expressed in this report.

My education includes a Bachelor of Science in Forestry (BSF) and a Master of Science (MSc.) from the University of British Columbia, specializing in Fire Science. My academic training has provided me with the opportunity to publish numerous research and contract reports related to fire management.

Specific work experience related to forest fire suppression, fire management and forest ecology includes:

- Three years with the BC Ministry of Forests Provincial Rapattack Program, specializing in fire suppression.
- Thirty years as a Professional Forester working in forest fire ecology, prescribed fire and fire management policy.
- Three years teaching the fire component of Forestry 320 (Abiotic Disturbance) at the University of British Columbia.
- Developing and teaching Applications of Fire in Ecosystem Restoration (RENR 8104) at the British Columbia Institute of Technology for the past seven years.
- Qualified as an expert in the B.C. Supreme Court to testify on wildfire behaviour, prescribed fire, fire suppression, fire ecology and fire management all related to the Greer Creek Fire (2010).
- Qualified as an expert to the Forest Appeals Commission to testify on wildfire hazard and mitigation related to the Anderson Pacific Forest Products Ltd. and harvesting abatement associated with Cutblock C059C3HT (Cutblock) pursuant to Timber Sale Licence A82206 in the vicinity of Port Renfrew, BC.

My consultancy has included fire related assignments throughout British Columbia on behalf of organizations that include the Ministry of Forest, Lands, Natural Resource Operations and Rural Development (MFLNRORD), Forest Practices Board, Ministry of Environment and Climate Change Strategy (MoECCS), Association of B.C. Forest Professionals (ABCFP), BC Hydro, B.C. Transmission Corp, numerous forest tenure holders, local governments, the private sector, First Nations, KPMG, and PricewaterhouseCoopers. Additionally, my firm has completed fire related assignments in Alberta and the State of Alaska, USA.

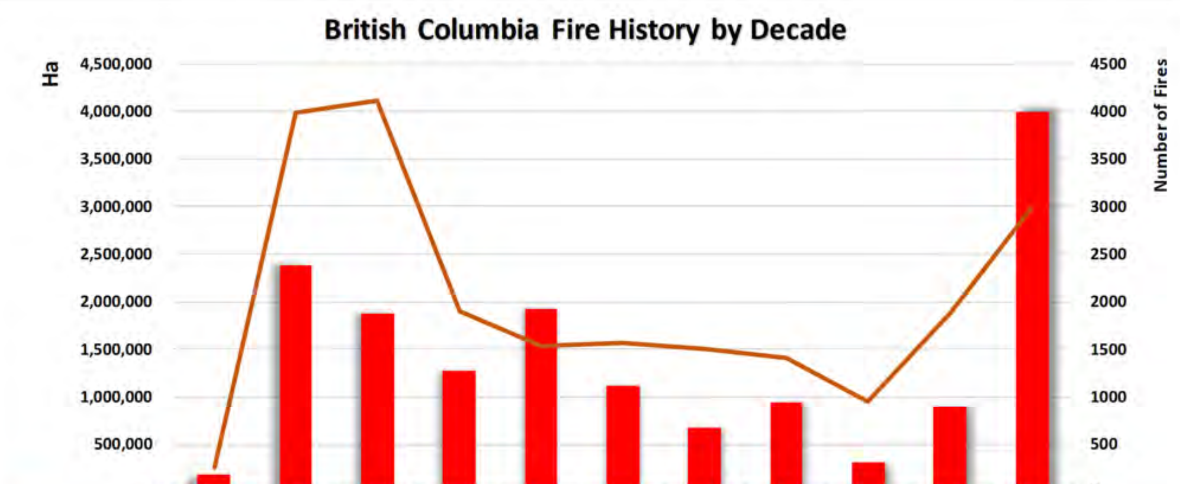
Work assignments have included detailed analyses of fire weather for prescribed burn prescriptions, fire history studies, and fire behaviour analyses. As part of the Firestorm 2003 Provincial Review[1] conducted by Gary Filmon

[1] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/wildfire-management/governance/bcws_firestormreport_2003.pdf

P.C., O.M, I was retained to assist in the development of recommendations on fuel and forest management practices. I was responsible for the development of a Provincial Strategic Threat Analysis[2] for the MFLNRORD Wildfire Management Branch, focusing on the identification of communities that were at risk from wildfire in British Columbia. Additionally, I co-authored a report entitled "Forest Health, Fuels, and Wildfire: Implications for Long-Term Ecosystem Health" for the B.C. Forest Practices Board (Gray and Blackwell, 2005) and was the project lead for the development of a professional guidance document providing Interim Guidelines – Fire and Fuel Management for the Association of B.C. Forest Professionals[3].

3.0 INTRODUCTION

Wildfire seasons in British Columbia, over the past two decades, have increased in numbers and the area burned across the Province. Large expenditures in wildfire suppression and forest resource losses have occurred in 2003, 2004, 2009, 2010, 2014, 2015, 2017 and 2018. Figure 1 shows the number of wildfires and the total area burned by decade since 1910. The period 2010 to 2018 only represents 8 years of data, and yet the area burned is larger than any other decade and the number fires is greater than all other decades, with the exception of 1920-1930. This is the result of two significant factors: 1) increases in fuel loads associated with long-term fire suppression and insects and disease, (see Section 4.0 for a description of the effects of historic fire suppression); and 2) a period of increasing drought during the fire season.



	1910'	1920'	1930'	1940'	1950'	1960'	1970'	1980'	1990'	2000'	2010' *
Area Burned (ha)	184,870	2,374,615	1,879,388	1,277,290	1,916,396	1,123,936	673,436	938,758	310,129	893,507	4,000,657
Number of Fires	263	3992	4118	1901	1530	1570	1502	1410	956	1879	2993

*2010 decade includes the 2018 fire seson

Figure 1. The number of fires and area burned summarized by decade in British Columbia (Source MFLNRORD, 2018).

[2] https://www2.gov.bc.ca/gov/content/safety/wildfire-status/prevention/fire-fuel-management/psta
[3] https://member.abcfp.ca/web/Files/policies/Fire_Fuel_Management-Interim_Guidelines.pdf

Transmission circuit 2L90 connecting Kelly Lake with Bridge River is being studied by BC Hydro for refurbishing and capacity increase. An overview of the study area which consists of the circuit buffered by 2 km (1 km either side of the centerline) is provided in Figure 2 The circuit utilizes wood structures and portions of this circuit were severely impacted by past wildfire events. Historically, the area the circuit transects has been exposed to high frequency, low to high severity surface fires and high severity stand replacement fires (fires that kill larger groups of trees) which occur every 20-120 years (Lloyd *et al.,* 1990) and have the potential to significantly alter the forests. The probability of large wildfires within these Interior forest ecosystems is generally considered high, and in many areas the consequences associated with a large wildfire would be very high to extreme.

B.A. Blackwell & Associates Ltd. was retained to complete a Wildfire Risk Management System (WRMS) evaluation for the circuit 2L90 corridor to determine the wildfire risk profile of the area and inform the planning process. The WRMS evaluation is aimed at determining the potential risk for circuit 2L90 and potential risk mitigations including planning, preparedness and debris disposal along the circuit. This report documents the methods and results of the WRMS analysis for the study area.

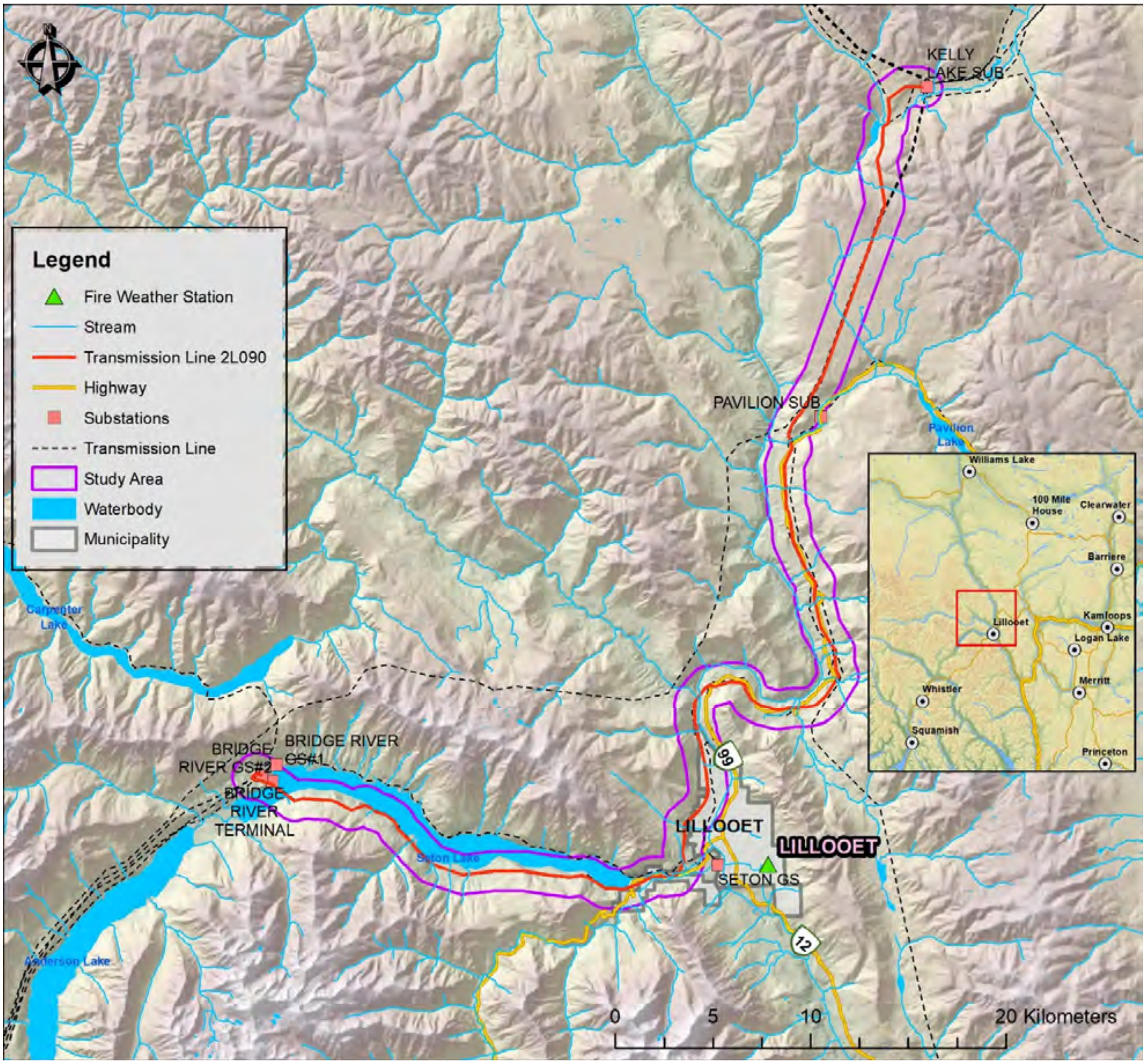


Figure 2. Overview of the study area.

The methodology used to develop the WRMS for this project builds on the wildfire threat analysis methodology that was initially pioneered in Australia (Muller 1993, Vodopier and Haswell 1995) and has since been adapted for use in British Columbia in a number of different contexts and scales (Hawkes and Beck 1997, Blackwell *et al.* 2003). In older applications, all fire related factors (fire risk, suppression response capability, fire behaviour, and values at risk) were related equally without consideration of formal risk management theory. The revised system developed by B.A. Blackwell & Associates Ltd. adopts a risk management approach to guide the quantification of discrete landscape-level probability and consequence ratings, using the same underlying data attributes.

4.0 STUDY AREA IGNITION AND SPATIAL FIRE HISTORY

Figure 3 provides a summary of ignitions (both human and lightning) for the period 1950-2018. The number of ignitions was largely stable between 1980 and 1999, and again between 2010 and 2018. However, the last complete decade (2000-2009) showed a marked increase in ignitions which can largely be attributed to a prolonged period with dry summers and increasing human ignitions related to periods of extended high fire danger.

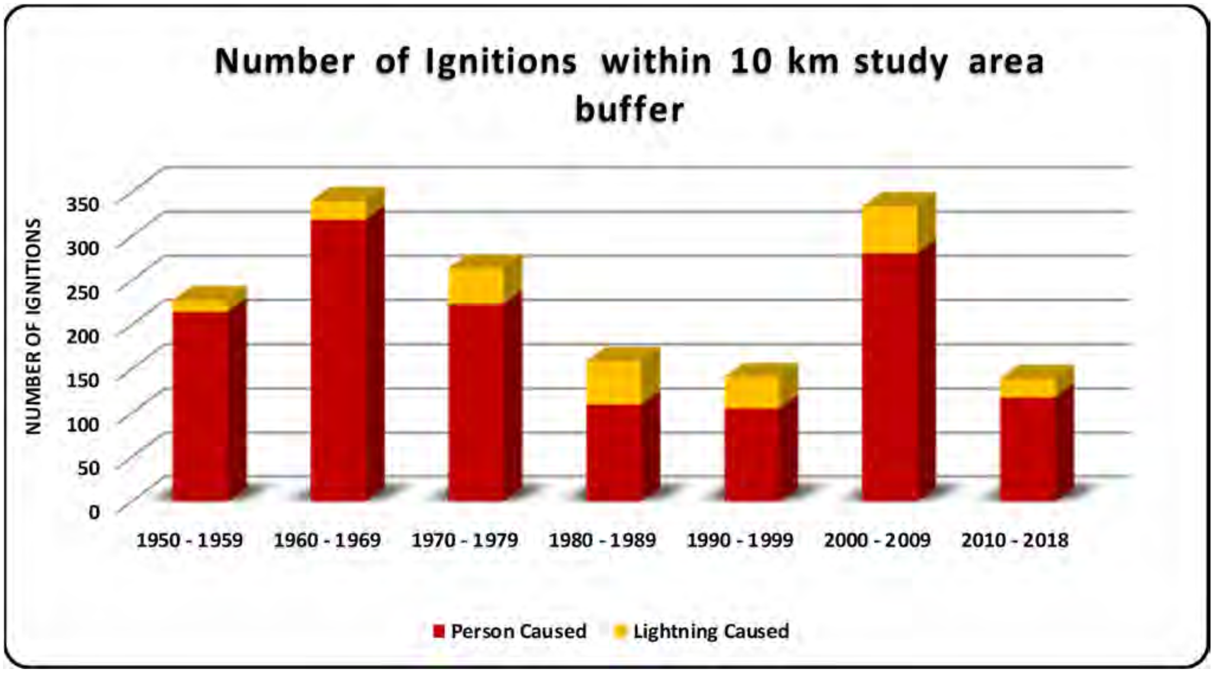


Figure 3. Number of ignitions for the study area

Figure 4 shows the spatial distribution of ignitions (both human and lightning caused) within the study area and highlights the concentration of ignitions (largely human) within the developed areas of Lillooet, Bridge River, and Pavilion and along the highway and road networks. This is consistent with ignitions density in other parts of the southern Interior.

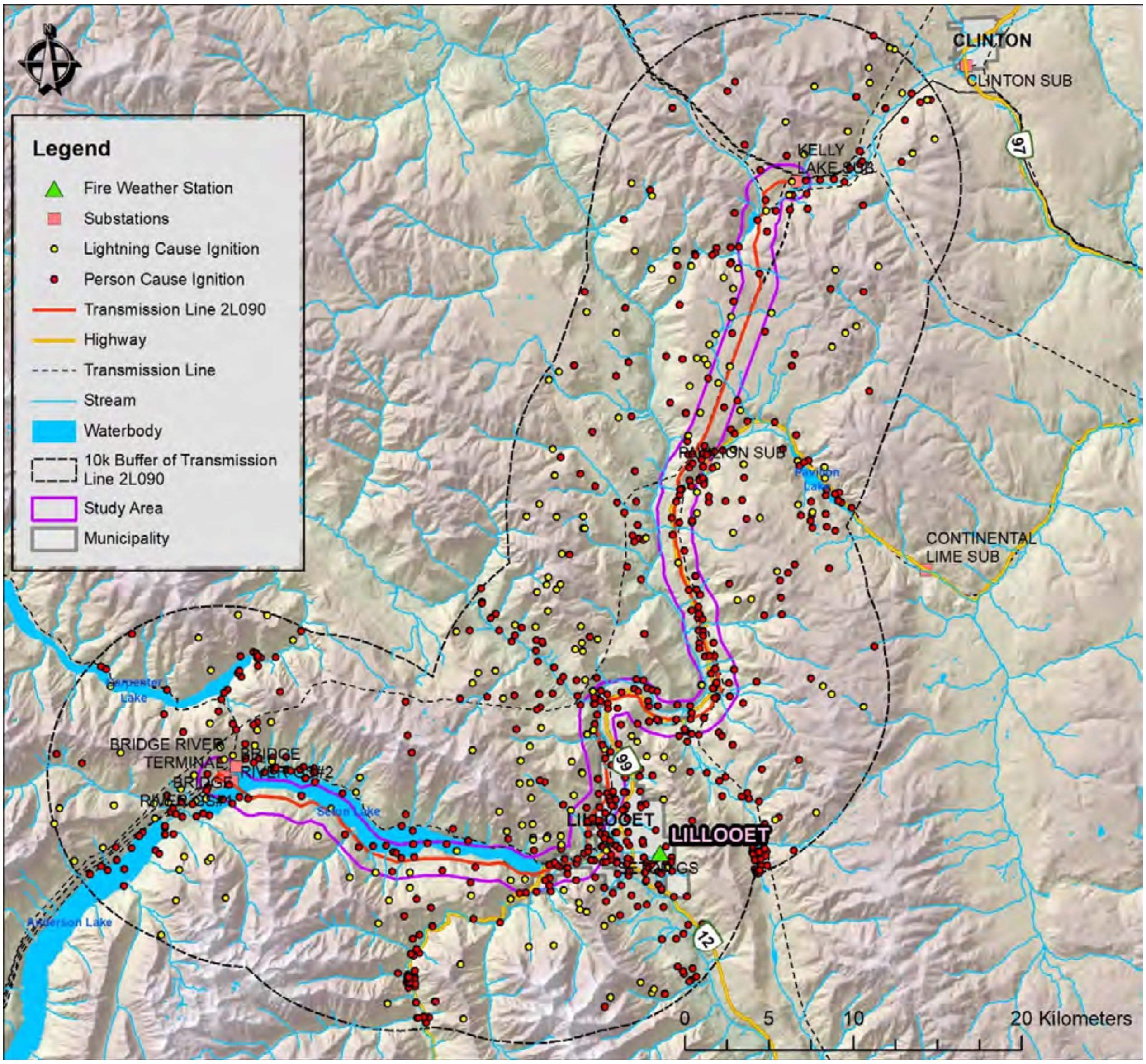


Figure 4. Spatial ignition history for the study area (1950-2018).

Fire has frequently occurred within the study area over the last 68 years (Figure 5) but up until more recently (2000-2009) the area burned within the study area has not been large (Figure 5). With the advent of advanced fire suppression following World War II the burned area footprint has been substantially reduced (Figure 5). Ecologically, this effective fire suppression has altered forest fuels such that there is ingrowth (increased tree density associated with long-term fire suppression) in forest stands and trees encroaching into grasslands which has resulted in an increase in the total fuel loading, resultant fire behaviour potential and the overall severity of wildfires within the region. The more recent Mount McLean wildfire, located above Lillooet, is an example of the changing wildfire conditions and the potential for damaging wildfires.

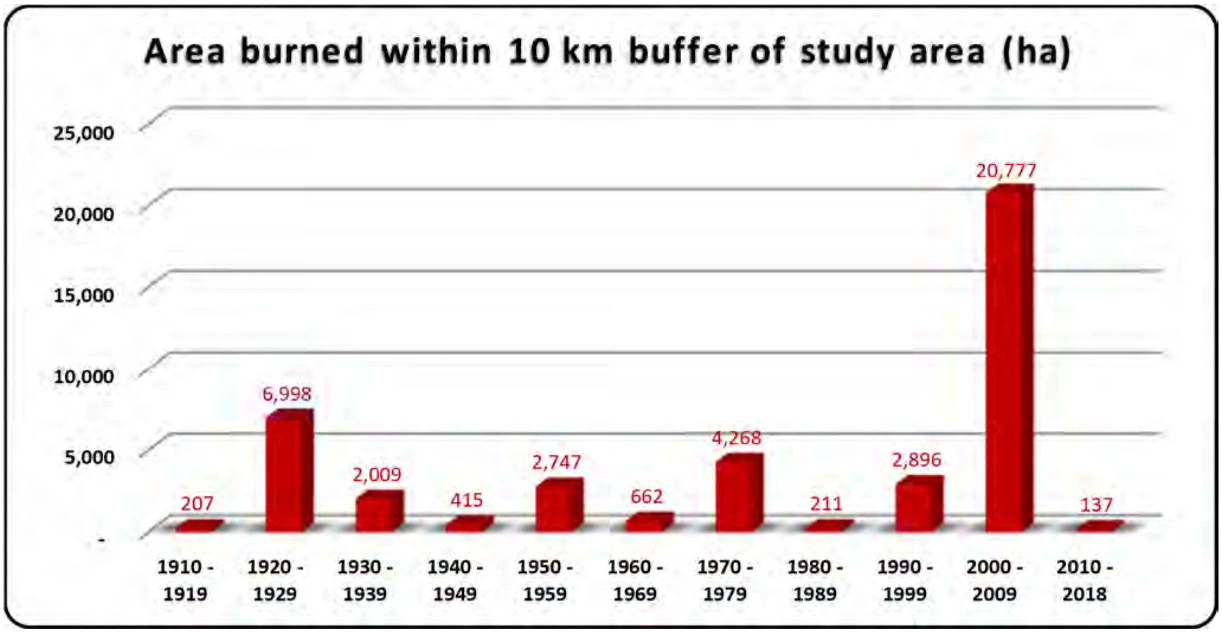


Figure 5. Area burned summarized by decade for the study area (1910-2018).

Figure 6 below shows that much of the corridor has seen historic fires of varying size. However, it is also clear that wildfires between 2000 and 2018 were much larger and more frequent when compared to previous decades. This is largely related to drier wildfire seasons and changes in forest health and fuel conditions that have occurred from 2000 onward.

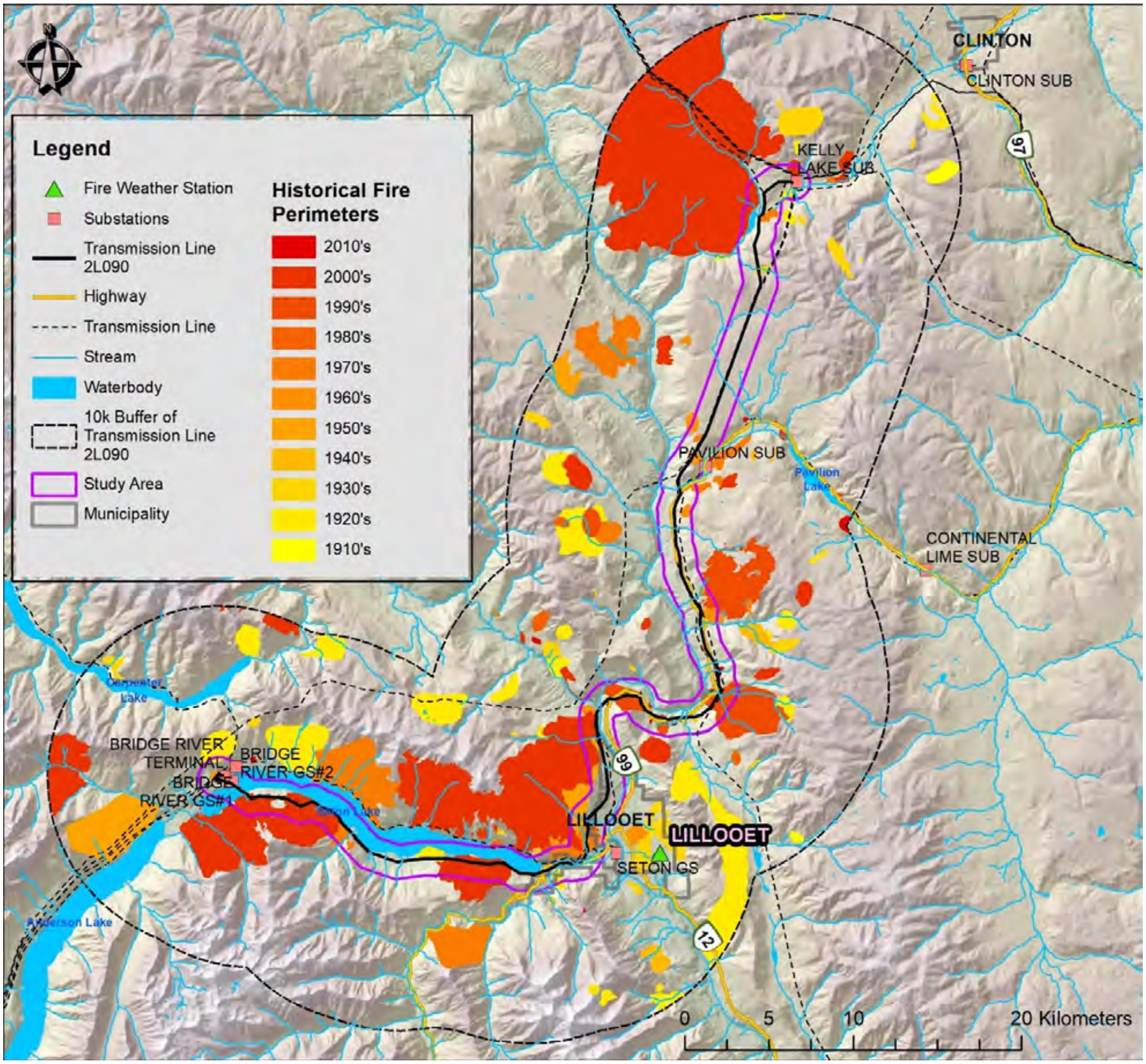


Figure 6. Spatial history, by decade, of fires that have occurred between 1919 to 2018

5.0 WILDFIRE RISK MANAGEMENT

Definitions of the term "risk" and all its derivatives (*e.g.* risk management, risk assessment, risk evaluation, etc.) are inconsistent in the wildfire literature, perhaps as a legacy of the fact that most wildfire research has been broken down into specialty topics such as fire behaviour, fire effects, and fire history/occurrence. For the purposes of the WRMS, wildfire risk is defined as the probability and consequence of wildfire at a specified location under specified conditions. This definition is consistent with the generic definition of risk and its derivative terms being adopted in many jurisdictions worldwide (Canadian Standards Association 1997, Council of Standards Australia/New Zealand 1999, International Standards Organization 2002).

Analytically, the WRMS approach to wildfire risk assessment provides a spatial characterization of risk based on probability and consequence ratings. In other words, the WRMS can indicate, at any given location and under specified conditions, what the probability of wildfire occurring is and, for a given wildfire behaviour, what the potential consequences on valued resources are.

In other fields of risk management (*e.g.*, hazardous materials management), a single resultant quantification of probability and consequence is often derived mathematically. However, in the case of wildfire risk assessment it has been found (as in Bachmann and Allgower 1998) more useful to keep these elements separate since they may imply different management approaches spatially. Figure 7 shows how various combinations of probability and consequence can imply basic management strategies. In practice, the implementation of this risk management approach requires a detailed spatial examination of assessment results across a full continuum from low to high ratings.

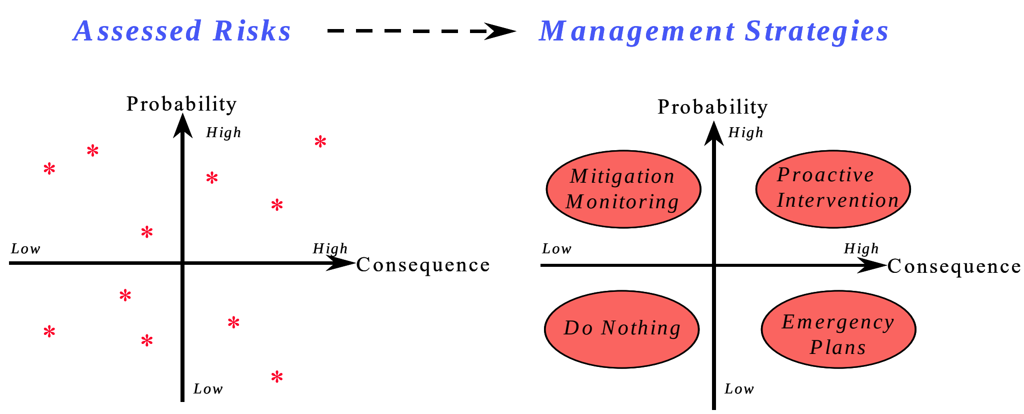


Figure 7. Conceptual representation of risk assessment/management as the resultant of two factors, Probability and Consequence.

6.0 CIRCUIT 2L90 PROJECT ASSESSMENT AREA

The project assessment area (study area) consists of the 2L90 circuit buffered by 2 km (1 km either side of the centerline). The assessment area encompasses 15,570 hectares with elevations ranging from 200 meters to 1,760 meters. Forests in the lower elevations include ponderosa pine, Douglas-fir (within the Ponderosa Pine and Interior Douglas-fir Biogeoclimatic Zones (encompassing approximately 87% of the study area). With increasing elevation, lodgepole pine and Engelmann spruce become the dominant tree species (within the Montane Spruce and Engelmann Spruce Subalpine-fir Biogeoclimatic Zones (approximately 1% of the study area). The remainder of the study area (12%) is within the Bunchgrass Biogeoclimatic Zone (very dry hot subzone Fraser Variant) and is dominated by grasslands with Douglas-fir forests (<15%) restricted to moister sites.

Wildfire is a natural disturbance agent in a portion of this open to heavily forested, Interior landscape. Historically these areas have been exposed to high frequency (fires occur every 20-120 years), low severity surface and high severity stand replacement fires (Lloyd *et al.* 1990). Given the current structure and fuel and forest health conditions in these forests the probability of large wildfires within the study area is considered high, and the consequences associated with a large wildfire have the potential to damage BC Hydro infrastructure in this area.

A detailed description of the risk assessment methodologies that were applied to this project are located in Appendix A: Wildfire Risk Modelling Methods.

7.0 COMPARISON OF PROBABILITY AND RELATED WILDFIRE RISK

A Wildfire Risk Management System was completed for the study area and the results were evaluated for the entire circuit 2L90 study area. This wildfire risk profile is intended to facilitate planning and potential mitigation activities along the circuit with respect to wildfire risk. The WRMS methods employed are described in Appendix A, including the model components, subcomponents and related attributes and their relative weighting.

The results of the WRMS evaluation for the circuit 2L90 are described below. Additionally, the wildfire risk profile of 5 km sectors for the corridor was determined using the WRMS and is illustrated in Section 7.5. The sector-level information was developed to support more detailed planning by BC Hydro.

7.1 IGNITION PROBABILITY OF WILDFIRE

A breakdown of the corridor into probability of ignition classes shows that the large majoity of the study area (65% or 10,090 ha) falls within a moderate to extreme probability class (Figure 8). Hazard classes 5 and 6 (moderate probability of ignition) represent the largest percentage at 45% (7,003 ha), while 20% (3,087 ha) of the study area is in high to extreme classes (7-10). The highest probability of wildfire occurs in the vicinity of Lillooet and is associated with both human and lightning ignitions as per Figure 9. Other hot spots of high ignition potential occurr at Pavillion and at the southern end of Anderson Lake. The only sections of the corridor that have a low probability of ignition include along a portion at the southeast side of Anderson lake where the terrain is steep and rock dominated and at the very northern end of the study corridior. Significant sections north of Pavillion and Lillooet are in the moderate to high probability class.

The ignition probability was calculated using the Wildfire Ignition Probability Prediction System (WIPP) as detailed in Appendix C: The Wildfire Ignition Probability Prediction System (WIPP).

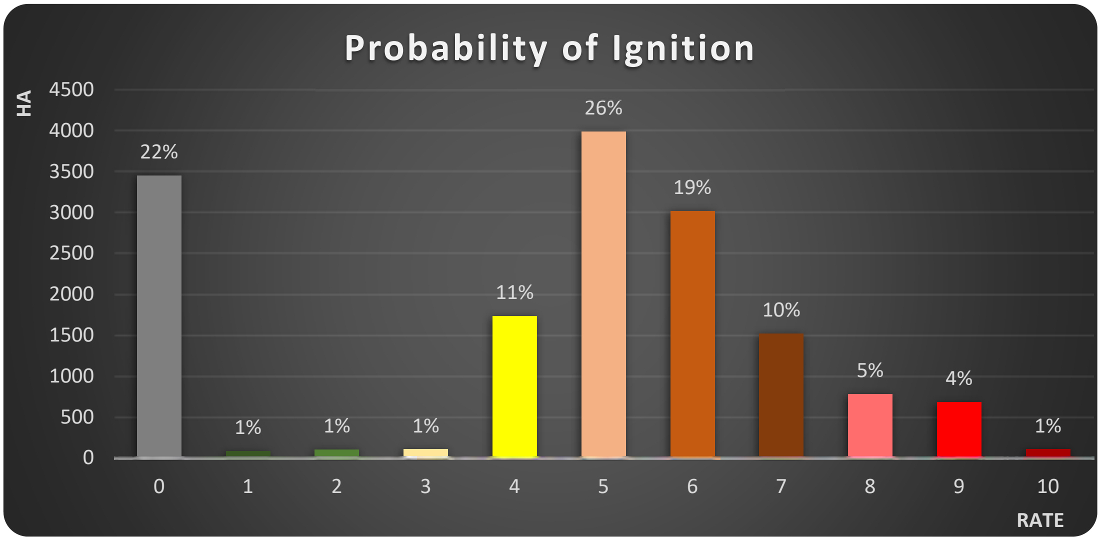


Figure 8. Ignition probability of wildfire, by percentage of each hazard class (hazard classes range from 0 – "none" to 10 – "extreme").

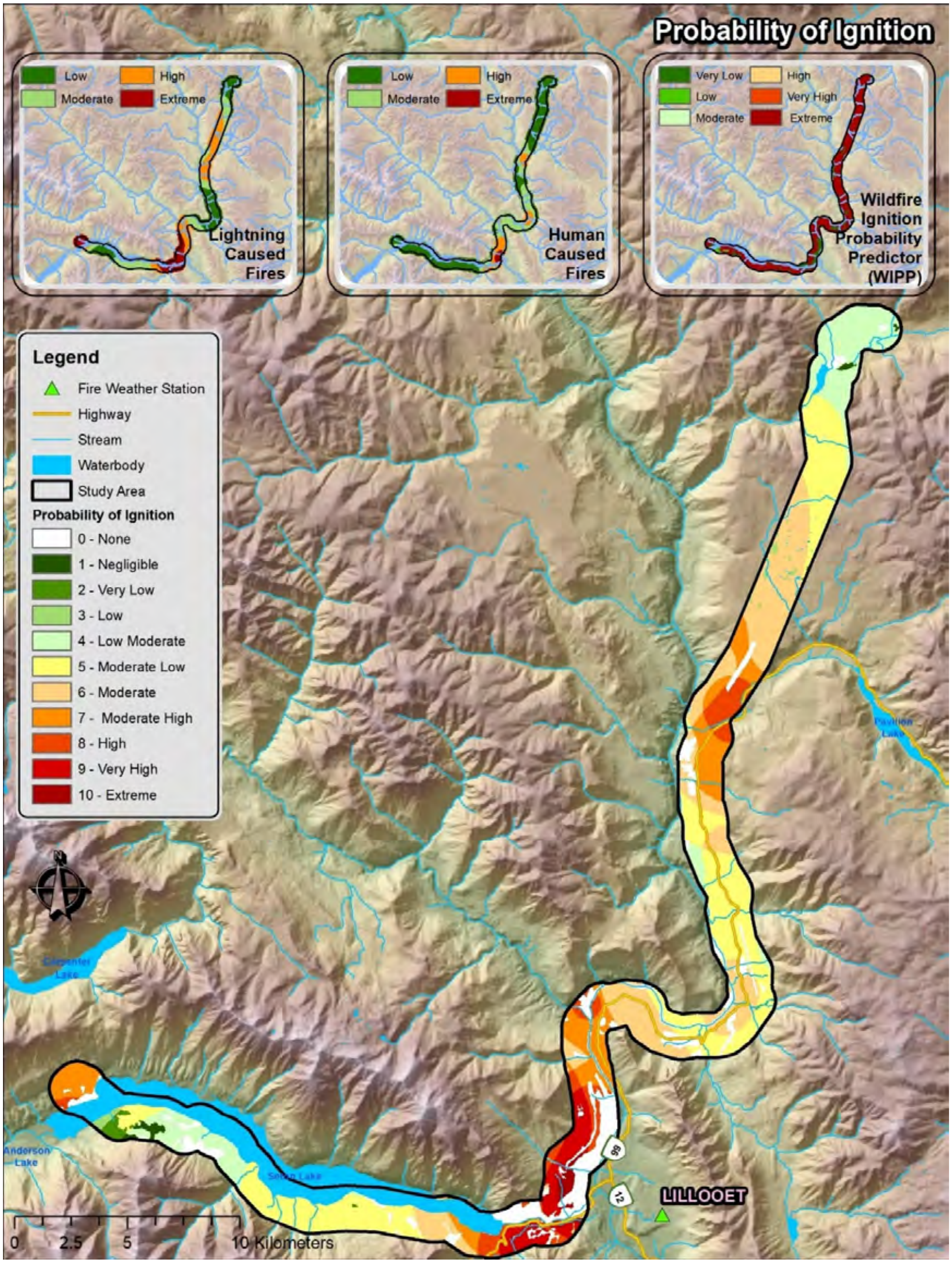


Figure 9. Probability of ignition and associated subcomponents (full size maps of the subcomponent model results are provided in Appendix B).

7.2 FIRE BEHAVIOUR

The fire behaviour potential is illustrated in Figure 10. The majority of the study corridor 54% (8,156 ha) has a wildifre fire behaviour of moderate (hazard class 5). It must be noted that the fuel type for the area has not been ground-truthed and that it is difficult to assess understory fuels with aerial photography; however, our experience suggests that a moderate classification is likely to be higher with on-the-ground fuel verification. Smaller sections of high and extreme fire behaviour (hazard classes 7-10) representing 8% of the study area (1,255 ha) are found at the north and south ends of the corridor. Otherwise there are isolated patches of the high and extreme fire behaviour potential within the corridor footprint (Figure 11). Again this potential fire behaviour may be under estimated given that the forest cover inventory has not been validated and the results are likely conservative. While some of these areas have recently burned it is expected that a lack of salvage harvest in these poor productivity forests combined with rapid grass development will contribute to the fuel loading such that many of the these burnt over areas will be vulnerable to rapidly spreading surface fires within the next twenty years. This is based on recent observations where wildifires have reburned areas, such as the example of the 2017 and 2018 wildfires that occurred in the Okanagan Mountain Park 2003 wildfire area.

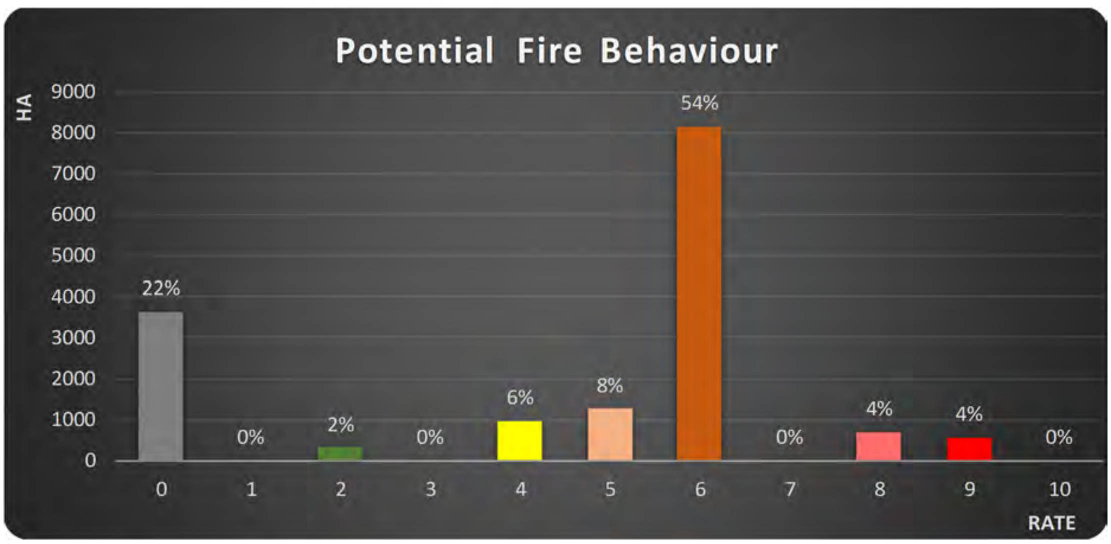


Figure 10. Potential wildfire behaviour, by percentage of each hazard class (hazard classes range from 0 – "none" to 10 – "extreme").

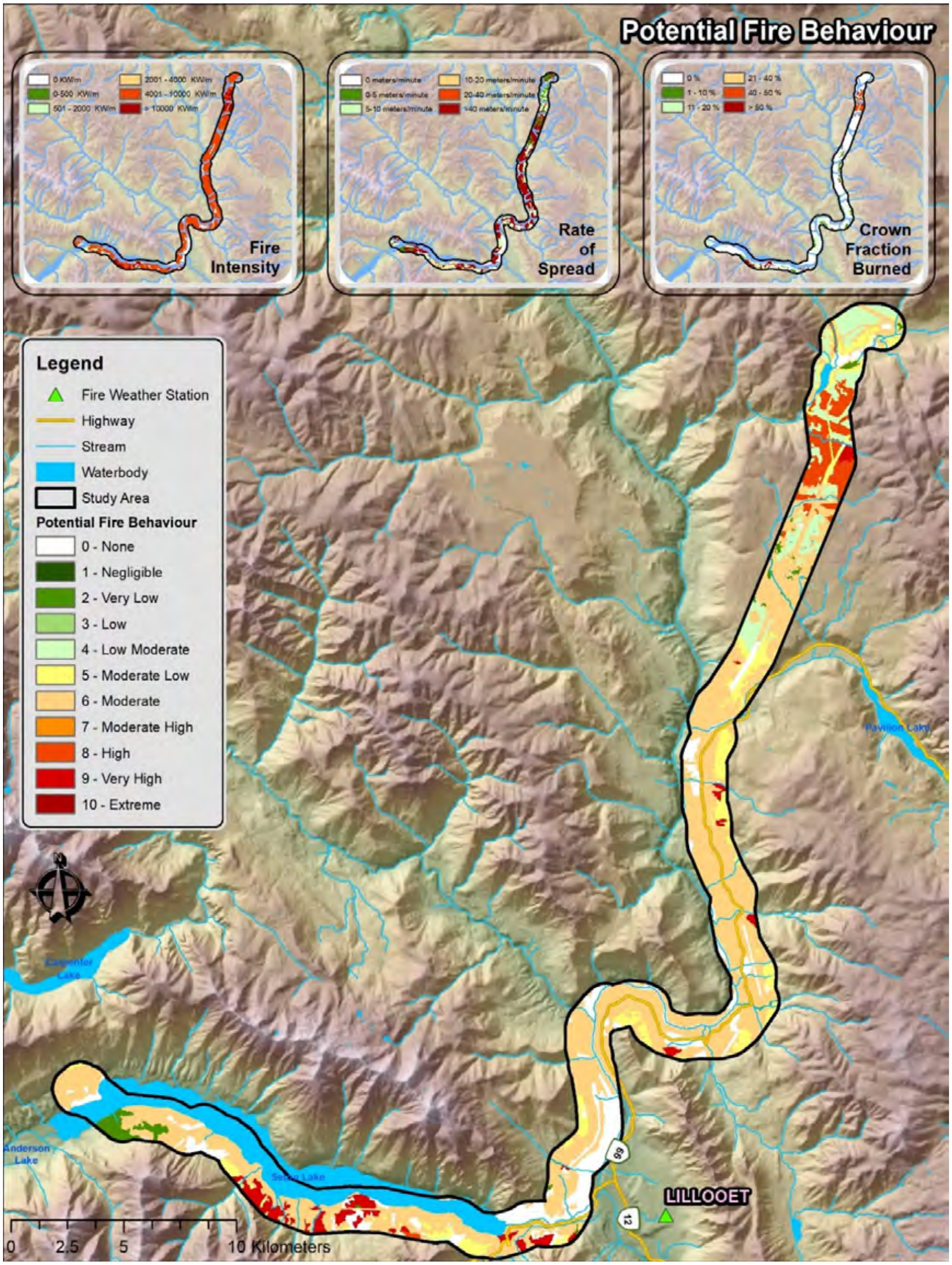


Figure 11. Potential fire behaviour and associated subcomponents (full size maps of the subcomponent model results are provided in Appendix B).

7.3 SUPPRESSION RESPONSE CAPABILITY

As illustrated in Figure 12 the suppression capability for significant sections of the corridor are classed moderate to low moderate (classes 5-7, representing 66% or 10, 464 ha of the study area) – meaning that these areas have moderate to low suppression capability, due primarily to the lack of roads and the time delay to travel by aircraft to this relatively remote area (Figure 13). Another significant consideration in these areas is the lack of available water on the slopes above the lake and the steep and difficult terrain within the study area. These two attributes pose the biggest limitations to fire suppression with the study area. Compared to many studies that we have undertaken for numerous clients, the wildfire suppression capability within this corridor is quite poor by comparion to areas in more developed centers. Overall the suppression capility adds to the overall risk of wildfire within this study area and should be a significant consideration in upgrading the transmission infrasturcture.

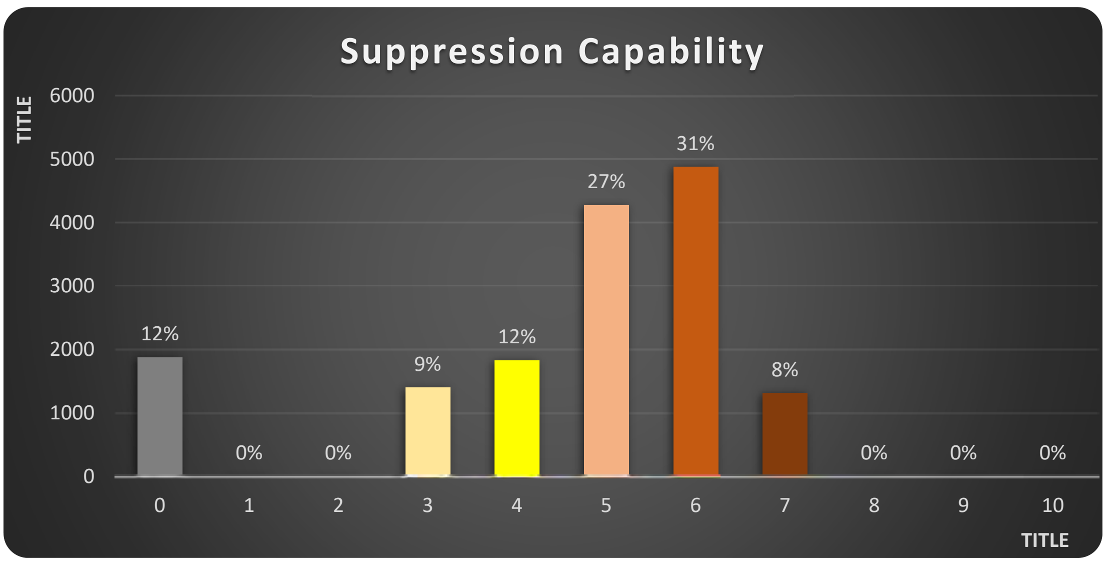


Figure 12. Suppression capability, by percentage of each hazard class (hazard classes range from 0 – “water”, and 1 – “extremely good”, to 10 – “extremely low”).

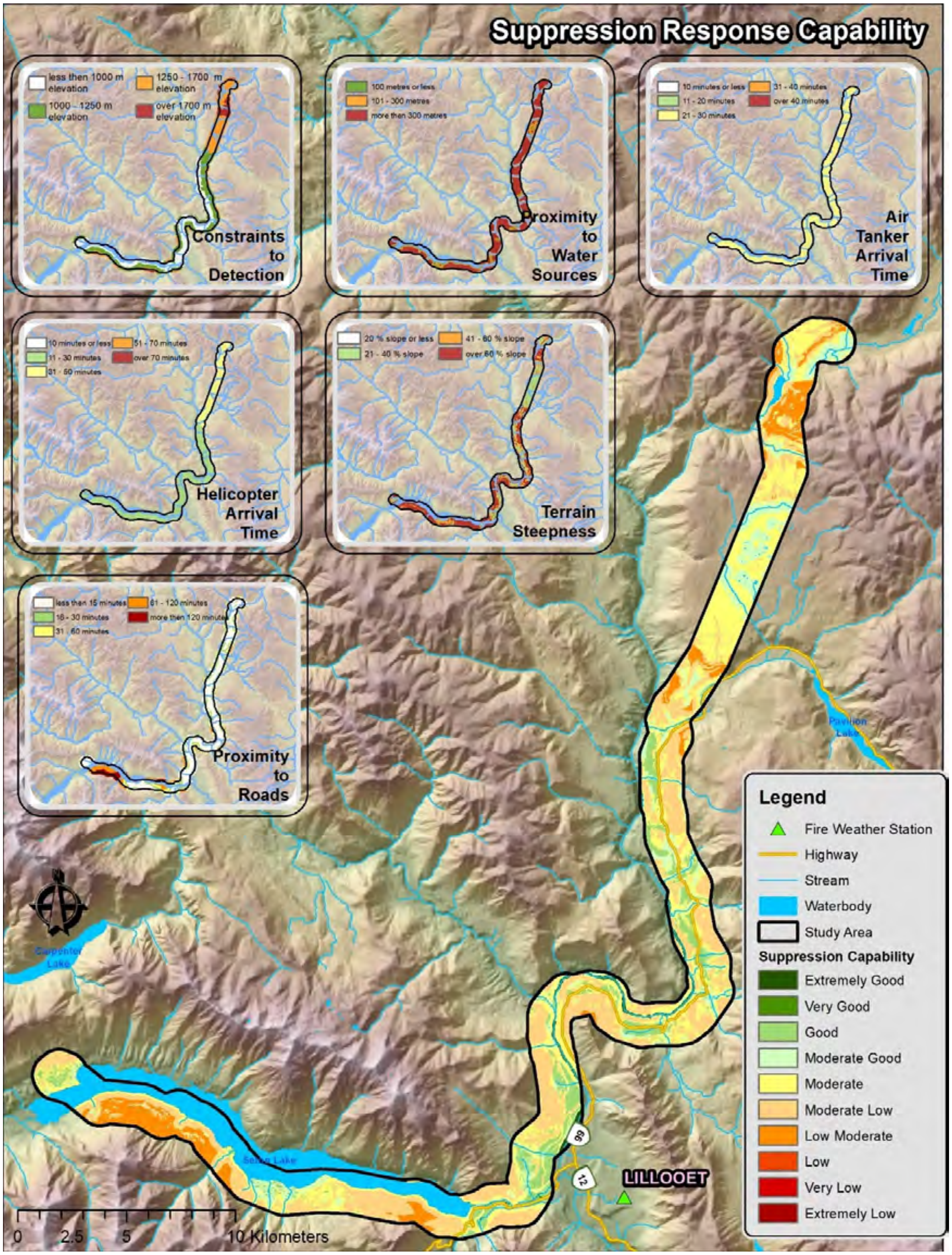


Figure 13. Suppression response capability for the circuit 2L90 study area (full size maps of the subcomponent model results are provided in Appendix B).

7.4 WILDFIRE PROBABILITY

The overall wildfire probability is characterized by Figure 15, which summarizes the area of different probability classes described as low, moderate, high and extreme. Areas of high fire probability occur in varying proportions along the 2L90 circuit and are largely related to the fuel type and fire behaviour, human and lightning caused ignitions, and suppression capability. Figure 14 shows the relative proportions of each hazard class, and the overall rating for the probability of fire with over 66% (10,448 ha) classed with a fire probability of moderate or greater. More than 38% of the corridor (6,028 ha) is classed as high to extreme. Based on the three factors contributing to the overall wildfire probability there are significant sections of the corridor that are susceptible to wildfire with the risk being concentrated around Pavillion and Lillooet south. Only the very northern part of the corridor and a small section north of Pavillion could be considered to have a low wildfire probability.

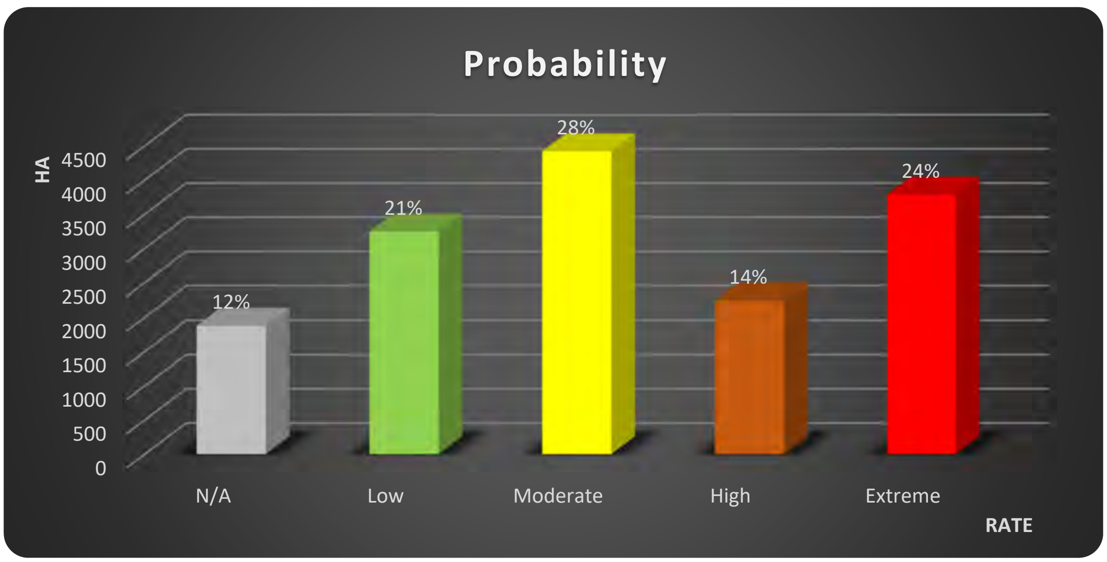


Figure 14. Wildfire probability, by percentage of each hazard class (N/A represents water bodies).

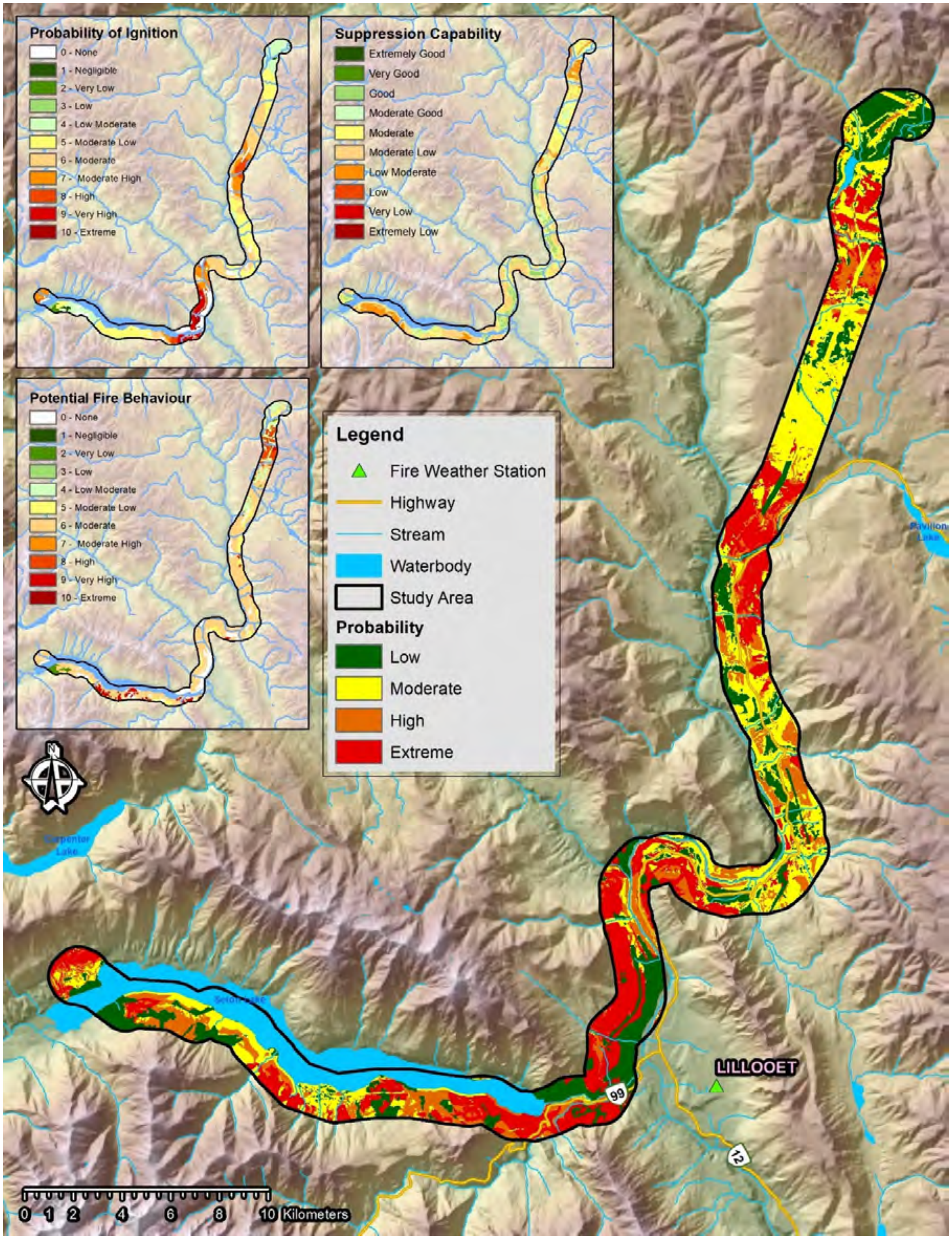


Figure 15. Wildfire probability for the circuit 2L90 study area.

7.5 PROFILE OF FIVE-KILOMETER SECTORS FOR EACH CORRIDOR

The 5 km sector profile for the study area is shown in Figure 16 to aid BC Hydro in planning for refurbishing and capacity increase on a more granular basis. Over the entire length of the 2L90 transmission corridor, 9 of the 15 five-kilometer sectors have high to extreme probability of a damaging wildfire impacting the infrastructure. Sectors 1 and 3 have the lowest probability, while sectors 6,7,8, and 15 have moderate probability profiles.

The overall wildfire probability suggests that this area has significant potential for ignition and spread of a wildfire under high and extreme fire danger and that suppression of a wildfire is more limited when compared to other more developed areas of the Province. In the areas of high and extreme probability, BC Hydro should carefully consider design measures that mitigate the infrastructure vulnerability to wildfire. The high probability of wildfire in these areas suggests that without additional mitigation a traditional wood pole line would be vulnerable to surface and crown fires. More comments on the design considerations are outlined in the section below.

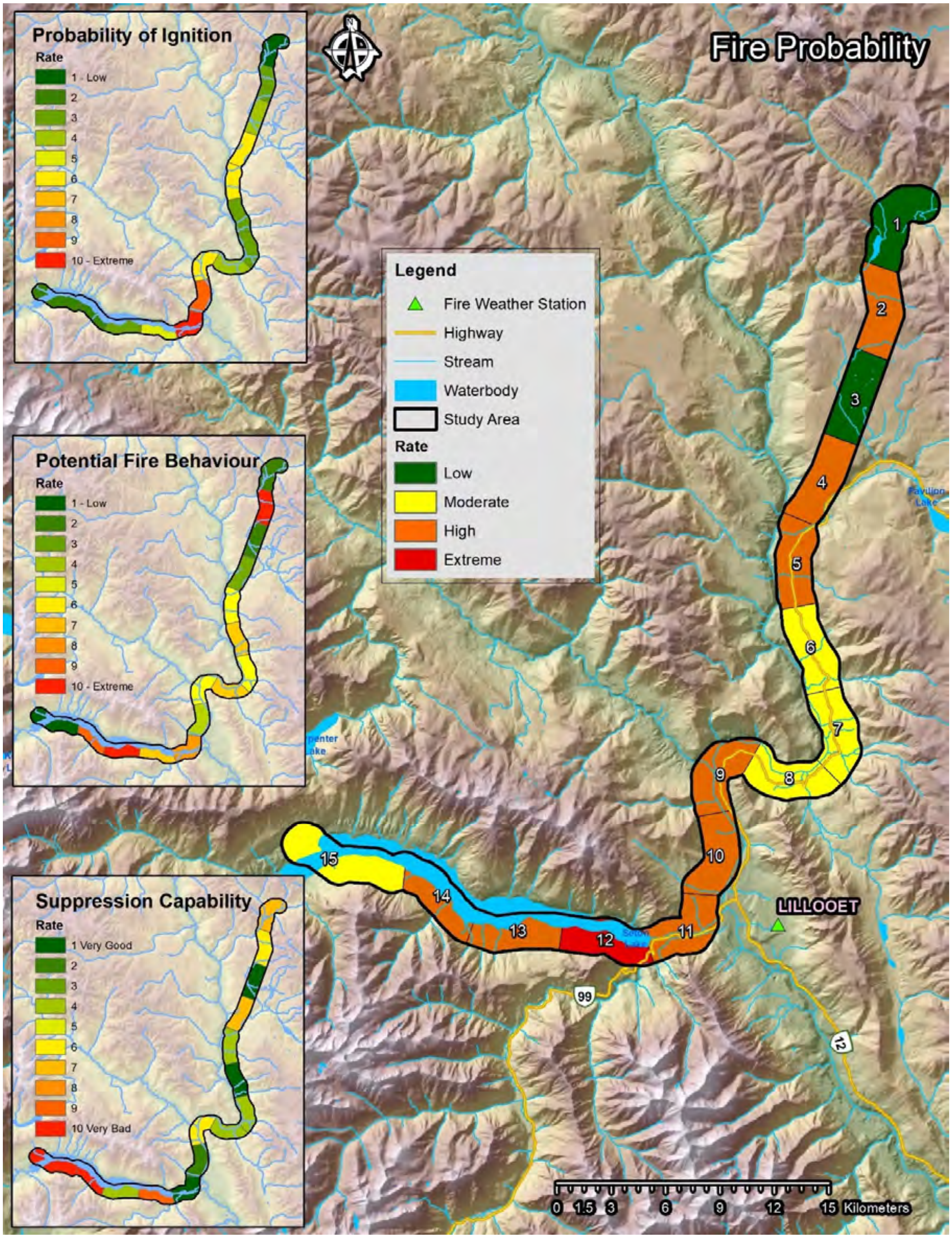


Figure 16. Ignition Probability of 5-km sectors for each corridor

8.0 CONCLUSIONS AND RECOMMENDATIONS

Planning for refurbishing and capacity increase of circuit 2L90 should consider the historic fire boundaries and fuel types, and where areas could be significantly impacted by wildfire, the appropriate mitigation measures should be employed and/or the standards of construction should be altered to account for the potential risk and fire behaviour. Fire spread and growth are often limited by topography and or features like water bodies and areas of non-fuel. Often fire boundaries are associated with these types of features. Unfortunately there are insufficient topographic features and water bodies within the study corridor that will limit the spread and growth of wildfires. Therefore it is necessary that BC Hydro carefully consider wildfire probability in the refurbishing and capacity increase of this transmission line.

Based on this assessment the following are offered as recommendations in the consideration of refurbishing and capacity upgrades to the 2L90 transmission line:

- All forested edges should be located a minimum of 10m away from the conductors such that radiant heat from any crown fire can dissipate across a fuel free zone between the forest edge and the conductors. The width of the right-of-way should be wide enough to allow for this additional clearance between the outer conductors and the forest edge.
- It is recommended that spans should be designed so conductors will be located a minimum of 15m above the ground surface where possible to provide increased clearance for the conductors above the vegetation in the maintained right-of-way.
- Consider using steel structures in the design instead of wood poles to reduce the risk of damage to the structures in the event of a wildfire. Where wood poles are used consider protecting them with a corrugated pipe at the base to 1m height, filled with gravel to dissipate radiant heat. This treatment may be particularly effective in grass fuels. If the corrugated pipe is not an option, create a 2m radius fuel free zone (mineral soil or concrete base at the bottom of each pole.
- Vegetation within BC Hydro's right-of-way is maintained to keep it a safe distance from the conductors. It is recommended that where possible, vegetation be maintained as required to provide a clearance of approximately 13m between the conductors and the tops of conifer vegetation to help reduce the risk of damage from flames should a wildfire occur within the right-of-way. The maintained clearance can be approximately 10m over deciduous types with little or no conifer component as these forest types have a lower fire behaviour potential and are unlikely to impact the conductors.
- Increase the frequency of vegetation maintenance treatments within the new right-of-way, as required to provide the additional clearance recommended above.
- On steeper terrain where vegetation maintenance must be completed using manual hand treatments, consider implementing mini-pile and burn techniques where appropriate for final hazard abatement to help prevent buildup of woody debris over time. Where appropriate, the selective use of herbicide on tall-growing deciduous trees is another effective tool that can be used to limit the rate of regrowth on these areas and reduce the frequency of successive treatments and fuel loading potential within the maintained right-of-way.
- Maintain permanent access along the right-of-way where possible to improve accessibility for vegetation maintenance and for fire suppression in the event of a wildfire.

The WRMS tool has been used to determine the wildfire risk profile of public and private assets and forms a spatial foundation on which to build a fire management plan focused on risk reduction along the right-of-way. By following the guidelines above, BC Hydro will be able to: 1) minimize the risk of damage to the conductors and structures in the event of a wildfire; 2) plan and schedule vegetation maintenance treatments to help minimize the potential fire intensity within the right-of-way; 3) help reduce the likelihood of fire escaping off, or onto the right-of-way; and, 4) protect critical infrastructure from fire related damage.

9.0 REFERENCES

Bachmann, A. and B. Allgower. 1998. Framework for the assessment of wildfire risk. In: Proceedings of the 3rd International Conference on Forest Fire Research/ 14th Conference on Fire and Forest Meteorology, Luso, 2:2177-2190.

Blackwell, B.A. and D.W. Ohlson. 2004. GVRD Watershed Wildfire Risk Management System. Contract Report to the Greater Vancouver Regional District. 9 pages.

Blackwell, B.A., Gray, R.W., Steele, F.M., Needoba, A.J., Green, R.N., and K. MacKenzie. 2003. A wildfire threat rating system for the Birkenhead and Gates Landscape Units, British Columbia. in: R.T. Engstrom and W.J. de Groot (eds.) Proceedings of the 22nd Tall Timbers Fire Ecology Conference: Fire in Temperate, Boreal, and Montane Ecosystems. Tall Timbers Research Station, Tallahassee, FL.

Canadian Standards Association, 1997. Risk Management: Guideline for Decision-Makers: A National Standard of Canada. CAN/CSA-Q850-97. Etobicoke, Canada.

Council of Standards Australia / Council of Standards New Zealand, 1999. Risk Management. AZ/NZS 4360:1999. Strathfield, Australia.

Forestry Canada. 1992. Development and structure of the Canadian Fire Behaviour Prediction System. https://cfs.nrcan.gc.ca/publications?id=10068

Hawkes, B. and Beck, J. 1997. A wildfire threat rating system. 1997. Forest Service, Pacific Forestry Centre, Victoria, BC. Technology Transfer Note 01.

International Standards Organization, 2002. Risk Management Vocabulary, Guidelines for use in Standards. First Edition. ISO/IEC Guide 73:2002(E/F). Geneva, Switzerland.

Lawson, B.D., O.B. Armitage, and G.N. Dalrymple. 1993. Ignition probabilities for simulated people-caused fires in British Columbia's lodgepole pine and white spruce-subalpine fir forests. Paper presented at the 12 International Conference on Fire and Forest Meteorology, Oct. 26-29, 1993, Jekyll Island, Georgia.

Lloyd, D, K. Angove, G. Hope and C. Thompson. 1990. A Guide to Site Identification and Interpretation for the Kamloops Forest Region. Land Management Handbook No. 23. ISSN 0229-1622.

Muller, C. 1993. Wildfire threat analysis: A decision support system for improved fire management. Paper presented at "The Burning Question: Fire Management in NSW", Coffs Harbour, Aug. 1993, UNE, Armidale, NSW, Australia.

Pyne, S.J. 1984. Introduction to Wildland Fire: Forest Management in the U.S. John Wiley and Sons. New York, NY.

Silverman, B. W. 1986. *Density Estimation for Statistics and Data Analysis*. New York: Chapman and Hall.

Vodopier, J.; Haswell, D. 1995. The application of wildfire threat analysis in forests of southwestern Australia. In: BUSHFIRE '95, Australian Bushfire Conference, Sept. 27-30, 1995, Hobart, Tasmania (no pagination in proceedings).

APPENDIX A: WILDFIRE RISK MODELLING METHODS

OVERVIEW

The purpose of this assessment was to create a spatial representation of factors that influence the probability and the potential consequence of wildfire to BC Hydro transmission infrastructure for circuit 2L90 line. The model was implemented in a GIS environment using ArcMap 10.6 (ESRI – Geographic Information System software developer) using a raster grid at 25m by 25m cell resolution (a raster consists of a matrix of cells organized into a grid, with each cell containing values representing the attributes of a corresponding physical space).

The circuit 2L90 model structure is portrayed in Figure 17. The final spatial probability rating was derived from three major components: *Probability of Ignition*, Potential *Fire Behaviour*, and *Suppression Capability*.

Probability Rating

		Attribute Rating	Attribute Weight	Weighted Sum	Component Weight	Weighted Sum
Probability of Ignition	Lightning Caused Fires		30%			
	Human Caused Fires		30%			
	Ignition Potential		40%			
					30%	
Potential Fire Behaviour	Fire Intensity		50%			
	Rate of Spread		25%			
	Crown Fraction Burned		25%			
					30%	
Suppression Response Capability	Constraints to Detection		10%			
	Proximity to Water Sources		10%			
	Helicopter Arrival Time		20%			
	Air Tanker Arrival Time		20%			
	Terrain Steepness		30%			
	Proximity to Roads		10%			
					40%	

Figure 17. Transmission circuit 2L90 WRMS model structure, showing major components and their subcomponents.[4]

Within each major model component, subcomponents are assigned individual ratings for each raster cell using a 0-10 scale based on existing biophysical databases and, in some cases, the application of sub-models (*e.g.* rate of fire spread calculated using the Canadian Fire Behaviour Prediction System and spatial fuel inventory data).

At the component level, the rating for each raster cell was calculated as a weighted sum of all its subcomponents. All the data sources used to compile this analysis are listed in Table 1. All other subcomponents were derived in a

[4] Crown Fraction Burned (CFB) is the predicted fraction of the tree crowns consumed by the fire. It is based on Buildup Index, Foliar Moisture Content, Surface Fuel Consumption, and Rate of Spread.

similar manner. The overall rating levels for probability and consequence were analogously constructed by calculating the weighted sum of their respective components.

Table 1. Overview of Methods, Databases and Sub-Models for Each Subcomponent of Each Component

	Component	Subcomponent	Overview Method	Database/Sub-Model
Probability Rating	Probability of Ignition	Ignition Potential	Calculation based on fuel type and fire weather indices	- Wildfire Ignition Probability Predictor[1]
		Lightning Caused Fire	Kernel point density of the number of lightning fire ignition points (since 1950) with a natural distribution into 4 classes	- ESRI Spatial Analyst[2] - Ministry of Forests fire records
		Human Caused Fire	Kernel point density of the number of human fire ignition points (since 1950) with a natural distribution into 4 classes	- ESRI Spatial Analyst - Ministry of Forests fire records
	Potential Fire Behaviour	Fire Intensity	Calculation using fire weather, fuel type and topography	- Fire Behaviour Predictor 97[3]
		Rate of Spread	Calculation using fire weather, fuel type and topography	- Fire Behaviour Predictor 97
		Crown Fraction Burned	Calculation using fire weather, fuel type and topography	- Fire Behaviour Predictor 97
	Suppression Capability	Constraints to Detection	Average elevation above valley bottom of forest inventory polygon	- Terrain Resource Information Management (TRIM)
		Proximity to Water Sources	Buffer distance from determinant streams and lakes	- TRIM
		Air Tanker Arrival Time	Measured flight time (concentric) from air tanker base	- Protection Branch data
		Helicopter Arrival Time	Measured flight time (concentric) from heli base	- Protection Branch data
		Terrain Steepness	Average slope of forest inventory polygon	- TRIM
		Proximity to Roads/Helipads	Buffer distance from roads, helipads, and alpine tundra/parkland	- TRIM

[1]FORTester v1.0 (Canadian Forest Service 2002); [2]ESRI Spatial Analyst 8.1.2 (ESRI 2001); [3]Fire Behaviour Predictor 97 (Remsoft, 1997)

DEVELOPMENT OF PROBABILITY THEME

The WRMS model components and subcomponents are described in greater detail below. Maps illustrating the individual component model results (including inset maps of the associated subcomponents) are provided in Section 7.0. **Full size maps of the subcomponent model results are provided in Appendix B: Subcomponent Maps**.

PROBABILITY OF IGNITION COMPONENT

The probability of ignition component (Figure 9) was divided into three subcomponents: fires caused by lightning, fires caused by human activity and ignition potential (**Error! Reference source not found.**). The subcomponent rating scales and assigned initial weights are shown (Figure 18).

The following figure represents the Probability of Ignition Component Table.

Wildfire Risk Management Component: **Probability of Ignition**

The Ignition component provides a rating of the probability of wildfire occurring in a given location based on historical fire frequency. The rating is calculated as a weighted sum rating using two attributes: **Lightning Caused Fires,** and **Human Caused Fires.**

Component Attributes:

Attribute	Indicator / Units	Rating Scale		Weight
Lightning Caused Fires *Indicator of historical frequency of lightning caused fires*		Extreme	10	30%
		High	7	
		Moderate	3	
		Low	0	
Human Caused Fires *Indicator of historical frequency of human caused fires*		Extreme	10	30%
		High	7	
		Moderate	3	
		Low	0	
Ignition Potential *Indicator of the potential for fire ignition based on fuel type and weather, calculated using WIPP (Wildfire Ignition Probability Predictor)*	Probability Class	Extreme	10	40%
		Very High	8	
		High	6	
		Moderate	4	
		Low	2	
		Very Low	0	

Figure 18. Probability Component Table: Probability of Ignition.

LIGHTNING AND HUMAN CAUSED FIRE

The first two subcomponents, lightning and human caused fires, were based on historical fire frequency and cause in the study area from 1950 to 2018. Fire history records from the BC Wildfire Service were translated into spatial points within the GIS framework. A surface kernel function was used to generate the ignition density. Kernel density calculates the density of point features around each output raster cell.

Conceptually, a smoothly curved surface is fitted over each point. The surface value is highest at the location of the point and diminishes with increasing distance from the point, reaching zero at the search radius distance from the point. Only a circular neighborhood is possible. The volume under the surface equals the population field value for the point, or 1 if “NONE” is specified. The density at each output raster cell is calculated by adding the values of all the kernel surfaces where they overlay the raster cell center. The kernel function is based on the quartic kernel function described in Silverman (1986, p. 76, equation 4.5).

If a population field setting other than “NONE” is used, each item's value determines the number of times to count the point. For example, a value of 3 would cause the point to be counted as three points. The values can be integer or floating points.

The resulting raster was classified using the Natural Breaks (Jenks) method into 4 classes: low, moderate, high and extreme.

IGNITION POTENTIAL

The third subcomponent, ignition potential, was an indicator of the potential for fire ignition based on fuel type and 90th percentile fire weather conditions where 90th percentile weather represents 10% of the historic fire weather extreme. It was calculated using the Wildfire Ignition Probability Predictor (WIPP), a tool from FORTester v1.0 (Lawson *et al.* 1993). The model determined the probability of sustained ignition from simulated people-caused fire brands (matches and camp fires) and predicted, in broad classes (a "no-fire day" if probability of sustained ignition was less than 50% and a "fire day" if probability was greater than 50%), from readily available indicators of fire danger based on benchmark fuel type groups applicable to British Columbia (see Appendix C for WIPP calculations). Ignition probabilities expressed on an area basis provided a measure of people-caused fire potential from simple fire danger rating system components.

FIRE BEHAVIOUR COMPONENT

The model developed for circuit 2L90 was designed using 90th percentile fire weather conditions[5]. The fire behaviour component (Figure 11) estimated how wildfire would behave under the study area's historic weather conditions that have occurred over the recorded climate record. Information was compiled that related stand-level fuel types, slope, aspect, and fire weather for the study area. The resulting data was processed through the FBP97 (Fire Behaviour Predictor 97) program. Fire Behaviour Predictor 97 is a Windows™ based version of the Canadian Fire Behaviour Prediction System (Forestry Canada 1992) developed by Remsoft Inc. The fire behaviour outputs of FBP97 include: fire intensity; rate of spread, and; crown fraction burned. These outputs form the subcomponents of the fire behaviour component (Figure 19).

The Canadian Fire Behaviour Prediction System uses 16 national benchmark fuel types to predict fire behaviour. For the assessment, all of the 16 fuel types were selected to estimate fire behaviour based on species composition and stand structure attributes. Forest cover from the Provincial Vegetation Resource Inventory data were used by the Province to produce a standardized fuel type map that describe the 16 benchmark fuel types. A fuel type map of the study area is provided in Appendix D: Fuel Types for the Study Area.

Weather information was derived from historic records collected from weather stations associated with the study area's Biogeoclimatic Ecosystem Classification. A provincial lookup table with computed fire weather indices summarized by station and Biogeoclimatic unit was used to determine 90th percentile weather conditions for the study area.

Fire weather data (temperature, relative humidity, precipitation, and wind speed) was used to calculate Fine Fuel Moisture Code (FFMC) and Build-Up Index (BUI). Fire behaviour was subsequently modeled in FBP97 using upslope winds calculated from the relevant aspect.

[5] 90th percentile weather represents the historic fire weather extreme that is representative of 10% of the fire weather record.

Wildfire Risk Management Component: **Potential Fire Behaviour**

The Fire Behaviour component provides a rating of the probability of a wildfire exhibiting extreme behaviour in a given location given existing fuel types and 90th percentile weather conditions. The rating is calculated as a weighted sum rating using three attributes that are output from the FBP system: **Fire Intensity, Rate of Spread,** and **Crown Fraction Burned.**

Component Attributes:

Attribute	Indicator / Units	Rating Scale		Weight
Fire Intensity *Indicator of the rate of heat energy released.*	kilowatts per metre	> 10,000	10	50%
		4,001 - 10,000	8	
		2,001 - 4,000	6	
		501 - 2,000	4	
		1-500	2	
		0	0	
Rate of Spread *Indicator of speed at which fire extends horizontally.*	metres per minute	> 40	10	25%
		21 - 40	8	
		11 - 20	6	
		6 - 10	4	
		1 - 5	2	
		0	0	
Crown Fraction Burned *Indicator of the proportion of tree crowns consumed by fire (i.e., a measure of tree mortality).*	%	76 - 100	10	25%
		51 - 75	8	
		21 - 50	6	
		11 - 20	4	
		1 - 10	2	
		0	0	

Figure 19. Probability Component Table: Fire Behaviour probability.

FIRE INTENSITY

The fire intensity subcomponent was a measure of the rate of heat energy released per unit time per unit length of fire front. It was based on the rate of spread and predicted fuel consumption of the fire, and was expressed in kilowatts per meter (Pyne 1984).

RATE OF SPREAD

The rate of spread subcomponent was a measure of the speed at which fire expands its horizontal dimensions at the head of the fire. This was based on the hourly Initial Spread Index (ISI) value and was expressed in meters per minute. The rate of spread was adjusted for steepness of slope and interactions between slope direction and wind direction determined from the Build-Up Index (BUI).

CROWN FRACTION BURNED

The crown fraction burned subcomponent was a measure of the proportion of the tree crowns consumed by fire and was expressed as a percentage value. It was based on rate of spread, crown base height and foliar moisture content.

SUPPRESSION RESPONSE CAPABILITY COMPONENT

The ability to suppress wildfire is dependent on the speed of detection, terrain, accessibility and availability of resources. Five subcomponents were used to determine overall suppression response capability (Figure 13). These included constraints to detection, proximity to water sources, air tanker arrival time, steepness of terrain, and proximity to roads and helipads (Figure 20). The road network as per the Provincial Digital Road Atlas geodatabase was used for the suppression capability to reflect current access and resultant enhanced suppression capability.

Wildfire Risk Management Component: **Suppression Response Capability**

The Suppression component provides a rating of the probability that a wildfire could be quickly exterminated in a given location given existing resources. The rating is calculated as a weighted sum rating using five attributes: **Contraints to Detection, Proximity to Water Sources, Air Tanker Attack Time, Helicopter Arrival Time, Terrain Steepness,** and **Proximity to Roads**

Component Attributes:

Attribute	Indicator / Units	Rating Scale		Weight
Constraints to Detection *Indicator of the ability to detect a fire: reconnaissance at higher elevations is often constrained by cloud cover.*	elevation metres	> 1500	10	10%
		1000 - 1500	7	
		500 - 1000	3	
		<500	0	
Proximity to Water Sources *Indicator of the ability to access water quickly for fire fighting. Based on distance from all season streams and lakes.*	distance metres	>300	10	10%
		101-300	7	
		<100	2	
		0	0	
Air Tanker Arrival Time *Indicator of time for air tanker action measured as flight time (concentric) from nearest tanker base (300k/hr)*	minutes	> 40	10	20%
		31 - 40 (200km)	7	
		21 - 30 (150km)	5	
		11 - 20 (100km)	3	
		0 - 10 (50km)	0	
Helicopter Arrival Time *Indicator of the time for initial attack, measured as flight time (concentric) from nearest base plus fixed assumptions about time of travel to the base.*	minutes	> 70	10	20%
		51 - 70 (210 km)	7	
		31 - 50 (150 km)	5	
		11 - 30 (90 km)	3	
		0 - 10 (30 km)	0	
Terrain Steepness *Indicator of the difficulty of control/contain on the landscape.*	slope Class %	> 60	10	30%
		41 - 60	7	
		21 - 40	3	
		0 - 20	0	
Proximity to Roads *Indicator of the ability to get suppression resources into an area: based on a bush walking rate of 1 km / hour.*	minutes	> 120 (>2km)	10	10%
		61 - 120 (2 km)	7	
		31 - 60 (1km)	5	
		16 - 30 (0.5km)	3	
		0 -15 (0.25km)	0	

Figure 20. Probability Component Table: Suppression Response Capability.

CONSTRAINTS TO DETECTION

In British Columbia, fires are detected by three primary methods: a provincial lightning location system, aircraft, and identification by the public. Due to the unpredictability of flight frequency and public response, it was not possible to quantify the speed of detection. Detection is primarily a function of visibility limitations associated with high elevation cloud in specific parts of the study area. A storm front with varying amounts of precipitation typically follows an active lightning period. This storm front creates cloud and fog within higher elevations zones of the study area during a 12 to 24-hour period following the storm. This cloud and fog cover inhibits the critical detection period; since most fire ignitions within the study area occur during the transition from a high to low-pressure weather system. The constraints to the detection subcomponent were therefore based on elevation classes. The higher the elevation, the more likely detection will be constrained by cloud and fog cover. Four classes were created based on the elevation range in the study area as follows:

- less than 750 meters;
- 750 – 1250 meters;
- 1250 – 1700 meters; and
- Over 1700 meters.

PROXIMITY TO WATER SOURCES

Proximity to water sources was delineated using the hydrological base and only included determinant (perennial) water sources. Proximity to water sources for fire suppression (an indicator of the ability to access water quickly for firefighting) was evaluated by creating a 100 m and 300 m buffer around all determinant rivers, creeks and lakes. Areas outside of the 300 m buffer were given the maximum subcomponent rating.

HELICOPTER ARRIVAL TIME

The helicopter arrival time subcomponent was determined based on the distance from the closest heli base to the study area. The ratings increased with greater distance from the base.

TERRAIN STEEPNESS

Steepness of terrain influences the ability of a ground crew to build fireguards and carry out ground suppression. Average slope class was determined from the terrain data and ratings were assigned according to slope class.

PROXIMITY TO ROADS

Proximity to roads was used to evaluate the accessibility of suppression resources reaching areas within a given landscape unit. It was evaluated based on a bush-walking rate of 1 km/h. Proximity to roads and helipads was rated by creating buffers around all roads and helipads in the study area and assigning weights relative to walking time from these areas.

The following graphic (Figure 21) summarizes all the mapping outputs required to develop the final probability theme as per the methods described above, for ignition probability, fire behaviour and suppression capability.

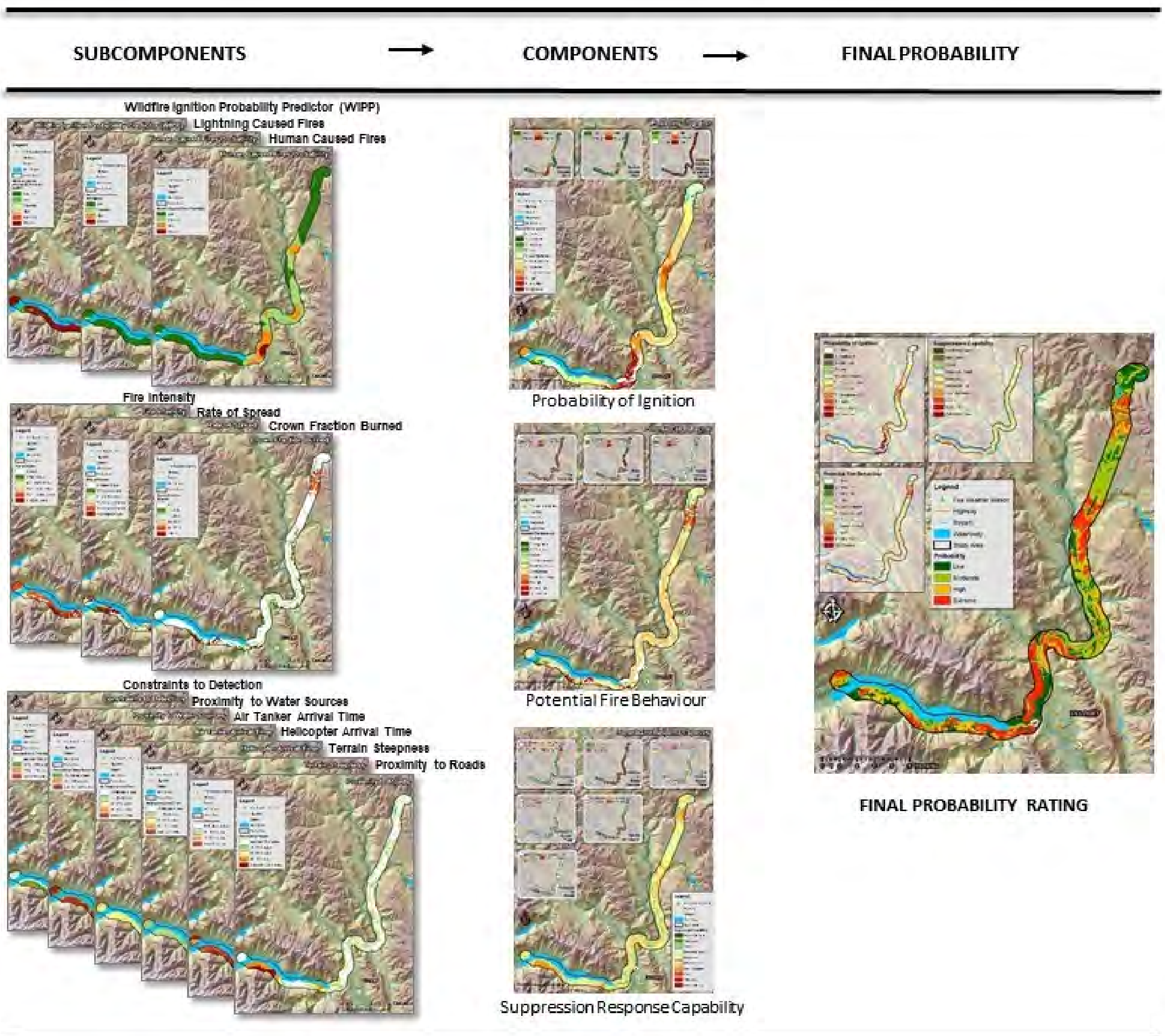


Figure 21. Summary mapping outputs from the Wildfire Risk Management System showing the individual subcomponents and components of Ignition Probability, Fire Behaviour, and Suppression Capability.

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APPENDIX B: SUBCOMPONENT MAPS

SUPPORTING SUBCOMPONENT MAPS FOR IGNITION PROBABILITY

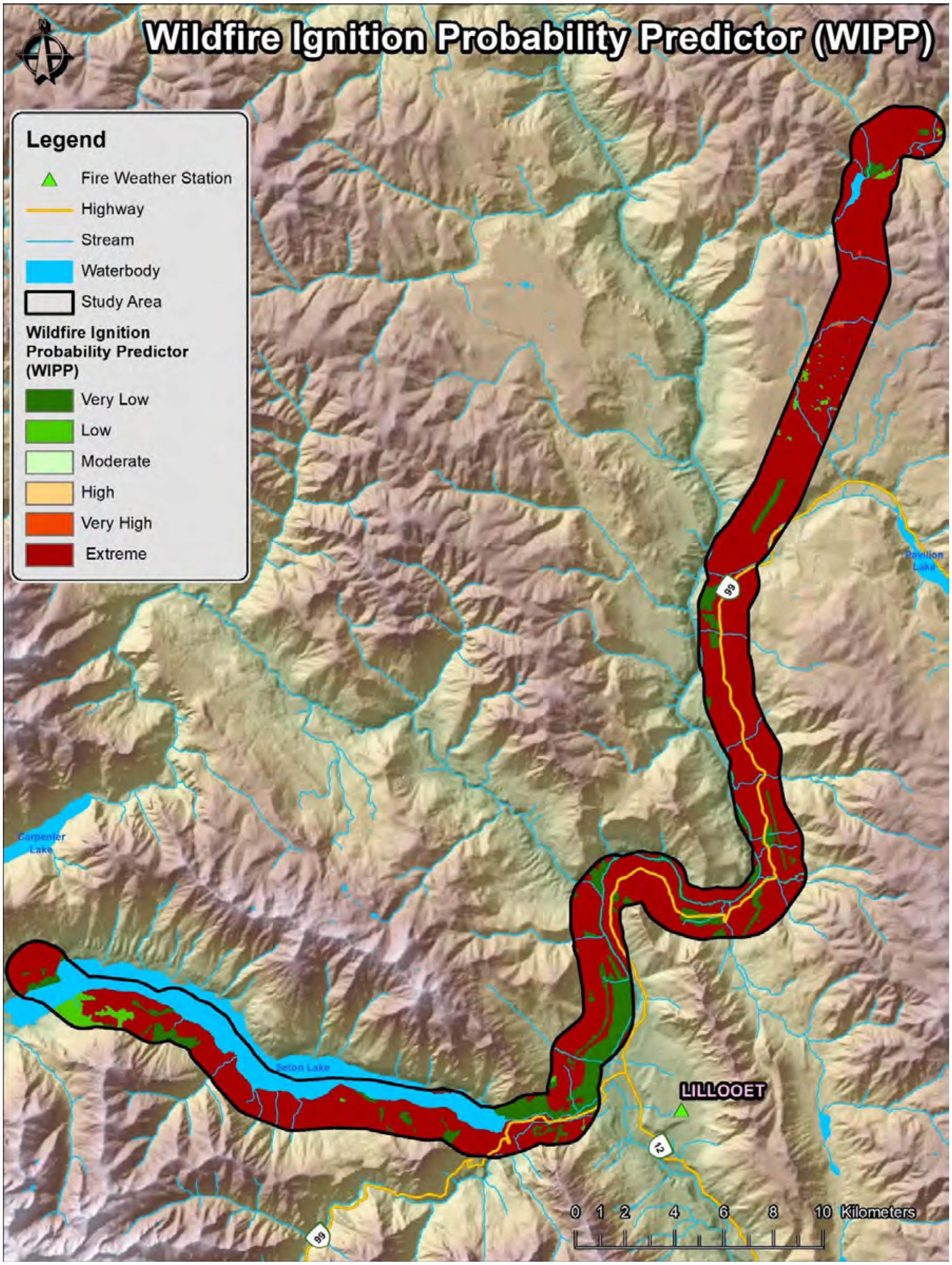

Figure 22. Wildfire Ignition Probability Predictor (WIPP).

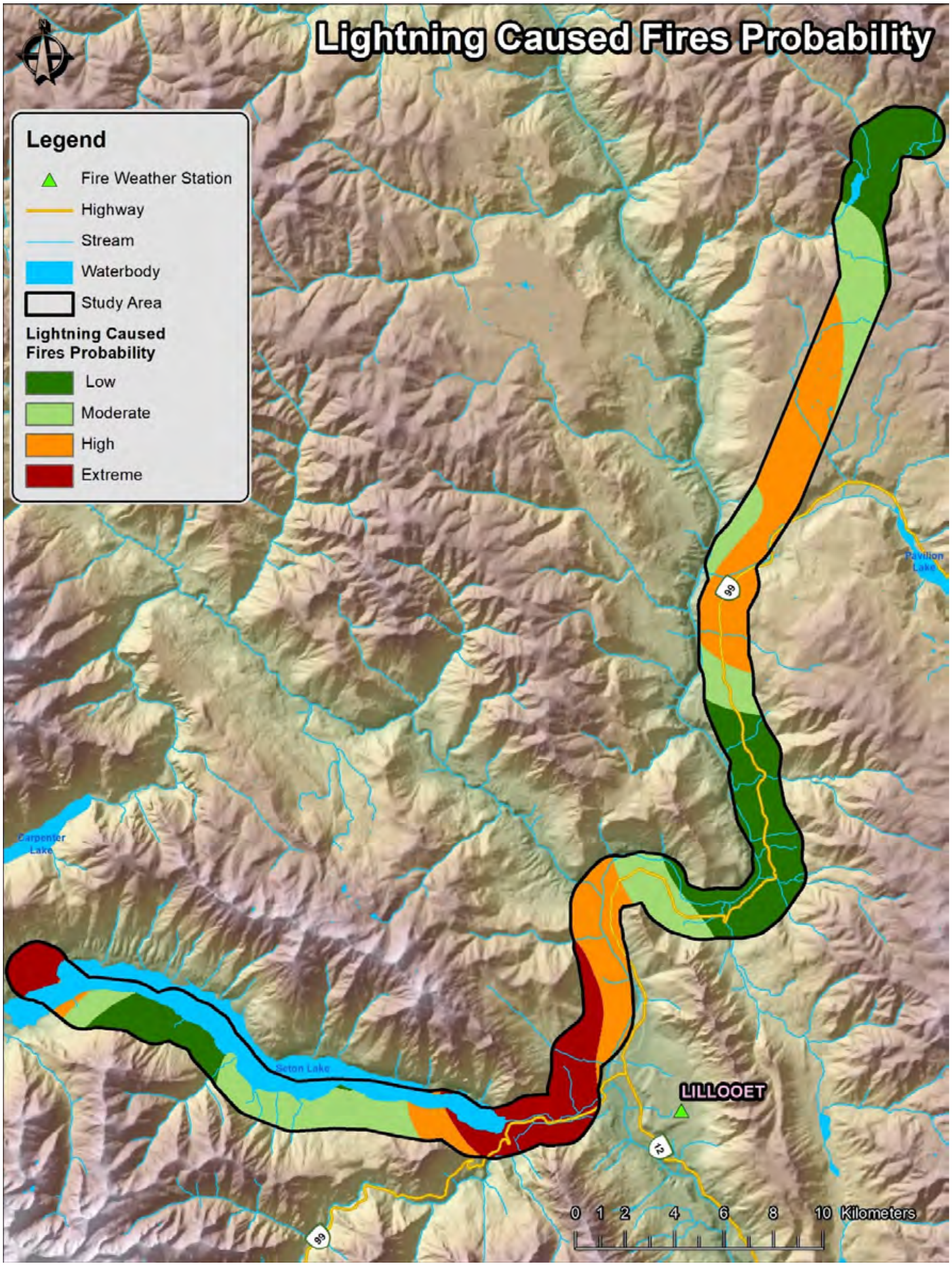

Figure 23. Probability of lightning caused fires

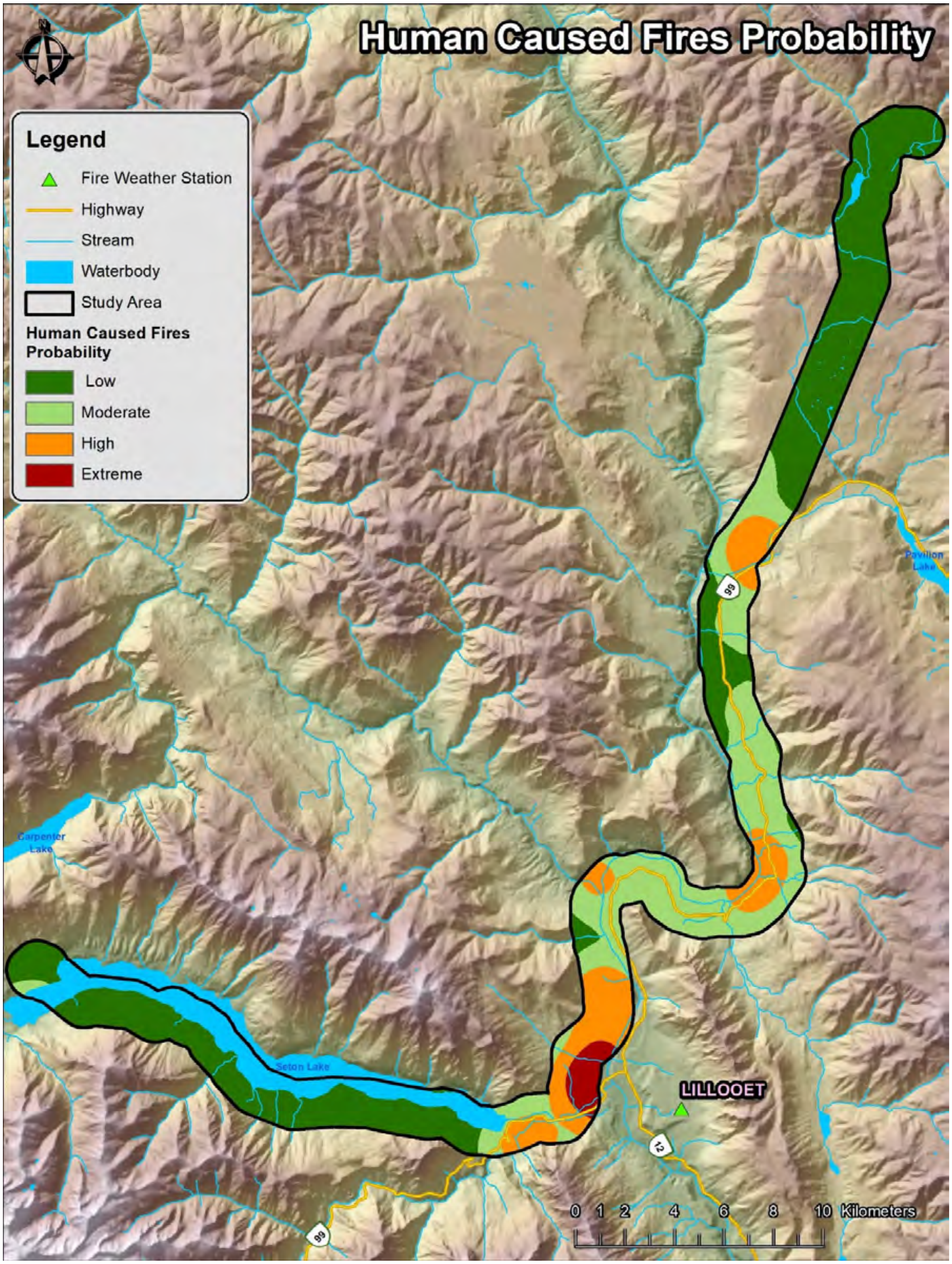

Figure 24. Probability of human caused fires.

SUPPORTING SUBCOMPONENT MAPS FOR FIRE BEHAVIOUR

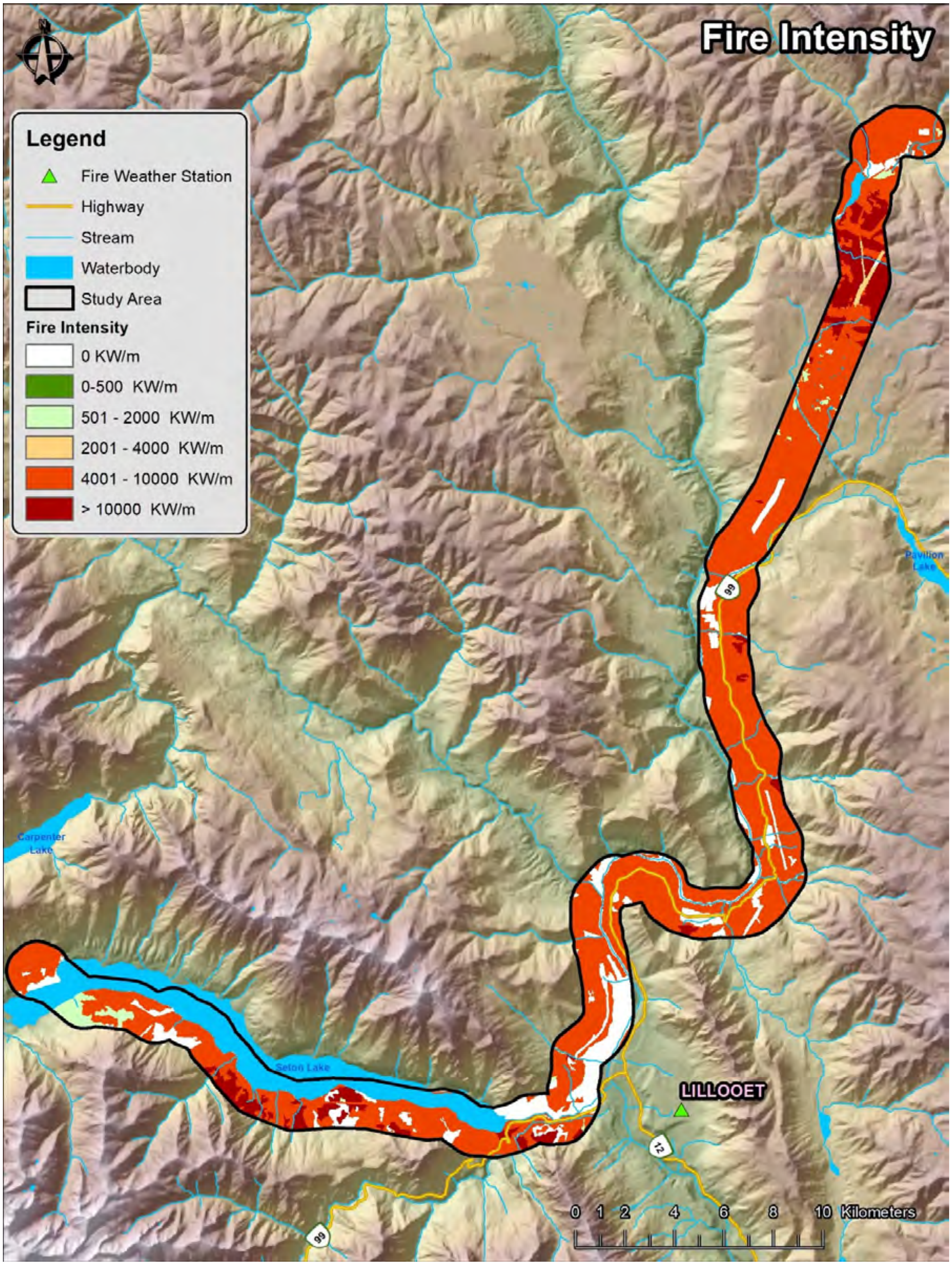

Figure 25. Fire intensity.

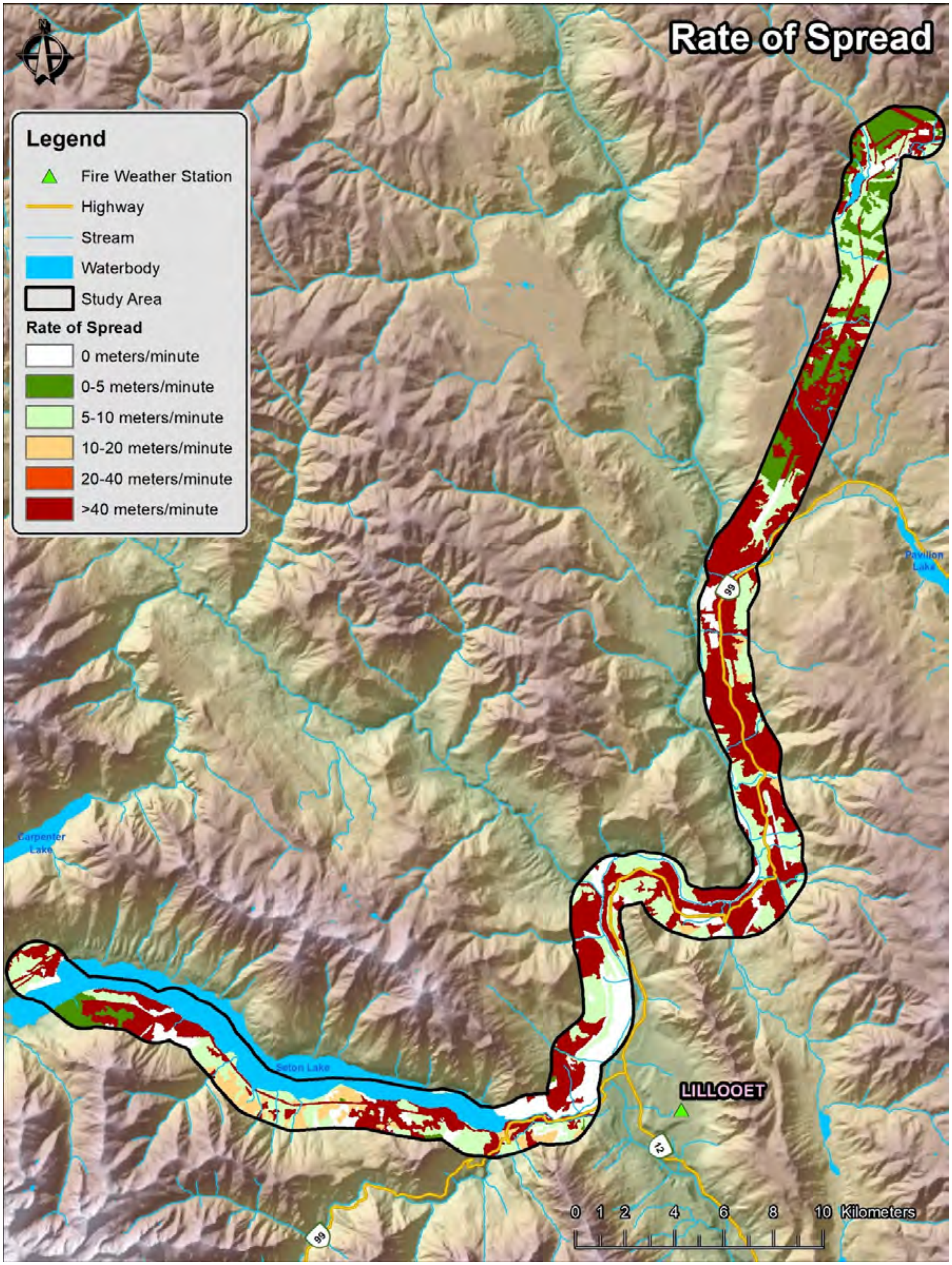

Figure 26. Rate of spread.

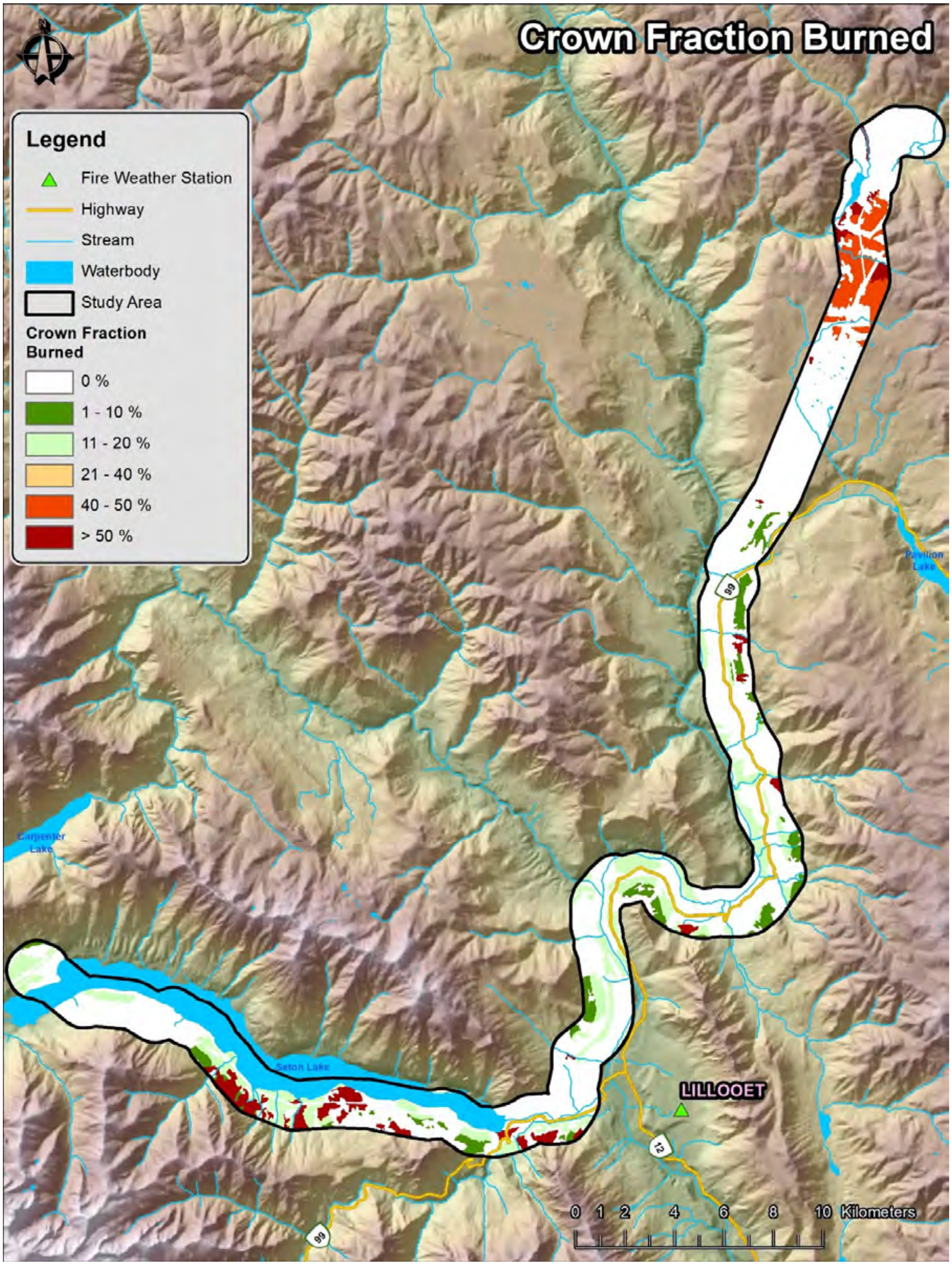

Figure 27. Crown fraction burned.

SUPPORTING SUBCOMPONENT MAPS FOR SUPPRESSION CAPABILITY

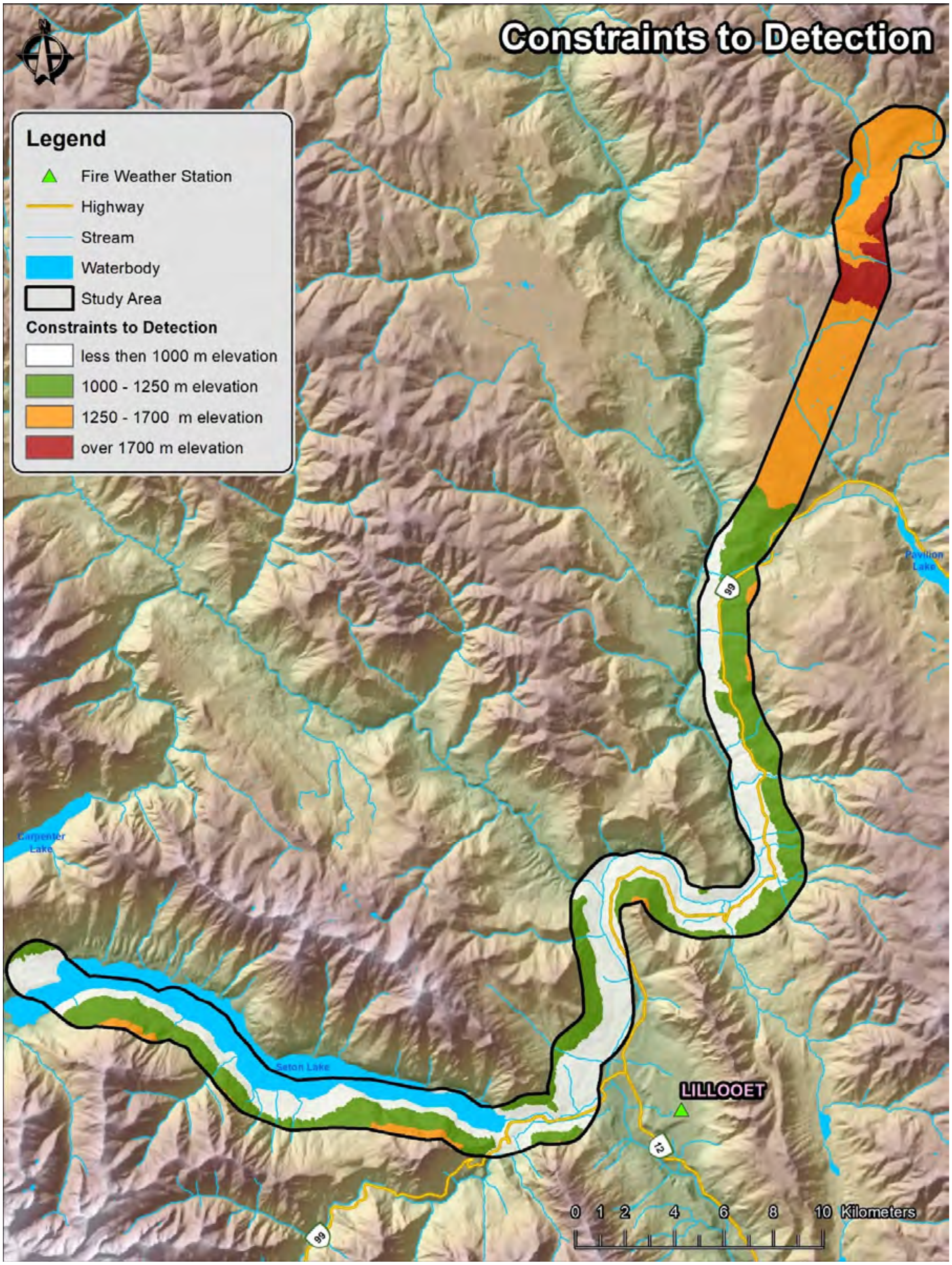

Figure 28. Constraints to detection.

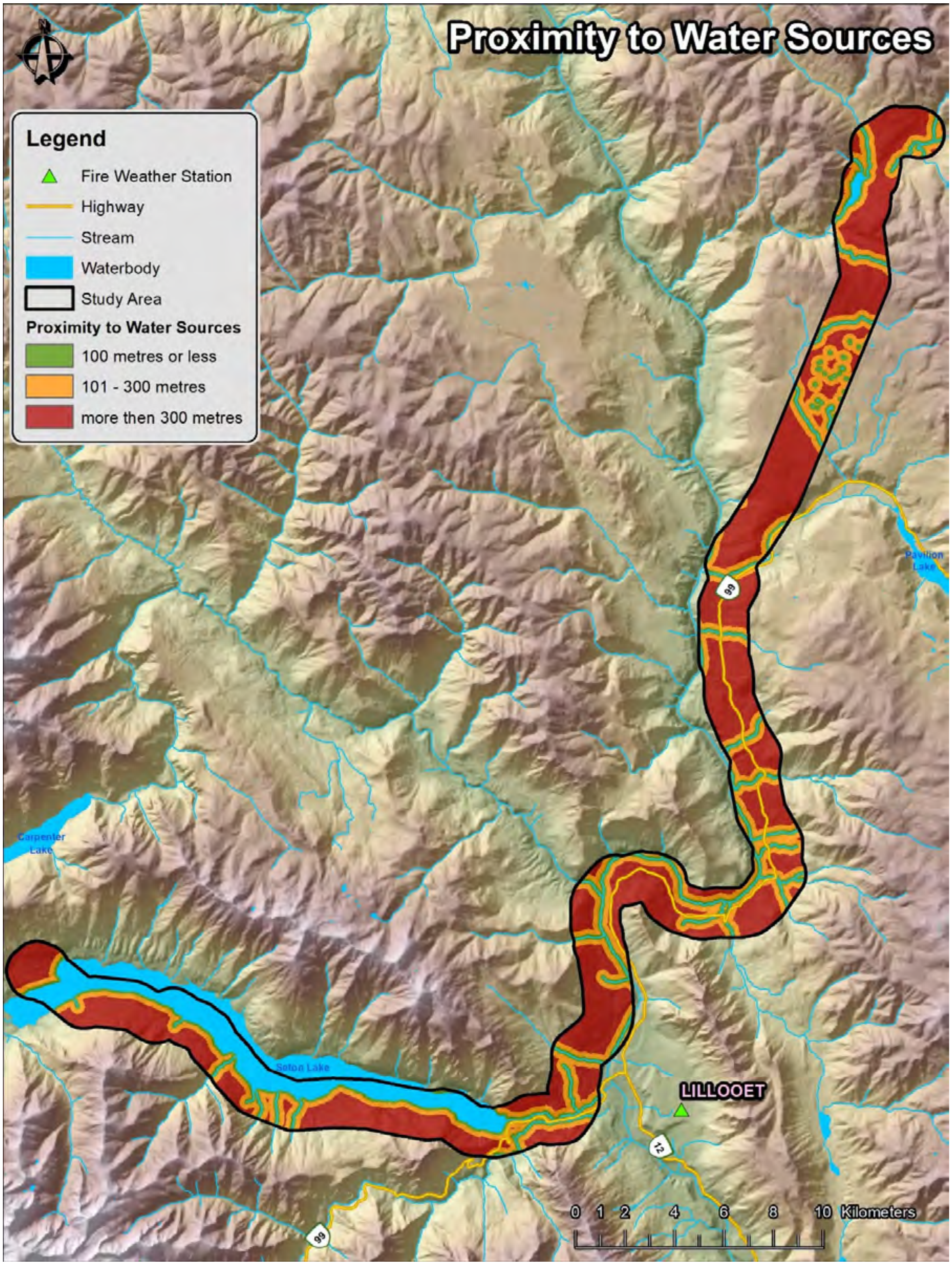

Figure 29. Proximity to water sources.

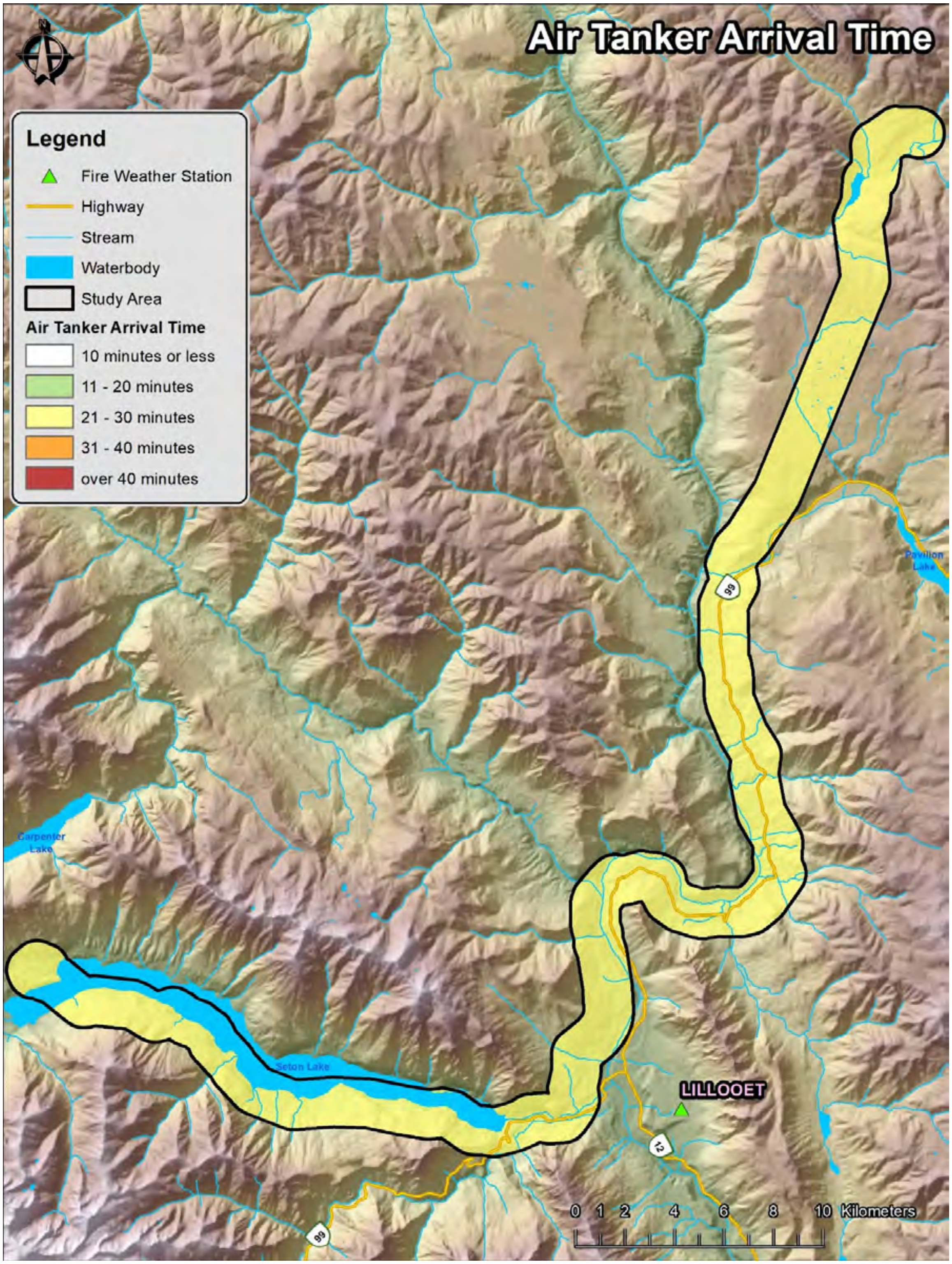

Figure 30. Air tanker arrival time.

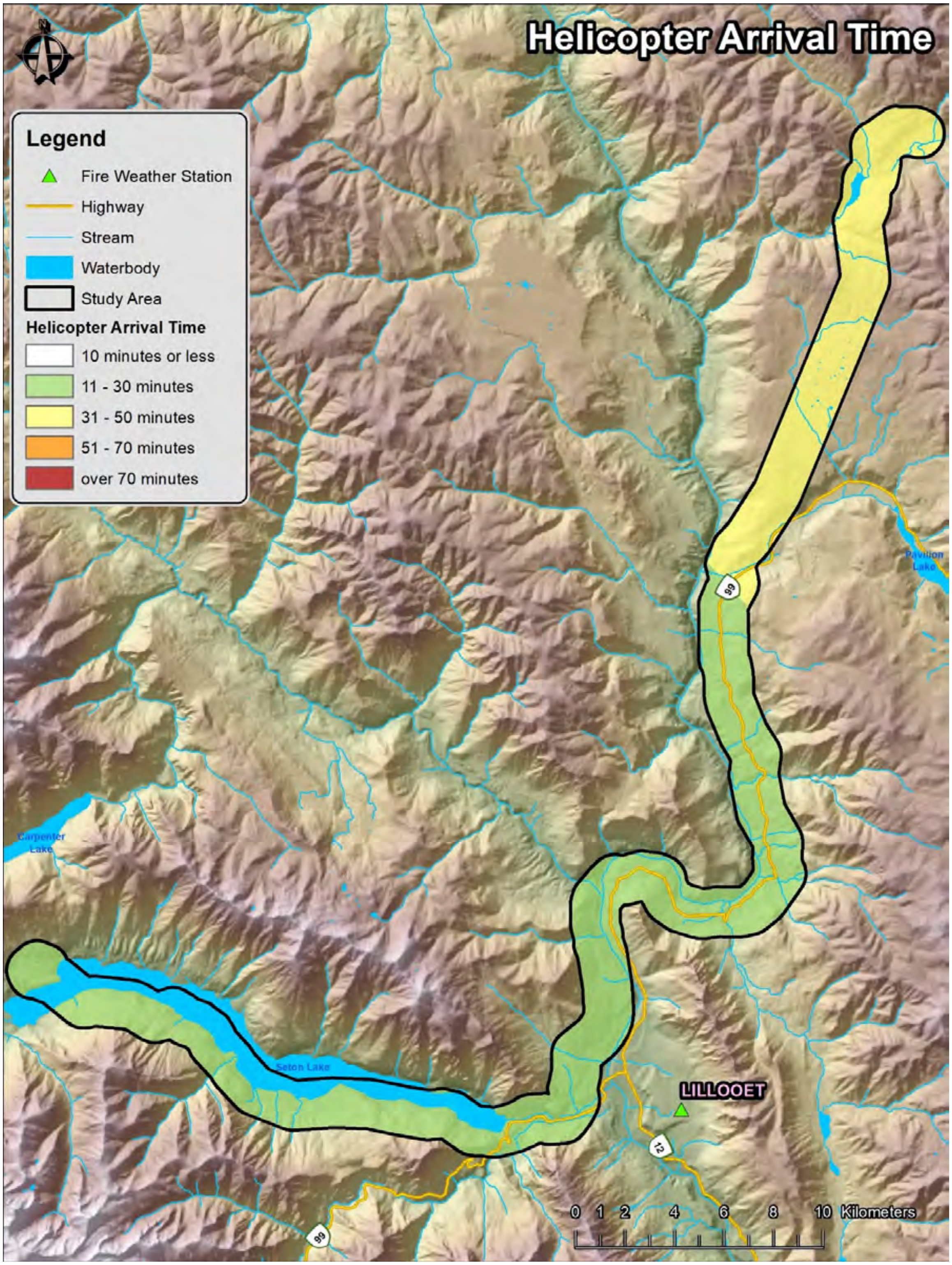

Figure 31. Helicopter arrival time.

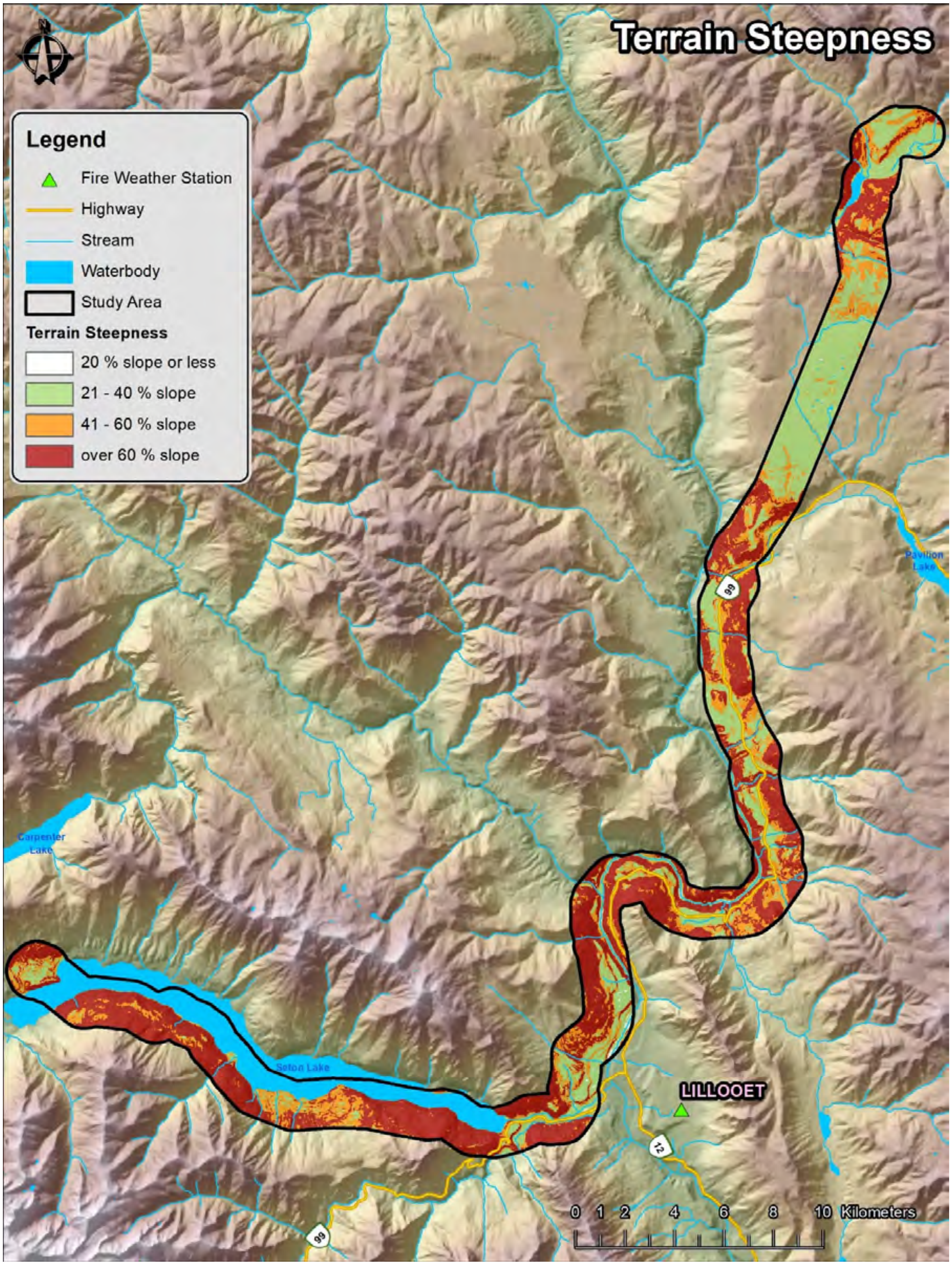

Figure 32. Terrain steepness.

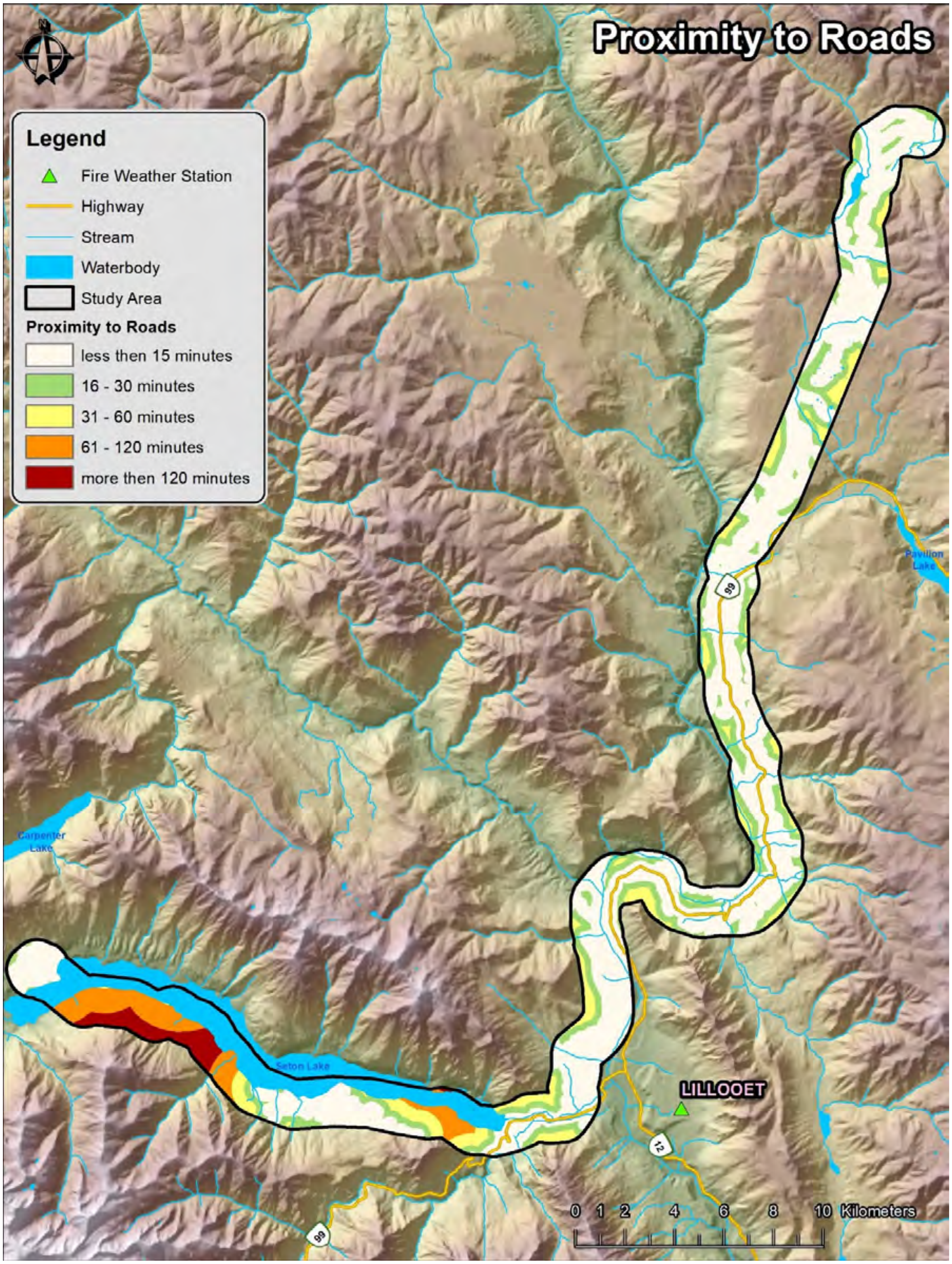

Figure 33. Proximity to roads.

APPENDIX C: THE WILDFIRE IGNITION PROBABILITY PREDICTION SYSTEM (WIPP)

(1) Format of the Standard WIPP Equation is:

P = 1 / {1 + exp[B0 + B1*FFMC + B2*DMC + B3*DC + B4*BUI + B5*FWI + B6*ISI] }

(2) Standard Association of FBP Fuel Types and WIPP Equations:

Table 2 provides the suggested standard association of WIPP equation to FBP Fuel types.

(3) Possible Association of WIPP Equations to FBP Fuel Types

The option exists to change the choice of the WIPP equation, which is used for each FBP fuel type. The default option, which is the first equation listed, and the subsequent possible options are listed in Table 4. These possible associations are from Lawson and Armitage (1997)

(4) Relationship of WIPP Equations to General Fuel Type and Provincial Experimental Sites

Table 4 details the general fuel types and provincial test sites that were used to create the individual WIPP equations.

References

Lawson, B.D., O.B. Armitage, and G.N. Dalrymple. 1994. Ignition probabilities for simulated people-caused fires in B.C.'s lodgepole pine and white spruce-alpine fir forests. Pages 493-505 in Proc.12th Conf. On Fire & Forest Meteorology. Oct 26-28, 1993. Jekyll Is. GA., Soc. Am. Foresters. Bethesda, MD.

Lawson, B.D., O.B. Armitage. 1997. Ignition Probability Equations for some Canadian Fuel Types. Report submitted to the Canadian Committee on Forest Fire Management. (Draft report).

Table 2. Standard Association of FBP Fuel Types and WIPP Equations.

FBP Fuel	WIPP Eqn	WIPP Equation
C1	1A	P = 1/(1+EXP(5.061 - 0.086*FFMC))
C2	9C	P = 1/(1+EXP(33.299 - 0.353*FFMC - 0.057*DMC))
C3	6A	P = 1/(1+EXP(2.199 - 0.021*DMC - 0.265*ISI))
C4	6-5012	P = 1/(1+EXP(3.731 - 0.079*DMC - 0.185*ISI))
C5	9BC	P = 1/(1+EXP(2.766 - 0.005*DC -0.396*ISI))
C6	BC Dry Pine	P = 1/(1+EXP(2.107 - 0.727*ISI))
C7	4BC	P = 1/(1+EXP(1.563 - 0.005*BUI - 0.478*ISI))
D1	8C	P = 1/(1+EXP(12.781 - 0.121*FFMC - 0.032*DMC))
D2	8	P = 1/(1+EXP(14.0 - 0.121*FFMC - 0.010*DMC))
M1	7A	P = 1/(1+EXP(25.540 - 0.264*FFMC - 0.036*DMC))
M2	9BC	P = 1/(1+EXP(2.766 - 0.005*DC -0.396*ISI))
M3	9A	P = 1/(1+EXP(2.144 - 0.423*ISI))
M4	9BC	P = 1/(1+EXP(2.766 - 0.005*DC -0.396*ISI))
S1	2A	P = 1/(1+EXP(7.219 - 0.107*FFMC))
S2	2A	P = 1/(1+EXP(7.219 - 0.107*FFMC))
S3	2A	P = 1/(1+EXP(7.219 - 0.107*FFMC))
O1a	SaA	P = 1/(1+EXP(0.161 - 0.016*DMC -0.240*ISI))
O1b	SaA	P = 1/(1+EXP(0.161 - 0.016*DMC -0.240*ISI))

Table 3. Possible Association of WIPP Equations to FBP Fuel Types.

FBP Fuel	WIPP Eqn	WIPP Equation
C1	1A	P = 1/ (1+EXP(5.061 - 0.086*FFMC))
C1	1B	P = 1/ (1+EXP(1.965 - 0.704*ISI))
C1	1C	P = 1/ (1+EXP(0.837 - 1.020*ISI))
C2	9C	P = 1/(1+EXP(33.299 - 0.353*FFMC - 0.057*DMC))
C2	9A	P = 1/(1+EXP(2.144 - 0.423*ISI))
C2	9B	P = 1/(1+EXP(10.675 - 0.112*FFMC - 0.100*DMC))
C2	9D	P = 1/(1+EXP(11.677 - 0.123*FFMC - 0.027*DMC))
C2	9E	P = 1/(1+EXP(6.438 - 0.077*DMC – 0.357*ISI))
C2	9BC	P = 1/(1+EXP(2.766 - 0.005*DC - 0.396*ISI))
C3	6A	P = 1/(1+EXP(2.199 - 0.021*DMC - 0.265*ISI))
C3	6-5012	P = 1/(1+EXP(3.731 - 0.079*DMC - 0.185*ISI))
C3	6-6017	P = 1/(1+EXP(1.754 - 0.021*DMC - 0.282*ISI))
C3	6B	P = 1/(1+EXP(14.424 - 0.171*FFMC - 0.017*DMC))
C3	BC Dry Pine	P = 1/(1+EXP(2.107 - 0.727*ISI))
C3	BC Moist Pine	P = 1/(1+EXP(2.146 - 0.009*BUI -0.349*ISI))
C4	6-5012	P = 1/(1+EXP(3.731 - 0.079*DMC - 0.185 ISI))
C4	6A	P = 1/(1+EXP(2.199 - 0.021*DMC - 0.265*ISI))
C4	6-7015	P = 1/(1+EXP(2.199 - 0.022*DMC - 0.119*ISI))
C4	6B	P = 1/(1+EXP(14.424 - 0.171*FFMC - 0.017*DMC))
C4	BC Dry Pine	P = 1/(1+EXP(2.107 - 0.727*ISI))

FBP Fuel	WIPP Eqn	WIPP Equation
C4	BC Moist Pine	P = 1/(1+EXP(2.146 - 0.009*BUI -0.349*ISI))
C5	9BC	P = 1/(1+EXP(2.766 - 0.005*DC -0.396*ISI))
C5	6A	P = 1/(1+EXP(2.199 - 0.021*DMC - 0.265*ISI))
C5	9A	P = 1/(1+EXP(2.144 - 0.423*ISI))
C5	9E	P = 1/(1+EXP(6.438 - 0.077*DMC – 0.357*ISI))
C6	BC Dry Pine	P = 1/(1+EXP(2.107 - 0.727*ISI))
C6	9BC	P = 1/(1+EXP(2.766 - 0.005*DC -0.396*ISI))
C6	6A	P = 1/(1+EXP(2.199 - 0.021*DMC - 0.265*ISI))
C6	6-5012	P = 1/(1+EXP(3.731 - 0.079*DMC - 0.185*ISI))
C6	9C	P = 1/(1+EXP(33.299 - 0.353*FFMC - 0.057*DMC))
C6	9D	P = 1/(1+EXP(11.677 - 0.123*FFMC - 0.027*DMC))
C7	4BC	P = 1/(1+EXP(1.563 - 0.005*BUI - 0.478*ISI))
D1	8C	P = 1/(1+EXP(12.781 - 0.121*FFMC - 0.032*DMC))
D1	8A	P = 1/(1+EXP(3.503 - 0.044*DMC - 0.407*ISI))
D1	8B	P = 1/(1+EXP(5.026 - 0.233*ISI))
D2	8	P = 1/(1+EXP(14.0 - 0.121*FFMC - 0.010*DMC))
M1	7A	P = 1/(1+EXP(25.540 - 0.264*FFMC - 0.036*DMC))
M1	7B	P = 1/(1+EXP(45.827 - 0.491*FFMC))
M2	9BC	P = 1/(1+EXP(2.766 - 0.005*DC -0.396*ISI))
M2	9A	P = 1/(1+EXP(2.144 - 0.423*ISI))

FBP Fuel	WIPP Eqn	WIPP Equation
M2	9B	P = 1/(1+EXP(10.675 - 0.112*FFMC - 0.100*DMC))
M2	9C	P = 1/(1+EXP(33.299 - 0.353*FFMC - 0.057*DMC))
M2	9D	P = 1/(1+EXP(11.677 - 0.123*FFMC - 0.027*DMC))
M2	9E	P = 1/(1+EXP(6.438 - 0.077*DMC – 0.357*ISI))
M3	9A	P = 1/(1+EXP(2.144 - 0.423*ISI))
M3	9B	P = 1/(1+EXP(10.675 - 0.112*FFMC - 0.100*DMC))
M3	9C	P = 1/(1+EXP(33.299 - 0.353*FFMC - 0.057*DMC))
M3	9D	P = 1/(1+EXP(11.677 - 0.123*FFMC - 0.027*DMC))
M3	9E	P = 1/(1+EXP(6.438 - 0.077*DMC – 0.357*ISI))
M3	9BC	P = 1/(1+EXP(2.766 - 0.005*DC -0.396*ISI))
M4	9BC	P = 1/(1+EXP(2.766 - 0.005*DC -0.396*ISI))
M4	9A	P = 1/(1+EXP(2.144 - 0.423*ISI))
M4	9B	P = 1/(1+EXP(10.675 - 0.112*FFMC - 0.100*DMC))
M4	9C	P = 1/(1+EXP(33.299 - 0.353*FFMC - 0.057*DMC))
M4	9D	P = 1/(1+EXP(11.677 - 0.123*FFMC - 0.027*DMC))
M4	9E	P = 1/(1+EXP(6.438 - 0.077*DMC – 0.357*ISI))
S1	2A	P = 1/(1+EXP(7.219 - 0.107*FFMC))
S2	2A	P = 1/(1+EXP(7.219 - 0.107*FFMC))
S3	2A	P = 1/(1+EXP(7.219 - 0.107*FFMC))
O1a	SaA	P = 1/(1+EXP(0.161 - 0.016*DMC -0.240*ISI))
O1a	SbA	P = 1/(1+EXP(46.942 - 0.508*FFMC - 0.063*DMC))
O1b	SaA	P = 1/(1+EXP(0.161 - 0.016*DMC -0.240*ISI))
O1b	SbA	P = 1/(1+EXP(46.942 - 0.508*FFMC -0.063*DMC)

FBP Fuel	WIPP Eqn	WIPP Equation

Table 4. Relationship of WIPP Equations to General Fuel Type and Provincial Experimental Sites.

FBP Fuel	WIPP Eqn	General Fuel Type(s)	Provincial Site(s)
C1	1A	Cladonia	NF (101-5), MB (501-6)
C1	1B	Pine-Cladonia, Spruce-Cladonia	AB-Whitecourt (702-2,702-8)
C1	1C	Cladonia	SK (601-6)
C2	9C	Spruce	NWT (901-3)
C2	9A	Spruce-Fir	NF (101-3)
C2	9B	Spruce	NF (101-4)
C2	9D	Pine-Spruce,Spruce,Spruce-Pine	MB (501-1),SK (601-4), AB-Kananaskis (701-9)
C2	9E	Spruce, Spruce	AB-Whitecourt (702-6, 702-7)
C2	9BC	White Spruce-Subalpine Fir	BC-Prince George
C3	6A	Closed Jack Pine/Lodgepole Pine, Pine-Spruce, Balsam Fir	NF (101-1), SK (601-7, 601-8), MB (501-2, 501-5, 501-9), AB-Kananaskis (701-5, 701-6), AB-Whitecourt (702-3) NWT (901-2)
C3	6-5012	Jack Pine (JY2)	MB (501-2)
C3	6-6017	Pine	SK (601-7)
C3	6B	Pine, Jack Pine	AB-Whitecourt (702-1), NWT (901-1)
C3	BC Dry Pine	Lodgepole Pine (Dry)	BC-Prince George
C3	BC Moist Pine	Lodgepole Pine (Moist)	BC-Prince George
C4	6-5012	Jack Pine (JY2)	MB (501-2)
C4	6A	See C3 – 6A above	
C4	6-7015	Lodgepole Pine (L4)	AB-Kananaskis (701-5)
C4	6B	Pine, Jack Pine	AB-Whitecourt (702-1), NWT (901-1)
C4	BC Dry Pine	Lodgepole Pine (Dry)	BC-Prince George
C4	BC Moist Pine	Lodgepole Pine (Moist)	BC-Prince George

FBP Fuel	WIPP Eqn	General Fuel Type(s)	Provincial Site(s)
C5	9BC	White Spruce-Subalpine Fir	BC-Prince George
C5	6A	See C3 – 6A above	
C5	9A	Spruce-Fir	NF (101-3)
C5	9E	Spruce, Spruce	AB-Whitecourt (702-6, 702-7)
C6	BC Dry Pine	Lodgepole Pine (Dry)	BC-Prince George
C6	9BC	White Spruce-Subalpine Fir	BC-Prince George
C6	6A	See C3 – 6A above	
C6	6-5012	Jack Pine (JY2)	MB (501-2)
C6	9C	Spruce	NWT (901-3)
C6	9D	Pine-Spruce,Spruce,Spruce-Pine	MB (501-1),SK (601-4), AB-Kananaskis (701-9)
C7	4BC	Interior Douglas Fir (open w/grass)	BC
D1	8C	Poplar-Birch, Poplar, Aspen	MB (501-4,501-8), NWT (901-6)
D1	8A	Pine-Poplar, Aspen	AB-Whitecourt (702-4, 702-5)
D1	8B	Aspen	SK (601-1)
D2	8	See Note	
M1	7A	Spruce-Aspen-Pine	NWT (901-5)
M1	7B	Poplar-Spruce-Pine	NWT (901-4)
M2	9BC	White Spruce-Subalpine Fir	BC-Prince George
M2	9A	Spruce-Fir	NF (101-3)
M2	9B	Spruce	NF (101-4)
M2	9C	Spruce	NWT (901-3)
M2	9D	Pine-Spruce,Spruce,Spruce-Pine	MB (501-1),SK (601-4), AB-Kananaskis (701-9)
M2	9E	Spruce, Spruce	AB-Whitecourt (702-6, 702-7)
M3	9A	Spruce-Fir	NF (101-3)
M3	9B	Spruce	NF (101-4)
M3	9C	Spruce	NWT (901-3)
M3	9D	Pine-Spruce,Spruce,Spruce-Pine	MB (501-1),SK (601-4), AB-Kananaskis (701-9)

FBP Fuel	WIPP Eqn	General Fuel Type(s)	Provincial Site(s)
M3	9E	Spruce, Spruce	AB-Whitecourt (702-6, 702-7)
M3	9BC	White Spruce-Subalpine Fir	BC-Prince George
M4	9BC	White Spruce-Subalpine Fir	BC-Prince George
M4	9A	Spruce-Fir	NF (101-3)
M4	9B	Spruce	NF (101-4)
M4	9C	Spruce	NWT (901-3)
M4	9D	Pine-Spruce,Spruce,Spruce-Pine	MB (501-1),SK (601-4), AB-Kananaskis (701-9)
M4	9E	Spruce, Spruce	AB-Whitecourt (702-6, 702-7)
S1	2A	Cutover-Bracken, Fir regen-open	BC-L Cowichan (802-2, 802-3)
S2	2A	Cutover-Bracken, Fir regen-open	BC-L Cowichan (802-2, 802-3)
S3	2A	Cutover-Bracken, Fir regen-open	BC-L Cowichan (802-2, 802-3)
O1a	SaA	Grass, Fir-grass-open	BC-100 Mile (801-3, 801-8)
O1a	SbA	Grass	AB-Whitecourt (702-10)
O1b	SaA	Grass, Fir-grass-open	BC-100 Mile (801-3, 801-8)
O1b	SbA	Grass	AB-Whitecourt (702-10)

APPENDIX D: FUEL TYPES FOR THE STUDY AREA

The Canadian Fire Behaviour Prediction System uses 16 national benchmark fuel types. The FBP fuel types occurring in the study area are summarized in Table 5 and their distribution is illustrated in Figure 34. The most extensive fuel type is O1 at 40% followed by C7 at 26% of the total study area.

Table 5. Canadian fuel types represented in the study area.

Fuel Type	Description	Area (ha)	Percent of Total Study Area
C2	Moderately dense regeneration to pole-sapling forest with crowns almost to the ground.	43	<1%
C3	Fully stocked, mature forest, crowns separated from ground.	1,213	8%
C7	Open, uneven-aged forest, crowns separated from ground except in conifer thickets, understorey of discontinuous grasses, herbs.	4,062	26%
D1	Moderately well-stocked deciduous stands.	306	2%
M2	Moderately well-stocked mixed stand of conifers and deciduous species, low to moderate dead, down woody fuels, crowns nearly to the ground.	180	1%
O1	Continuous standing grass	6,301	40%
S1/S2	lodgepole pine slash	14	<1%
NF	Non-fuel	1,578	10%
W	Water	1,873	12%
	TOTAL:	**15,570**	**100%**

Hazardous fuel types (C2, C3 and C7) were mapped for the study area and illustrated in Figure 35. The C2 and C3 hazardous fuel types represent less than 9% of the total study area and cover 1,256 ha. In the absence of ground-truthing, C7 is included as a hazardous fuel type as it is expected to include significant amounts of conifer ingrowth. Traditionally, C7 is a low hazard fuel type where there have been frequent surface fires, limiting the amounts of ingrowth. With the inclusion of the C7 fuel type, all hazardous fuel types combined represent approximately 34% of the study area (5,318 ha).

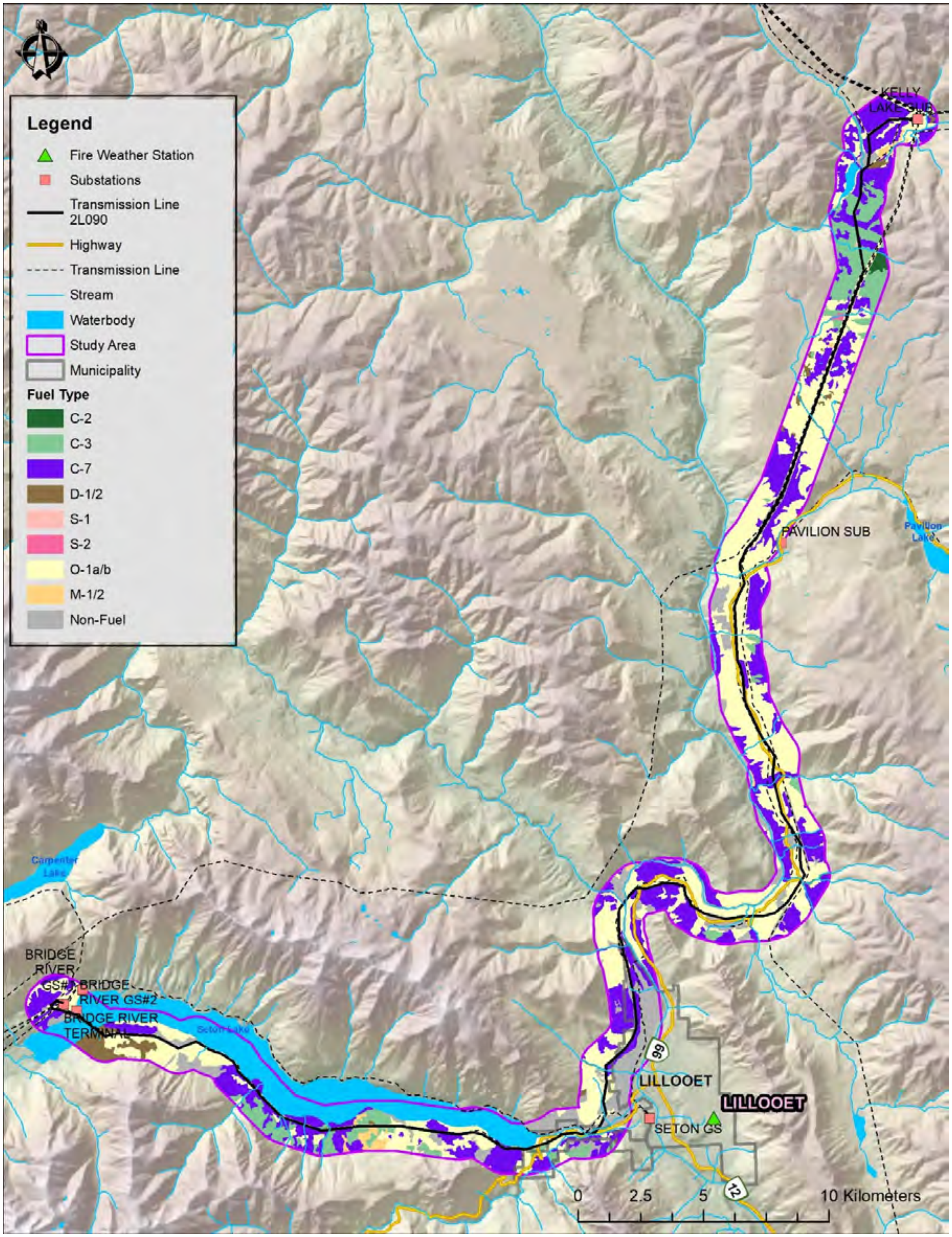

Figure 34. Fuel type distribution in the study area

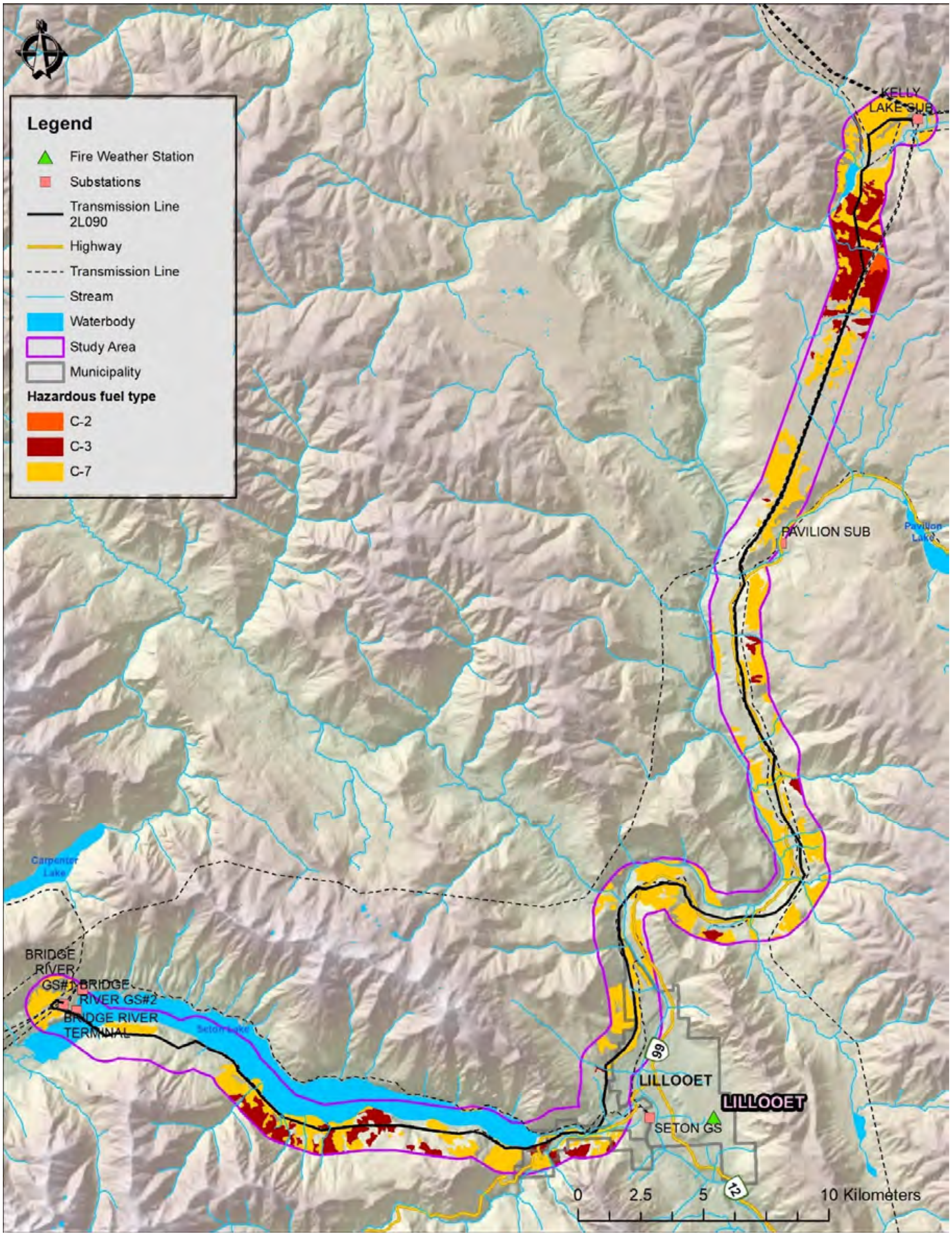

Figure 35. Hazardous fuel types.

Appendix B
2L90 Scope of Work

*the list has been updated as STARR 2019 list provided by AIM

WC = structure assemblies such as crossarm, crossbrace, insulators, guy anchors, or guy guards that need to be replaced.

2L90 Scope of Work									Poles		
Str. #	Type	Deficiency	Clearance Deficiencies	Alternative 2&3	Work Required	Heli	IR Lands	FRP	Left	Ctr	Right
A2	3PDE	Clear.	55 °C	yes	New 3PDE	Heli			80	65	80
A5	3PDE	Clear & STARR	55 °C	yes	New 3PDE	Heli			65	65	65
1/5	3PDE	STARR		yes	New 3PDE	Heli		Yes	75 FRP	75 FRP	75 FRP
2/1	H-Frame	Clear.	90 °C	no	New H-Frame	Heli		Yes	85 FRP		75 FRP
2/3	H-Frame	STARR		yes	New H-Frame	Heli		Yes	85 FRP		75 FRP
2/4	H-Frame	STARR		yes	WC	Heli					
3/1	H-Frame	STARR		yes	New H-Frame	Heli		Yes	65 FRP		60 FRP
3/2	H-Frame	STARR		yes	New H-Frame	Heli		Yes	60 FRP		60 FRP
5/3	3PDE	STARR		yes	New 3PDE	Heli		Yes	65 FRP	65 FRP	65 FRP
6/5	H-Frame	STARR		yes	New H-Frame	Heli		Yes	85 FRP		70 FRP
7/1	H-Frame	Clear.	90 °C	no	New H-Frame			Yes	75 FRP		75 FRP
7/3	H-Frame	Clear.	90 °C	no	New H-Frame			Yes	75 FRP		75 FRP
7/5	H-Frame	Clear.	90 °C	no	New H-Frame			Yes	75 FRP		75 FRP
7/6	H-Frame	Clear & STARR	90 °C	yes	New H-Frame			Yes	75 FRP		75 FRP
8/2	H-Frame	Clear.	55 °C	yes	New H-Frame			Yes	80 FRP		75 FRP
9/8A	H-Frame X	Clear & STARR	55 °C	yes	New H-Frame	Heli		Yes	100 FRP		85 FRP
10/1A	H-Frame X	Clear.	55 °C	yes	New H-Frame	Heli		Yes	65 FRP		65 FRP
10/4	H-Frame	Clear.	55 °C	yes	New H-Frame	Heli		Yes	80 FRP		70 FRP
12/2 ex. 2L91	H-Frame	Clear.	55 °C	yes	New H-Frame	Heli		Yes	95 FRP		75 FRP
12/5 ex. 2L91	3PDE	Clear.	90 °C	no	New 3PDE	Heli		Yes	70 FRP	70 FRP	70 FRP
13/2 ex. 2L91	H-Frame	Clear.	55 °C	yes	New H-Frame				75		75

13/5 ex. 2L91	H-Frame	STARR		yes	New H-Frame				70		70
14/1 ex. 2L91	3PDE	Clear.	55 °C	yes	New 3PDE				85	85	85
14/2 ex. 2L91	H-Frame	Clear & STARR	55 °C	yes	New H-Frame				75		75
14/4A ex. 2L91	H-Frame	Clear.	55 °C	yes	New H-Frame				65		65
14/6 ex. 2L91	H-Frame	Clear.	55 °C	yes	New H-Frame				75		90
14/8	3PDE	NEW FOR 2L90/91 TRANSFER		no	New 3PDE				70	70	70
15/2A	H-Frame	Clear.	90 °C	no	New H-Frame		Yes		75		75
15/3	3PDE	Clear.	90 °C	no	New 3PDE		Yes		80	80	80
15/5	H-Frame	Clear.	90 °C	no	New H-Frame		Yes		75		75
16/1	H-Frame	STARR		yes	WC		Yes				
16/5	H-Frame	STARR		yes	WC	Heli					
17/2	H-Frame	STARR		yes	WC						
17/4	H-Frame	Clear.	55 °C	yes	New H-Frame				80		80
18/5	H-Frame	Clear.	90 °C	no	New H-Frame				85		85
19/1	H-Frame	Clear & STARR	90 °C	yes	New H-Frame				70		70
19/3	H-Frame	Clear & STARR	90 °C	yes	New H-Frame				80		85
19/4	H-Frame	STARR		yes	New H-Frame				70		70
20/1	3PMA	Clear.	55 °C	yes	New 3PMA	Heli			75	80	80
20/2	3PDE	Clear & STARR	55 °C	yes	New 3PDE	Heli	Yes	Yes	75 FRP	80 FRP	85 FRP
21/1	3PDE	STARR		yes	New 3PDE	Heli			65	65	65
21/2	H-Frame	STARR		yes	WC	Heli					
21/3	3PDE	STARR		yes	New 3PDE	Heli	Yes	Yes	75 FRP	75 FRP	75 FRP
21/4	3PDE	Clear & STARR	55 °C	yes	New 3PDE	Heli	Yes	Yes	85 FRP	75 FRP	65 FRP
21/5	H-Frame	Clear & STARR	55 °C	yes	New H-Frame	Heli	Yes	Yes	90 FRP		70 FRP
21/6	H-Frame	Clear & STARR	55 °C	yes	New H-Frame				90		75
21/7	H-Frame	STARR		yes	WC						
21/8	3PMA	STARR		yes	Replace insulators						
22/1	H-Frame	STARR		yes	WC						
22/2	H-Frame	STARR		yes	WC	Heli	Yes				
22/3	3PDE	STARR		yes	New 3PDE	Heli	Yes	Yes	75 FRP	65 FRP	60 FRP
22/4	H-Frame	STARR		yes	WC	Heli	Yes				

22/5	3PDE	STARR		yes	New 3PDE	Heli	Yes	Yes	65 FRP	65 FRP	65 FRP
22/6	H-Frame	STARR		yes	New H-Frame				65		60
22/7	3PDE	STARR		yes	New 3PDE			Yes	70 FRP	70 FRP	70 FRP
22/8	3PMA	STARR		yes	New 3PMA				60	65	70
22/9	3PDE	STARR		yes	New 3PDE			Yes	70 FRP	65 FRP	60 FRP
23/1	H-Frame	STARR		yes	New H-Frame			Yes	90 FRP		90 FRP
23/2	3PDE	STARR		yes	New 3PDE	Heli	Yes	Yes	70 FRP	70 FRP	70 FRP
23/3	H-Frame	Clear & STARR	90 °C	yes	New H-Frame	Heli	Yes	Yes	70 FRP		70 FRP
23/4	H-Frame	STARR		yes	New H-Frame	Heli	Yes	Yes	65 FRP		65 FRP
23/5	H-Frame	STARR		yes	New H-Frame	Heli	Yes	Yes	70 FRP		70 FRP
23/6	3PDE	STARR		yes	New 3PDE	Heli	Yes				
24/1	H-Frame	STARR		yes	New H-Frame	Heli	Yes	Yes	75 FRP		75 FRP
24/2	H-Frame	STARR		yes	WC	Heli	Yes				
24/3	3PMA	Clear & STARR	55 °C	yes	New 3PMA	Heli	Yes	Yes	75 FRP	75 FRP	75 FRP
24/4	H-Frame	Clear.	55 °C	yes	New H-Frame	Heli	Yes	Yes	80 FRP		80 FRP
24/5	H-Frame	STARR		yes	WC	Heli	Yes				
24/6	3PMA	STARR		yes	Replace insulators	Heli	Yes				
25/1	3PDE	STARR		yes	Replace insulators	Heli	Yes				
25/2	H-Frame	STARR		yes	WC	Heli	Yes				
25/3	3PDE	STARR		yes	Replace insulators	Heli	Yes				
25/4	H-Frame	STARR		yes	WC						
25/5	H-Frame	STARR		yes	New H-Frame				70		70
26/1	H-Frame	STARR		yes	New H-Frame				80		80
26/2	3PDE	STARR		yes	Replace insulators						
26/3	H-Frame	STARR		yes	WC						
26/4	3PMA	STARR		yes	Replace insulators						
26/5	H-Frame	STARR		yes	WC						
26/6	3PMA	STARR		yes	Replace insulators						
26/7	H-Frame	STARR		yes	WC						
27/1	3PDE	STARR		yes	Replace insulators						
27/2	H-Frame	STARR		yes	WC	Heli	Yes				

27/3	H-Frame	Clear & STARR	90 °C	yes	New H-Frame	Heli	Yes	Yes	90 FRP		90 FRP
27/4	H-Frame	Clear & STARR	55 °C	yes	New H-Frame	Heli	Yes	Yes	90 FRP		90 FRP
27/5	H-Frame	Clear & STARR	55 °C	yes	New H-Frame	Heli	Yes	Yes	90 FRP		90 FRP
28/1	3PMA	STARR		yes	Replace insulators	Heli	Yes				
28/2	H-Frame	STARR		yes	New H-Frame	Heli	Yes	Yes	70 FRP		70 FRP
28/3	H-Frame	STARR		yes	New H-Frame	Heli	Yes	Yes	80 FRP		80 FRP
28/4	H-Frame	STARR		yes	New H-Frame	Heli	Yes	Yes	75 FRP		75 FRP
28/5	H-Frame	STARR		yes	WC	Heli	Yes				
28/7	3PDE	STARR		yes	Replace insulators						
29/1	H-Frame	Clear.	55 °C	yes	New H-Frame				75		75
29/2	H-Frame	Clear.	55 °C	yes	New H-Frame			Yes	95 FRP		95 FRP
29/5	H-Frame	Clear.	90 °C	no	New H-Frame				70		70
30/2	H-Frame	Clear.	55 °C	yes	New H-Frame				70		70
30/4	H-Frame	Clear.	55 °C	yes	New H-Frame				85		85
30/6	H-Frame	Clear.	90 °C	no	New H-Frame				75		75
31/2	H-Frame	Clear.	90 °C	no	New H-Frame				85		85
31/5	3PMA	STARR		yes	New 3PMA				70	70	70
32/1	3PDE	STARR		yes	New 3PDE				70	65	60
33/2	H-Frame	Clear.	90 °C	no	New H-Frame				80		80
33/3	3PDE	STARR		yes	New 3PDE				75	80	85
33/4	3PDE	STARR		yes	Replace insulators						
34/5	H-Frame	Clear & STARR	55 °C	yes	New H-Frame	Heli	Yes	Yes	70 FRP		80 FRP
35/4	H-Frame	Clear.	90 °C	no	New H-Frame	Heli	Yes	Yes	80 FRP		80 FRP
35/6	H-Frame	Clear.	90 °C	no	New H-Frame	Heli	Yes	Yes	90 FRP		90 FRP
36/4	H-Frame	STARR		yes	WC	Heli	Yes				
36/6	H-Frame	Clear.	90 °C	no	New H-Frame	Heli	Yes	Yes	80 FRP		80 FRP
37/1	H-Frame	Clear & STARR	90 °C	yes	New H-Frame				75		75
37/2	H-Frame	STARR		yes	WC						
37/3	H-Frame	Clear.	55 °C	yes	New H-Frame				75		85
38/1	H-Frame	STARR		yes	New H-Frame				80		80
38/5	H-Frame	Clear.	90 °C	no	New H-Frame	Heli			80		80
39/1	H-Frame	Clear & STARR	90 °C	yes	New H-Frame				75		75
39/3 - 39/4	H-Frame	Clear.	90 °C	no	New H-Frame				80		80

39/5	H-Frame	Clear & STARR	90 °C	yes	New H-Frame				80		80
39/7	H-Frame	STARR		yes	WC						
40/3	H-Frame	Clear & STARR	90 °C	yes	New H-Frame				80		80
40/7	H-Frame	Clear & STARR	90 °C	yes	New H-Frame				80		80
41/1	H-Frame	Clear & STARR	90 °C	yes	New H-Frame				80		80
41/2	H-Frame	STARR		yes	WC						
42/1	H-Frame	Clear.	55 °C	yes	New H-Frame				80		80
42/2	H-Frame	STARR		yes	New H-Frame				75		75
42/2 - 42/3	span	Clear.	90 °C	no	recontour						
42/3 - 42/4	span	Clear.	90 °C	no	recontour						
43/1 - 43/2	span	Clear.	90 °C	no	recontour						
43/5	H-Frame	STARR		yes	New H-Frame			Yes	75 FRP		75 FRP
43/7	3PDE	Clear & STARR	90 °C	yes	New 3PDE				65	65	65
44/5 - 45/1	span	Clear.	55 °C	yes	recontour						
45/5	3PMA	Clear.	90 °C	no	New 3PMA				70	70	70
45/13	H-Frame	Clear.	90 °C	no	New H-Frame				70		70
45/14	H-Frame	STARR		yes	New H-Frame			Yes	65 FRP		65 FRP
45/16	H-Frame	Clear.	90 °C	no	New H-Frame				75		75
45/18	H-Frame	Clear.	55 °C	yes	New H-Frame				70		70

Appendix C
ROS Asset Plan

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Appendix G
Constructability Review

BC Hydro
Power smart

Project Memo

To: Jason Lee, PM

From: Construction Management and Construction Planning

CC: Nate Stevens, Capital Construction
Peter Jung, Project Engineering

Subject: TM 0287 BRTP Constructability Review – Conceptual Phase Memo

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The Bridge River Transmission Project (BRTP) will reinforce the transmission system to ensure generation can be delivered at all times of the year in the Bridge River Area. As the project nears the end of conceptual stage, three alternatives have been considered by the Project Team:

Alternative 1: Upgrade to 90 °C

- Upgrade 2L090 to sustainment level (91 structures)
- Upgrade 2L090 to upgrade level (44 structures)

Alternative 2: Add a 360/230 kV transformer in Rosedale Substation (ROS)

- Upgrade 2L090 to sustainment level (91 structures)
- Replace transformer at ROS

Alternative 3: Curtail IPP generation

Alternative 3 has been excluded from this constructability review.

A side note for consideration by the Project Team is that the existing ROS transformers, which contain Polychlorinated Biphenyl (PCB), are nearing end of life (60 years old) and potentially will require replacement in the near future. An assessment should be completed by Engineering to determine their remaining lifespan and Equipment Health Rating. Depending on the EHR, this could drive Alternative 2 as the leading alternative. Alternative 2 for ROS has three options being considered by the project team. These are:

Option 1:
Install four new transformers, one per phase with one new spare. Relocate 230KV Gantry for new position of existing 2L78. Remove old T1 transformer after new transformer is in service.

Option 2:
Install four new transformers, one per phase with one new spare. Relocate 230KV Gantry for new position of existing 2L78. Extend bus work to connect new T2 with old T1 and keep old T1 on cold stand by.

Option 3:
Install two new single three phase transformers with one in service and one spare. Relocate 230KV Gantry for new position of existing 2L78.

Based on the current information the project team is in favor of the Alternative 1 as being the leading Alternative

Based on the constructability review of BRTP for Alternative 1, completed by Construction Management, the following construction methodology and risks are provided.

1.0 Construction Methodology

In order to complete the works safely, a possible construction methodology is as follows:

1.1 Pre-Outage Works for Work on 2L90 (Alt 1)

In order to limit the amount of works required during the short outage window(s), the Contractor would be required to complete as much pre-works as possible. This would include pre-assembling new structures on the ground, delivering the structures to their respective staging areas, and completing all civil works outside of limits of approach. Engineering would need to factor in the outage constraints into their design and where possible, allow for works to be completed without an outage.

As access and laydown areas are challenging along the majority of the transmission line, substantial prep works should be considered. This would include clearing and preparing work areas/staging areas at strategic locations along the right of way and constructing access to each structure location well in advance of construction contractor mobilizing. Consideration should be given to constructing access roads to all structures as helicopter works may pose an increase risk to the project due to weather constraints and limitations of helicopter flights. Currently, 44 to 56 structures are identified as helicopter access only. All required helicopter pads should be installed during the site prep activities.A detailed schedule (for the duration of the outage window) and planning coordination meeting should be completed prior to each outage to ensure work is coordinated appropriately. The detailed schedule will be submitted by the Contractor and should document work each day and the location where the Contractor will be.

Any pre-outage work should consider limits of approach and may require additional safety oversight.

1.2 Outage Work for Work on 2L90 (Alt 1)

During outages of 2L90, the Contractor would install the new pre-assembled structures via crane/helicopter, install all associated hardware and transfer the conductor from the old structure to the new structure. Where the old structure may pose risk to energization, the Contractor should remove/buck the old structure and leave in place for future removal outside the outage window. This would maximize the productivity during the outage.

As the outage windows are extremely tight, it is expected that the Contractor would crew up and have multiple crews along the transmission line.

Outage work should focus on difficult structure change outs as a priority

1.3 Post-Outage Work for Work on 2L90 (Alt 1)

As the outages are extremely tight, it would be expected that the Contractor would complete all removal works post outage and ensure the area is safe prior to demobilizing from the area.

1.4 Live Line Work

Although outages are preferred from a safety perspective, some live line work is possible. Any live line work is required to be carefully planned. . If live line work is required, the Contractor would temporarily lift the conductor using a crane and construct the new structure. Live line procedures could also be used at locations where cross arm and/or insulator change outs are required.

All live line work should be reviewed by BCH Work Methods.

1.5 General Construction Methodology Recommendation

While upgrading 2L090, existing structures on 2L091 can be used as a temporary by-pass. This is a preferred method to safely complete the work on 2L090. A structure assessment would need to be completed on 2L091 existing structures to ensure they are structurally sound to allow this. If temporary by-passes are allowed, the Contractor would complete these in sections and would return the line to its original position once the upgrade work is completed in that section.

2.0 Construction Risk

2.1 Outage Availability on 2L090

Due to system reliability obtaining outages on 2L090 are challenging. Limited outages are available for this work; 3 weeks in April with the possibility of an additional outage in Oct / Nov.

Response:

With the limited outage window each year, construction of either alternative would require all clearing, access, road building, heli pads, and permits to be inplace before the year before line construction work to commence. Alternative 2 may provide an advantage of extending the outage window if the line work is completed after the transformer is replaced at ROS.

2.2 Construction Access – Helicopter

Due to the terrain in the area, access for up to 56 structures has been identified as helicopter access. Helicopter access poses an increase safety and construction risk. Construction works requiring the use of a helicopter should be performed under outage conditions.

Response:

It is recommended to have access roads constructed to as many existing helicopter sites as possible. Where this is not possible, the use of tracked vehicles and expanded work areas may be a possibility and should be explored. Clarification is required for helicopter sites that are located in close proximity to road access sites as shown on the current drawings.

Alternative 2 requires less access to structures along the right of way and in particular to those structures where helicopter access has been identified. Therefore, the risk to access is reduced for Alternative 2.

2.3 Construction Access – Existing

Due to the requirement to upgrade existing or construct new access roads, environmental, archeological and engineering risks need to be identified. Existing road infrastructures may not be suitable for larger construction vehicle traffic.

Response:

Field assessments should be completed by Environment, Archeology, Engineering and Construction to determine the risk of the design.

As Alternative 2 requires less road upgrades and new construction, the risk of encounter is reduced compared to Alternative 1. However, this should be confirmed through detailed field studies.

2.4 Schedule

There is a risk that any schedule delay may cause an overall impact to the ISD due to the tight outage window and substantial amount of work required.

Response:

Detail construction requirements shall be included in the contract and milestones should be clearly stated. In addition, the minimum number of crews should be determined and included in the contract. If prep works, including clearing and access can be completed in DEF, phase, this would allow for the utilization of the first outage in April 2022 once IMP starts.

Both alternatives have schedule risk that should be considered and will be managed as the project progresses.

The following outlines a high level timeline for construction activities associated with line work:

For scheduling purposes the productivity rates below can be assumed using 1 crew per structure change.

Helicopter access only: Change-out rate of 1 structure per day.
Drive in access: Change-out rate average of 1 – 1.25 structures per day. Adjacent structure installation may allow for 2 structures per day.

Assuming 120 structures (sustainment work): 56 helicopter access only, 64 drive in access.

It is anticipated to take the following durations:
1 crew

- 56 days to complete helicopter access structure work,
- 51days to complete drive in access structures

2 crew

- 28 days to complete helicopter access structure work,
- 25.5 days to complete drive in access structures

More crews decreases time accordingly.

The use of multiple crews will be expect on this work with helicopter work and drive in access work being completed in parallel.

First year 2022:

- Complete all access road refurbishment works, vegetation management and other non T/L electrical works in preparation for the line upgrade work.
- Complete all helicopter pad clearing and pad installations
- Prep Laydown areas for following years work.
- Procure and long lead items.

Second Year 2023:

- Complete as many helicopter structure replacements during the April line outage as weather permits. Assume 1 structure per day per crew, can utilize 3-4heli crews to meet outage window, possible 4 fronts of construction.
- Complete difficult road access structure replacements during April outage
- All remaining road accessible structure replacement work can be completed during summer months when dry conditions permit using live line methods.
- Complete balance of helicopter only sites during the Oct/Nov outage window should this be required. Complete helicopter only removals.
- Removals of old structures should be ongoing through out construction duration from first outage to end of Oct.

- BRT and KLY station upgade work to align with outages.

Third Year 2024:

- Utilize Aprill line outage to complete any outstanding structures replacements.
- Complete any outstanding deficiencies and removals.

Fourth Year 2025:

- Schedule contingency to account for limited outage durations, adverse weather conditions, wildfire and bird nesting seasons wich may limit the amount of line work completed in years 2 and 3.

2.5 Investigative and Construction Access

Access to the right of way is currently being denied for investigative and work purposes due to First Nations sensitivities. Due to this, desktop exercises are being performed only. If access to our ROW is not resolved then this could delay activities in the Feasibility Stage.

Response:

The project team will seek to engage the respective stakeholders and obtain access. Investigative works to be planned for summer of 2019.If access is not permitted, both alternatives would be at risk as the scope will have uncertainties

2.6 Lost Productivity / Opportunity

With both options having substantial time gaps between outages, there will be lost productivity or inefficiencies due to remobilizations and re-submissions of works.

Response:

The project should consider other methodologies to allow for a continuous build and reduce the reliance on outages. If this is not possible, engineering should design the works such that work can be completed outside of outages as much as possible.

Alternative 2, if an extended outage is allowed after the completion of ROS works, would be preferred due to increased continuity of works allowed onsite.

2.7 Substation Line Interconnections KLY/BRT

It was noticed during the June 25, 2019 site visit that upgrades to both the KLY and BRT substations electrical equipment for both line connections may be required due to the age of the equipment and possible under capacity of the bus/equipment (BRT). Team found current revision of drawings at KLY were not reflective of actual site layout. It was noticed that a significant section of connecting equipment inside the station after line gantry for 2L91 at KLY has been removed.

Response:

The Project Team should engage engineering to update the drawings for KLY 230KV layout, review bus/equipment capacity requirements, and age of equipment for BRT.

Link to photos below from June 25, 2019 site visit:

KLY/BRT June 25, 2019 Site Visit Pics

3.0 Proposed Recommended Alternative

Through a review of the project, a fourth alternative, referred to as Alternative 1B, is being recommended by Construction Management (CCM), which is a viable variation to Alternative 1.

Alternative 1B: Bridge 2L090 and 2L091

- Rebuild 2L091 to achieve project requirements
- Re-terminate and re-name 2L091 to 2L090.

A detailed survey of the existing structures on 2L091 would be required to determine the scope of work required for Alternative 1B. It is recommended that a detailed survey be completed regardless of the alternative chosen and therefore Alternative 1B should also be considered. Alternative 1B would provide substantial benefits as upgrades to the existing 2L091 can be done on the de-energized circuit with a single outage for the final line cutover. This methodology would be substantially safer than the line work for both Alt 1 and 2. There would also be substantial schedule improvements as the work on the existing 2L091 circuit could be planned over a single build period.

4.0 Summary

After a review of the project, limited outage duration and availability appears to be the main risk from a constructability perspective for the line work of Alternative 1. With an annual three week outage window in April and a potential additional outage in Oct / Nov, the construction of either alternative will be challenging and nearly impossible to have a continuous construction build. Therefore, there would be a loss in productivity due to the start and restart of construction at each outage. This could potentially increase the cost of the project while increasing the schedule risk. Any helicopter work in the short outage windows also poses a risk of schedule delay.

As the right of way is currently acquired for two 230 kV transmission lines with only one transmission line in service, there is a potential to utilize the extra space and abandoned structures to optimize the construction. However, a detailed assessment and field survey will be required for the abandoned transmission line.

Based on the alternative proposed, Alternative 1 and 2, the constructability of Alternative 2 appears to provide advantages compared to alternative 1. However, consideration should be given to Alternative 1B, which has been proposed by CCM, and is the preferred alternative from a constructability and safety stand point.

As the project progresses, the next steps that should be considered are as follows:

- Completion of all field assessments/investigations along the right of way including engineering assessment of existing structures and access, detail archeological studies, environmental studies, and construction assessment from a constructability standpoint.

- Additional geotechnical investigations along the right of way, if required.

- Follow up conversations with FVO to determine outage availability for each alternative and requirements for each outage.

- Re-assessment of the schedule to determine timeline based on construction. Complete a high level construction schedule based on known outages.

Appendix H
Cost Estimate

Engineering Memorandum

Inter-Office Memo

TO:	Jason Lee	**DATE:**	2020-08-14
FROM:	Man Hin Lo	**PROJECT #:** **TES #:**	TM0287-0145-C200 TES21020
SUBJECT:	Bridge River Transmission Project (BRTP) – Conceptual Estimates **(Not for Funding)**		

As requested, please find the Conceptual estimates for the Bridge River Transmission Project (BRTP). This is a transmission reinforcement project for Bridge River Area. Included are the synopsis and cash flows. The purpose of this document is to provide cost estimates for the three alternatives.

Alternative 1 – Upgrade 2L090 to 90˚C Operation and Address All Reliability Related Defects

- Replace ninety-eight 2L090 overhead structures,
- Address deficiencies recorded in the System for Transmission Asset Recording & Reporting (STARR) for approximately thirty-three 2L090 structures,
- Uprate 2L090 to operate at 90˚C ambient,
- Refurbish Transformer T1 at ROS **(excluded from this estimate)**

Alternative 2: Address All Reliability Related Defects for 2L090 and Increase Rosedale Substation (ROS) Transformer Capacity to 600MVA

- Replace seventy-six 2L090 overhead structures,
- Address STARR deficiencies for approximately thirty-three 2L090 structures,
- Continue to operate 2L090 at 55˚C ambient,
- BCUC application required,
- To add transformer capacity at ROS, there are three options:
  - Option A: Replace existing T1 with new T2 (single phase transformers),
  - Option B: Add T2 (single phase transformers), refurbish and retain existing T1 transformers as cold standby transformer,
  - Option C: Replace existing T1 with new T2 (three phase transformer)

Alternative 3: Curtailment of IPP Generation and Address All Reliability Related Defects for 2L090

- Replace seventy-six 2L090 overhead structures,
- Address STARR deficiencies for approximately thirty-three 2L090 structures,
- Continue to operate 2L090 at 55˚C ambient,
- Implement IPP Generation curtailment scheme **(excluded from this estimate)**

The project team has identified Alternative 1 as the leading alternative through Structured Decision Making (SDM). 2L090 is a strategically important transmission path and it provides needed operation flexibility for the Bridge River power system; the total costs, on a present value basis, for Alternative 1 are superior to the other alternatives.

The project costs are summarized in the following tables.

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Alternative 1 – Upgrade 2L090 to 90˚C Operation and Address All Reliability Related Defects

Description	2L090 ($ M)	STARR Defects ($ M)
Needs (OMA) (Actuals)	0.1	-
Conceptual Stage Cost (OMA) – EAC	0.8	-
Feasibility Stage Cost	2.0	-
DEF Phase Cost	2.8	-
IMP Phase Cost	29.3	9.8
Subtotal Project Cost (Without Contingency)	**34.9**	**9.8**
Feasibility Contingency (10%)	0.2	-
Definition Contingency (20%)	0.6	-
IMP Contingency (25%)	9.0	2.5
Subtotal Project Cost (With Contingency)	**44.8**	**12.2**
Inflation	3.2	0.7
Subtotal Inflated Project Cost (With Contingency)	**48.0**	**12.9**
COH (Capital Overhead)	2.2	-
IDC (Interest During Construction)	3.0	-
Alternative 1 Total Project Cost (Loaded) (+100%/-35%)	**53.3**	**12.9**
	66.2	
	43 ~ 132	

In-Service Date (ISD): 2025-10-30

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Alternative 2: Address All Reliability Related Defects for 2L090 and Increase Rosedale Substation (ROS) Transformer Capacity to 600MVA – Option A

Description	2L090 ($ M)	STARR Defects ($ M)	ROS ($ M)
Needs (OMA) (Actuals)	0.1	-	-
Conceptual Stage Cost (OMA) – EAC	0.8	-	-
Feasibility Stage Cost	2.0	-	1.3
DEF Phase Cost	2.5	-	2.3[1]
IMP Phase Cost	24.6	9.4	35.9
Subtotal Project Cost (Without Contingency)	**29.9**	**9.4**	**39.4**
Feasibility Contingency (10%)	0.2	-	0.1
Definition Contingency (20%)	0.5	-	0.5
IMP Contingency (25% for 2L090 & STARR, 20% for ROS)	6.1	2.4	7.2
Subtotal Project Cost (With Contingency)	**36.8**	**11.8**	**47.2**
Inflation	3.8	0.8	4.2
Subtotal Inflated Project Cost (With Contingency)	**40.7**	**12.6**	**51.4**
COH (Capital Overhead)	2.0	-	2.5
IDC (Interest During Construction)	2.5	-	3.7
Alternative 2 Option A Total Project Cost (Loaded) (+100%/-35%)	**45.3**	**12.6**	**57.5**
	115.4		
	75 ~ 231		
Note: [1]BCUC regulatory cost included under ROS			

In-Service Date (ISD): 2026-10-30

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Engineering Memorandum

Alternative 2: Address All Reliability Related Defects for 2L090 and Increase Rosedale Substation (ROS) Transformer Capacity to 600MVA – Option B

Description	2L090 ($ M)	STARR Defects ($ M)	ROS ($ M)
Needs (OMA) (Actuals)	0.1	-	-
Conceptual Stage Cost (OMA) – EAC	0.8	-	-
Feasibility Stage Cost	2.0	-	1.1
DEF Phase Cost	2.5	-	2.3[1]
IMP Phase Cost	24.6	9.4	37.1
Subtotal Project Cost (Without Contingency)	**29.9**	**9.4**	**40.5**
Feasibility Contingency (10%)	0.2	-	0.1
Definition Contingency (20%)	0.5	-	0.5
IMP Contingency (25% for 2L090 & STARR, 20% for ROS)	6.1	2.4	7.4
Subtotal Project Cost (With Contingency)	**36.8**	**11.8**	**48.5**
Inflation	3.8	0.8	4.3
Subtotal Inflated Project Cost (With Contingency)	**40.7**	**12.6**	**52.8**
COH (Capital Overhead)	2.0	-	2.7
IDC (Interest During Construction)	2.5	-	3.8
Alternative 2 Option B Total Project Cost (Loaded) (+100%/-35%)	**45.3**	**12.6**	**59.3**
	117.2		
	76 ~ 234		
Note: [1]BCUC regulatory cost included under ROS			

In-Service Date (ISD): 2026-10-30

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Engineering Memorandum

Alternative 2: Address All Reliability Related Defects for 2L090 and Increase Rosedale Substation (ROS) Transformer Capacity to 600MVA – Option C

Description	2L090 ($ M)	STARR Defects ($ M)	ROS ($ M)
Needs (OMA) (Actuals)	0.1	-	-
Conceptual Stage Cost (OMA) – EAC	0.8	-	-
Feasibility Stage Cost	2.0	-	1.1
DEF Phase Cost	2.5	-	2.1[1]
IMP Phase Cost	24.6	9.4	29.1
Subtotal Project Cost (Without Contingency)	**29.9**	**9.4**	**32.3**
Feasibility Contingency (10%)	0.2	-	0.1
Definition Contingency (20%)	0.5	-	0.4
IMP Contingency (25% for 2L090 & STARR, 20% for ROS)	6.1	2.4	5.8
Subtotal Project Cost (With Contingency)	**36.8**	**11.8**	**38.6**
Inflation	3.8	0.8	3.4
Subtotal Inflated Project Cost (With Contingency)	**40.7**	**12.6**	**42.0**
COH (Capital Overhead)	2.0	-	2.1
IDC (Interest During Construction)	2.5	-	3.0
Alternative 2 Option C Total Project Cost (Loaded) (+100%/-35%)	**45.3**	**12.6**	**47.1**
	105.0		
	68 ~ 210		
Note: [1]BCUC regulatory cost included under ROS			

In-Service Date (ISD): 2026-10-30

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Alternative 3: Curtailment of IPP Generation and Address All Reliability Related Defects (Curtailment Cost Excluded)

Description	2L090 ($ M)	STARR Defects ($ M)
Needs (OMA) (Actuals)	0.1	-
Conceptual Stage Cost (OMA) – EAC	0.8	-
Feasibility Stage Cost	2.0	-
DEF Phase Cost	2.5	-
IMP Phase Cost	24.0	9.4
Subtotal Project Cost (Without Contingency)	**29.3**	**9.4**
Feasibility Contingency (10%)	0.2	-
Definition Contingency (20%)	0.5	-
IMP Contingency (25%)	7.4	2.4
Subtotal Project Cost (With Contingency)	**37.5**	**11.8**
Inflation	2.7	0.8
Subtotal Inflated Project Cost (With Contingency)	**40.2**	**12.6**
COH (Capital Overhead)	1.9	-
IDC (Interest During Construction)	2.4	-
Alternative 3	**44.5**	**12.6**
Total Project Cost (Loaded)	**57.1**	
(+100%/-35%)	**37 ~ 114**	

In-Service Date (ISD): 2025-10-30

These estimates are based on the draft Conceptual Design Report.

Exclusions

The estimate excludes:

- GST
- Book value of decommissioned equipment
- Outage costs (loss of revenue)
- Circuit 2L091 related removal work
- Existing T1 foundation removal at ROS
- Refurbishment of T1 at ROS for Alternative 1 (by Stations Asset Sustainment Group)
- Cost related to implementation of an IPP Generation Curtailment Scheme for Alternative 3

Assumptions

The following key assumptions were used to prepare these estimates:

- Certificate of Public Convenience and Necessity (CPCN) application is required for Alternative 2.

2L090:

- Outages can be obtained during April.
- 2L091 runs parallel to 2L090 but is currently de-energized. Existing structures on 2L091 may be used as a temporary by-pass while completing work on 2L090; conditions of 2L091 structures are assumed to be adequate for temporary use. No costs have been included to repair or upgrade the line or structures on 2L091.

ROS:
- Control building expansion is not required at ROS and the existing control building will not be retrofitted to current seismic standard.
- Ground improvements required for new foundations; 30% area replacement for deep soil mixing.

Risks

Assigned contingencies account for the uncertainties and risks identified. The risks on this project are as follows:

2L090:
- Obtaining and planning outages to complete the work.
- Steel poles maybe required for some structures.
- Existing conductor condition is worse than anticipated and may require replacement.
- Condition of the line may have further deteriorated since the STARR data was collected.

ROS:
- Lack of competitive bids or qualified contractors.
- Transformers will be purchased under non-blanket contract orders and prices can be higher than anticipated.
- Obtaining and planning outages.

Details of the basis of the estimate appear in the attached Cost Estimate Synopsis.

Inflation, Capital Overhead and Interest During Construction were developed using the Transmission Estimating team's loading calculator.

Please indicate your acceptance of the Cost Estimate Synopsis by signing the synopsis.

Man Hin Lo

Prepared by Man Hin Lo

Attachments
- Cost estimate summaries, details and cashflows
- Risk register
- One line diagram

cc: Dale Bromley, P&C/Telecom Division Manager
Denis Clement, Station Division Manager
Laura Erven, Transmission Division Manager

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Cost Estimate Synopsis

Project Title:	Bridge River Transmission Project (BRTP)		
Project Number:	TM-0287	**Project Manager:**	Jason Lee

Description

Project Classification: Identification Phase
Study Type: Conceptual Estimate (AACE Class 5)

Amount of Estimate

	Alt. 1 ($ M)	Alt. 2 Opt. A ($ M)	Alt. 2 Opt. B ($ M)	Alt. 2 Opt. C ($ M)	Atl. 3 ($ M)
Expected amount (loaded):	66.2	115.4	117.2	105.0	57.1

Exclusions

The estimate excludes:

- GST
- Book value of decommissioned equipment
- Outage costs (loss of revenue)
- Circuit 2L091 related removal work
- Existing T1 foundation removal at ROS
- Refurbishment of T1 at ROS for Alternative 1 (by Stations Asset Sustainment Group)
- Cost related to implementation of an IPP Generation Curtailment Scheme for Alternative 3

Estimating Review

Prepared by:	Man Hin Lo Man Hin Lo, P.Eng., Estimator	August 14, 2020 Date
Reviewed by:	Qaiser Iqbal, P.Eng., Transmission Estimating Team Lead	August 14, 2020 Date
Reviewed by:	Kevin Tong, P.Eng., Lead Estimator	14 Aug 2020 Date
Reviewed by:	Christa Groves Christa Groves, P.Eng., Estimating & Project Engineering Division Manager	August 14, 2020 Date
Reviewed by:	Shari Carlaw, P.Eng., Director, Engineering Services	17 Aug 2020 Date
Accepted by:	Jason Lee, P.Eng., Project Manager	August 20, 2020 Date

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Cost Estimate Synopsis

1 Basis of Estimate

The purpose of this estimate is to provide a Conceptual estimate for Feasibility design stage funding.

The accuracy range of the estimates is assessed at +100%/-35%.

Reference documents on PPM site:

- ScopeNotes 3286 R18 as of October 8, 2019
- Statement of Objective (SOO) Rev. 2 – Dated April 27, 2020
- User Requirements – Dated May 25, 2018
- Draft Conceptual Design Report – Accessed on August 14, 2020
- Draft Feasibility Stage Design Basis – Accessed on August 14, 2020
- Geotechnical Assessment for Upcoming FEAS Phase (Draft) – Dated January 15, 2019
- 2L090 Scope of Work Breakdown
- 2L090 Project Scope Maps
- Vegetation & Access Management Estimate – Prepared by Chartwell on March 14, 2019
- Constructability Memo for Alternative 1 – Accessed on July 24, 2020

2 Project Scope

The Bridge River area transmission system is restricted in the summer months and cannot operate at the desirable rating. The objective of this project is to address the 2L090 rating defects, maintain operational reliability and increase the transfer capacity of the Bridge River Transmission System to the Bridge River area.

There are three alternatives to this project:

Alt. 1: Upgrade 2L090 to 90˚C Operation and Address All Reliability Related Defects

The objective for this alternative is to replace 98 overhead structures and address deficiencies for 33 structures for the defects recorded in STARR (System for Transmission Asset Recording & Reporting) such that the line can be uprated to operate at 90˚C ambient with no clearance violations.

Scope of Work for 2L090

Site Access Scope of Work:

- Upgrade ~63km of existing access roads.
- Construct ~7km of new access roads.

Work Related to Addressing Clearance Violations for 90˚C Operating Requirements:

- Re-contouring four (4) circuit spans.
- Replace 64 structures:
    - Supply and install 21 H-frame fibre reinforced plastic (FRP) structures,
    - Supply and install 31 H-frame wood pole structures,
    - Supply and install one (1) 3-pole medium angle FRP structure,
    - Supply and install two (2) 3-pole medium angle wood structures,
    - Supply and install three (3) 3-pole dead end FRP structures,
    - Supply and install six (6) 3-pole dead end wood structures,
- Reinstall conductor.

Work Related to Addressing STARR Defects:

- Replace 34 structures:
  - Supply and install 13 H-frame fibre reinforced plastic (FRP) structures,
  - Supply and install seven (7) H-frame wood pole structures,
  - Supply and install two (2) 3-pole medium angle wood structures,
  - Supply and install eight (8) 3-pole dead end FRP structures,
  - Supply and install four (4) 3-pole dead end wood structures,
- Address STARR defects by replacing crossarms, cross braces, insulators, guy anchors or guy guards for 33 structures.
- Reinstall conductor.

Alt. 2: Address All Reliability Related Defects for 2L090 and Increase Rosedale Substation (ROS) Transformer Capacity to 600MVA

The objective for this alternative is to restore 2L090 to its full operating temperature of 55˚C ambient and to increase transformer capacity from 450MVA to 600MVA at ROS. There are three options for the transformer capacity increase at ROS:

- Option A – Replace existing T1 with new T2 (single phase transformers)
- Option B – Add T2 (single phase transformers) and retain the existing T1 as a cold standby transformer
- Option C – Replace existing T1 with new T2 (three phase transformer)

Options A, B and C share the same 2L090 restoration scope; 2L090 will involve replacing 76 structures and addressing STARR defects for 33 structures. BCUC application will be required for Alternative 2.

Scope of Work for 2L090 Restoration for Options A, B & C

Site Access Scope of Work:

- Upgrade ~63km of existing access roads.
- Construct ~7km of new access roads.

Work Related to Addressing Clearance Violations:

- Re-contouring one (1) circuit span.
- Replace 42 structures:
  - Supply and install 14 H-frame fibre reinforced plastic (FRP) structures,
  - Supply and install 20 H-frame wood pole structures,
  - Supply and install one (1) 3-pole medium angle FRP structure,
  - Supply and install one (1) 3-pole medium angle wood structures,
  - Supply and install two (2) 3-pole dead end FRP structures,
  - Supply and install four (4) 3-pole dead end wood structures,
- Reinstall conductor.

Work Related to Addressing STARR Defects:

- Replace 34 structures:
  - Supply and install 13 H-frame fibre reinforced plastic (FRP) structures,
  - Supply and install seven (7) H-frame wood pole structures,
  - Supply and install two (2) 3-pole medium angle wood structures,
  - Supply and install eight (8) 3-pole dead end FRP structures,
  - Supply and install four (4) 3-pole dead end wood structures,

- Address STARR defects by replacing crossarms, cross braces, insulators, guy anchors or guy guards for 33 structures.
- Reinstall conductor.

Scope of Work at ROS: Option A – Replace existing T1 with new T2 (single phase transformers)

- Ground improvement using Deep Soil Mixing (DSM) to 20m depths around the footprint of the new transformers (T2).
- Supply and install new transformers foundation, firewalls and oil containment system.
- Supply and install one (1) 230 kV gantry structure.
- Supply and install one (1) 230 kV overhead structure outside ROS.
- Supply and install four (4) single phase 360/230 kV, 200 MVA auto-transformers (one of the transformers will be a spare transformer kept on site).
- Relocate circuit breaker 3CB1 and rename as 3CB4.
- Supply and install one (1) 360 kV manually operated disconnect switch (2000A), one (1) 360 kV motor operated disconnect switch (1600A) and associated buswork (2000A).
- Relocate 3SAB3 and rename as 3SAB4.
- Supply and install a 230 kV motor operated disconnect switch (2000A) and associated buswork (3000A).
- Supply and install a 230 kV line terminal tower and re-terminate 2L78.
- Supply and install one (1) set of 360 kV surge arresters, one (1) set of 230 kV surge arresters and one (1) set of capacitive voltage transformers.
- Supply and install one (1) station service transformer, one (1) set of 12 kV voltage transformers, one (1) set of 12 kV surge arresters, one (1) 12 kV manual disconnect switch and associated buswork and connection cables.
- Supply and install power cables and buswork for T2 transformer tertiary connections.
- Supply and install P&C, SCADA and telecom equipment for T2.
- Remove the existing T1 and associated equipment, buswork and 2L78 tower.

Scope of Work at ROS: Option B – Add T2 (single phase transformers) and keep the existing T1 as a cold standby transformer

- Ground improvement using Deep Soil Mixing (DSM) to 20m depths around the footprint of the new transformers (T2).
- Supply and install new transformers foundation, firewalls and oil containment system.
- Supply and install one (1) 230 kV gantry structure.
- Supply and install one (1) 230 kV overhead structure outside ROS.
- Supply and install four (4) single phase 360/230 kV, 200 MVA auto-transformers (one of the transformers will be a spare transformer kept on site).
- Supply and install one (1) 360 kV circuit breaker (2000A) and one (1) 360 kV disconnect switch (2000A).
- Supply and install one (1) 360 kV motor operated disconnect switch (1600A).
- Supply and install one (1) 230 kV a motor operated disconnect switch (2000A).
- Supply and install 360 kV buswork (2000A) and 230 kV buswork (3000A).
- Relocate 3SAB3 and rename as 3SAB4;
- Supply and install one (1) set of 360 kV surge arresters and one (1) set of 230 kV surge arresters.
- Relocate 2CVT1 to common bus.

- Supply and install one (1) station service transformer, one (1) set of 12 kV voltage transformers, one (1) set of 12 kV surge arresters, one (1) 12 kV manual disconnect switch and associated buswork and connection cables.
- Relocate one (1) single phase T1 spare transformer to a new foundation with oil containment pit, refurbish three (3) single phase T1 transformers in their existing locations.
- Supply and install power cables and buswork for T2 transformer tertiary connections.
- Supply and install P&C, SCADA and telecom equipment for T2.
- Remove 12SA1 and 12VTT1 after commissioning of T2, remove other tertiary equipment of T1.

Scope of Work at ROS: Option C – Replace existing T1 with new T2 (three phase transformer)

- Ground improvement using Deep Soil Mixing (DSM) to 20m depths around the footprint of the new transformers (T2).
- Supply and install new transformers foundation and oil containment system.
- Supply and install one (1) 230 kV gantry structure.
- Supply and install one (1) 230 kV overhead structure outside ROS.
- Supply and install two (2) three phase 360/230 kV, 600 MVA auto-transformers (one of the transformers will be a spare transformer kept on site).
- Relocate circuit breaker 3CB1 and rename as 3CB4.
- Supply and install one (1) 360 kV manually operated disconnect switch (2000A), one (1) 360 kV motor operated disconnect switch (1600A) and associated buswork (2000A).
- Relocate 3SAB3 and rename as 3SAB4.
- Supply and install a 230 kV motor operated disconnect switch (2000A) and associated buswork (3000A).
- Supply and install a 230 kV line terminal tower and re-terminate 2L78.
- Supply and install one (1) set of 360 kV surge arresters, one (1) set of 230 kV surge arresters and one (1) set of capacitive voltage transformers.
- Supply and install one (1) station service transformer, one (1) set of 12 kV voltage transformers, one (1) set of 12 kV surge arresters, one (1) 12 kV manual disconnect switch and associated buswork and connection cables.
- Supply and install P&C, SCADA and telecom equipment for T2.
- Remove the existing T1 and associated equipment, buswork and 2L78 tower.

Alt. 3: Curtailment of IPP Generation and Address All Reliability Related Defects for 2L090
This alternative has two components: generation and transmission. The generation scope involves reducing generation from IPPs [redacted]
The work pertaining to IPP generation curtailment is outside of this project scope and the costs are excluded in this estimate.

The transmission scope for Alternative 3 is the same as the Alternative 2 2L090 refurbishment scope to maintain operation at 55˚C ambient, as outlined below:

Site Access Scope of Work:
- Upgrade ~63km of existing access roads.
- Construct ~7km of new access roads.

Work Related to Addressing Clearance Violations:
- Re-contouring one (1) circuit span.

- Replace 42 structures:
  - Supply and install 14 H-frame fibre reinforced plastic (FRP) structures,
  - Supply and install 20 H-frame wood pole structures,
  - Supply and install one (1) 3-pole medium angle FRP structure,
  - Supply and install one (1) 3-pole medium angle wood structures,
  - Supply and install two (2) 3-pole dead end FRP structures,
  - Supply and install four (4) 3-pole dead end wood structures,
- Reinstall conductor.

Work Related to Addressing STARR Defects:

- Replace 34 structures:
  - Supply and install 13 H-frame fibre reinforced plastic (FRP) structures,
  - Supply and install seven (7) H-frame wood pole structures,
  - Supply and install two (2) 3-pole medium angle wood structures,
  - Supply and install eight (8) 3-pole dead end FRP structures,
  - Supply and install four (4) 3-pole dead end wood structures,
- Address STARR defects by replacing crossarms, cross braces, insulators, guy anchors or guy guards for 33 structures.
- Reinstall conductor.

3 Design Information

The design and specification are based on the Conceptual Design Report.

4 Supply Chain Strategy

The Supply Chain Strategy will be developed in the upcoming project phase. Based on preliminary discussions with Indigenous Procurement team, there is an opportunity for Indigenous Directed Procurement. The following has been assumed for the estimate:

Equipment and Materials

Alternatives 1 and 3

- FRP Poles: Blanket Order
- Wood Poles: Blanket Order

Alternative 2

- FRP Poles: Blanket Order
- Wood Poles: Blanket Order
- Transformers: Public RFx
- Protection & Control (P&C) Panels: Blanket Order

Construction

Alternatives 1 and 3

- Vegetation Clearing: Public RFx / First Nations Award (Indigenous Directed Procurement Opportunity)
- 230 kV Transmission Line Construction: Public RFx / First Nations Award (Indigenous Directed Procurement Opportunity)

Alternative 2

- Vegetation Clearing: Public RFx / First Nations Award (Indigenous Directed Procurement Opportunity)
- 230 kV Transmission Line Construction: Public RFx / First Nations Award (Indigenous Directed Procurement Opportunity)
- Substation Construction: Public RFx

Other

Alternatives 1 and 3

- Project Management: BCH
- Engineering: ESP
- Construction and Contract Management: BCH

Alternative 2

- Project Management: BCH
- Engineering: ESP
- Construction and Contract Management: BCH
- Site Engineering and Acceptance: BCH
- Communication, Protection and Control (CPC) Technologist: BCH

5 Assumptions

The estimate is based on these assumptions:

Engineering & Project Management Assumptions

- Partial IMP will be required to ensure construction may start in April 2023.

Specific Work Assumptions

2L090 Specific (Alternatives 1, 2 & 3):

- Outages can be obtained during April.
- 2L091 runs parallel to 2L090 but is currently de-energized. Existing structures on 2L091 may be used as a temporary by-pass while completing work on 2L090; conditions of 2L091 structures are assumed to be adequate for temporary use. No costs have been included to repair or upgrade the line or structures on 2L091.
- New pole structures will be supported by guy anchors, the assumption is 50% of the guy anchors will be installed in rock, and 50% of the guy anchors will be buried in earth.
- Construction schedule is derived from the following assumed productivity rates:
    - Helicopter access only structures: change out rate of 1 structure per day,
    - Drive in accessible structures: change out rate of 1.25 structures per day.
- Construction will be completed over 3 years:
    - First construction season in 2022: complete all access road refurbishments, vegetation clearing and helicopter accessible structure replacement,
    - Second construction season in 2023: helicopter accessible and drive in accessible structure replacements,
    - Third construction season in 2024: complete removals,
    - Current schedule includes 2025 for schedule contingency.

ROS Specific (Alternative 2):

- Control building expansion is not required at ROS and the existing control building will not be retrofitted to current seismic standard.
- Ground improvements required for new foundations; 30% area replacement for deep soil mixing.
- Certificate of Public Convenience and Necessity (CPCN) application is required.

6 Basis of Quantities

Item breakdowns and quantities are based on 2L090 Scope of Work Breakdown:
.

Major quantities include:

Description	Unit of Measure	Quantities				
		Alt. 1	Alt. 2 Opt. A	Alt. 2 Opt. B	Alt. 2 Opt. C	Alt. 3
FRP Poles	EA	104	87	87	87	87
Wood Poles	EA	118	84	84	84	84
Single phase 360/230 kV, 200 MVA Transformer	EA	0	4	4	0	0
Three phase 360/230 kV, 600 MVA Transformer	EA	0	0	0	2	0
360 kV Circuit Breaker	EA	0	0	1	0	0
360 kV Disconnect Switch	EA	0	2	2	2	0
230 kV Disconnect Switch	EA	0	1	1	1	0
360 kV Surge Arrester	SET	0	1	1	1	0
230 kV Surge Arrester	SET	0	1	1	1	0
230 kV CVT	SET	0	1	0	1	0

7 Basis of Direct Construction Cost Estimates

Estimated costs are in August 2020 constant dollars before the application of inflation.

The direct construction cost estimate is based on:

- Historical data – Installation rates from TY-0485 2L13 & 2L14 Replacement & TY-0508 60L021 Structure Replacement, ESP engineering from TM-0155 Telkwa Relocation
- Information from the project team
- Estimator's judgement

- Blanket orders

Operation Cost Estimates
The construction cost estimates include costs for site resources/field operations, training and safety coordination.

8 Basis of General Construction Requirements and Indirect Cost Estimates

Feasibility phase management and engineering costs are based on historical cost percentages / work package agreements. Definition and Implementation phase costs are based on historical cost percentages.

Alternative 1 - Cost Category	Percentage of Total Direct Construction Costs excluding General Construction Requirements		
	Feasibility	Definition	Implementation
General Construction Requirements	0.0%	0.1%	12.2%
Site Operations / Supports	0.0%	0.0%	3.7%
Site Engineering & Acceptance (SEA) / Testing and Commissioning	0.0%	0.0%	0.4%
Contract Management	0.0%	0.0%	1.0%
Environmental monitoring (during construction)	0.0%	0.0%	3.3%
Other Site Specific Requirements by BCH (such as site security, safety instructor, first aid, ETV, project firefighting, etc.)	0.0%	0.1%	3.8%
Construction Management	0.8%	0.8%	5.9%
Project Management	0.7%	1.0%	2.7%
Design Management	3.1%	4.7%	8.2%
Internal (including Contingent Labour Resource Augmentation)	1.1%	1.0%	1.9%
External Service Provider	2.0%	3.7%	6.3%
Procurement / QM Management	0.0%	0.5%	2.0%
Others (Environmental, Safety, Indigenous Relation)	1.9%	2.2%	6.4%

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Cost Estimate Synopsis

Alternative 2A - Cost Category	Percentage of Total Direct Construction Costs excluding General Construction Requirements		
	Feasibility	Definition	Implementation
General Construction Requirements	0.0%	0.1%	9.2%
Site Operations / Supports	0.0%	0.0%	2.7%
Site Engineering & Acceptance (SEA) / Testing and Commissioning	0.0%	0.0%	3.2%
Contract Management	0.0%	0.0%	1.1%
Environmental monitoring (during construction)	0.0%	0.0%	1.8%
Other Site Specific Requirements by BCH (such as site security, safety instructor, first aid, ETV, project firefighting, etc.)	0.0%	0.1%	0.4%
Construction Management	0.6%	0.7%	4.8%
Project Management	0.4%	0.6%	2.3%
Design Management	3.3%	3.5%	7.6%
Internal (including Contingent Labour Resource Augmentation)	0.3%	0.7%	1.4%
External Service Provider	3.0%	2.8%	6.2%
Procurement / QM Management	0.0%	0.2%	2.1%
Others (Environmental, Safety, Indigenous Relation)	1.6%	3.8%	4.5%

BC Hydro
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Cost Estimate Synopsis

Alternative 2B - Cost Category	Percentage of Total Direct Construction Costs excluding General Construction Requirements		
	Feasibility	**Definition**	**Implementation**
General Construction Requirements	0.0%	0.1%	7.8%
Site Operations / Supports	0.0%	0.0%	2.2%
Site Engineering & Acceptance (SEA) / Testing and Commissioning	0.0%	0.0%	2.4%
Contract Management	0.0%	0.0%	1.1%
Environmental monitoring (during construction)	0.0%	0.0%	1.7%
Other Site Specific Requirements by BCH (such as site security, safety instructor, first aid, ETV, project firefighting, etc.)	0.0%	0.1%	0.4%
Construction Management	0.6%	0.7%	4.7%
Project Management	0.4%	0.6%	2.3%
Design Management	3.0%	3.6%	7.4%
Internal (including Contingent Labour Resource Augmentation)	0.3%	0.8%	1.4%
External Service Provider	2.6%	2.8%	6.0%
Procurement / QM Management	0.0%	0.2%	2.1%
Others (Environmental, Safety, Indigenous Relation)	1.6%	3.8%	4.3%

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Cost Estimate Synopsis

Alternative 2C - Cost Category	Percentage of Total Direct Construction Costs excluding General Construction Requirements		
	Feasibility	Definition	Implementation
General Construction Requirements	0.0%	0.1%	9.4%
Site Operations / Supports	0.0%	0.0%	3.1%
Site Engineering & Acceptance (SEA) / Testing and Commissioning	0.0%	0.0%	2.4%
Contract Management	0.0%	0.0%	1.2%
Environmental monitoring (during construction)	0.0%	0.0%	2.1%
Other Site Specific Requirements by BCH (such as site security, safety instructor, first aid, ETV, project firefighting, etc.)	0.0%	0.1%	0.4%
Construction Management	0.7%	0.8%	5.1%
Project Management	0.4%	0.7%	2.8%
Design Management	3.4%	3.8%	9.3%
Internal (including Contingent Labour Resource Augmentation)	0.4%	0.8%	1.8%
External Service Provider	3.0%	3.0%	7.5%
Procurement / QM Management	0.0%	0.3%	2.6%
Others (Environmental, Safety, Indigenous Relation)	1.8%	4.5%	5.4%

Alternative 3 - Cost Category	Percentage of Total Direct Construction Costs excluding General Construction Requirements		
	Feasibility	Definition	Implementation
General Construction Requirements	0.0%	0.1%	8.3%
Site Operations / Supports	0.0%	0.0%	3.6%
Site Engineering & Acceptance (SEA) / Testing and Commissioning	0.0%	0.0%	0.4%
Contract Management	0.0%	0.0%	1.0%
Environmental monitoring (during construction)	0.0%	0.0%	2.9%
Other Site Specific Requirements by BCH (such as site security, safety instructor, first aid, ETV, project firefighting, etc.)	0.0%	0.1%	0.5%
Construction Management	1.0%	1.0%	5.6%
Project Management	0.9%	1.2%	3.1%
Design Management	3.7%	5.0%	9.4%
Internal (including Contingent Labour Resource Augmentation)	1.3%	1.0%	2.2%
External Service Provider	2.4%	4.0%	7.2%
Procurement / QM Management	0.0%	0.5%	2.2%
Others (Environmental, Safety, Indigenous Relation)	2.4%	1.8%	7.4%

General Construction Requirements

- Construction Manager,
- Construction Officer,
- Contract Manager / Professional,
- Site Engineering & Acceptance,
- Communication Protection and Control (CPC) Testing and Commissioning,
- Fraser Valley Operation (FVO), and
- Telecom Network Operation (TNO).

Project Management and Design Management Cost Estimates

- Project Manager,
- Commercial Manager,
- Scheduler,
- Cost Analyst,
- Estimator,
- Project Engineering,
- Station Design (Alternative 2 only),
- Transmission Design, and
- Protection & Control Telecom Design (Alternative 2 only).

Procurement and Quality Management Cost Estimates

- Procurement,
- Quality Management.

Environmental / Safety / Public Consultation / Regulatory / Legal / Indigenous Relations Cost Estimates

- Regulatory,
- Environmental,
- Stakeholder Engagement,
- Public Safety,
- Properties, and
- Indigenous Relations.

9 Project Risks/Contingency

Conceptual estimates in general include only contingency, which is developed based on the risk items identified by the project team. To develop the contingency, these risks are separated into two categories – typical risks encountered in most projects of a similar nature and level of definition, and risks that are unusual and that can affect the accuracy of the project cost estimate.

Typical risk items for this project include, but are not limited to, labour productivity, market conditions, working conditions and accessibility. A minimal amount of design growth and rework, schedule delay, installation rework and variance in equipment costs is also typical. Project-specific risk items are included in the following table:

Type of Cost-Risk Attributes	Risks for 2L090	Possible Cost Impact
Unforeseen Working Conditions & Schedule Delay	• Archaeological discoveries. • Obtaining and planning outages. There are 3 weeks available in April, with the possibility of additional outages in Oct/Nov. • Adverse weather leading to delays with helicopter related work.	• Changes to 2L090 design. • Construction schedule may be extended. • Additional mobilization and demobilization for contractor.
Design Progression	• Steel poles may be required for some structures.	• Increase to construction cost.
Scope Increase	• Existing conductor condition is worse than anticipated and may require replacement. • Condition of the line may have further deteriorated since the STARR data was collected.	• Increase to construction cost and may extend schedule.
Unforeseen Working Conditions	• 2L90 passes through a high fire risk area and a fire events during construction may delay or affect productivity.	• Increase to construction cost and may extend schedule.

Type of Cost-Risk Attributes	Risks for ROS	Possible Cost Impact
Market Conditions	• Transformers will be purchased under non-blanket contract orders	• Construction cost higher than base estimate cost.

Type of Cost-Risk Attributes	Risks for ROS	Possible Cost Impact
	and prices can be higher than anticipated. • Lack of competitive bids and qualified contractors.	
Schedule Delay	• Obtaining and planning outages.	• Construction schedule may be extended. • Additional mobilization and demonization for contractor.

Contingency was not included for items subject to external influences that are not under the control of the project manager/estimator (for example, tax changes, additional major scope, force majeure and so on), per the estimating procedure.

The estimate includes contingencies, expressed as a percentage of the Total Construction Cost without contingency, as follows:

Contingency Level	Percentage of Total Construction Cost Without Contingency	Alt. 1 ($M)	Alt. 2A ($M)	Alt. 2B ($M)	Alt. 2C ($M)	Alt. 3 ($M)
IDN Phase	10%	0.2	0.3	0.3	0.3	0.2
DEF Phase	20%	0.6	1.0	1.0	0.9	0.5
IMP Phase – Overhead	30%	11.0	8.1	8.1	8.1	9.5
IMP Phase – Transmission Asset Dismantle	20%	0.4	0.4	0.4	0.4	0.3
IMP Phase – Station	25%	N/A	7.2	7.4	5.8	N/A
Total		12.3	17.0	17.2	15.5	10.5

10 Schedule

The key milestone dates for this project are:

Description	Milestone Dates		
	Alternative 1	Alternative 2	Alternative 3
Conceptual Design Completion	October 19, 2020	October 19, 2020	October 19, 2020
Feasibility Design Completion	December 21, 2021	December 21, 2021	December 21, 2021
Definition Completion	December 31, 2022	August 25, 2023	December 31, 2022
Expected Award of Transformer Contract	N/A	September 30, 2023	N/A
Start of Construction	April 1, 2023	October 1, 2023	April 1, 2023

In-Service Date	October 30, 2025	October 30, 2026	October 30, 2025
Project Close Out	April 1, 2026	April 1, 2027	April 1, 2026

11 Cash Flow, Inflation and Loading Parameters (Capital Overhead and Interest During Construction)

Inflation, Capital Overhead (COH) and Interest During Construction (IDC) were calculated using the Transmission Estimating team's loading calculator with the following annual rates.

Fiscal Year	Percent Inflation	Loading Calculator Rates	
		Percent COH	Percent IDC
2021	2.5	5.1	3.53
2022	2.0	5.1	3.30
2023	2.0	5.1	3.25
2024 and beyond	2.0	5.1	3.18

TM-0287 Bridge River Transmission Project
Alt. 1 - Upgrade 2L090 to 90˚C Operation and Address All Reliability Related Defects

2020-08-14

[redacted]

Note:
(1) Costs are in Current Canadian Dollars.
(2) Costs of capital overhead, inflation, GST and interest during construction have been excluded.

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Risk Register

ID	Risk Status	Risk Event Description	Risk Drivers Description	Consequences Description	Treatment Option	Treatment Plan	Risk and Response Summary	Consequence Type	Consequence Severity	Probability of Consequence
14	Active	In-service date later than BRR project	Limited outage windows, rainy weather delays helicopter work, unable to access structures or roads on Xaxlip land, permits for access delayed.	IPP curtailment or BRR curtailment	Mitigate	- for pole replacements that are not heli-access use live line work methods (residual safety risk though) - piggy back on Seton Generator station outages if possible - find ways to hire Xaxlip for field work in order to gain their support and access the ROW without compromising broader access negotiations. -apply for permits early - complete pole replacements for line clearances (upgrade work) first	Due to limited outage windows, rainy weather affecting helicopter work, Xaxlip restrictions on access to structures or roads, and delays in getting permits there is a risk that the in-service date for this project will be later than the BRR generation projects causing curtailment of either the IPP's or BRR. Curtailment of BRR would increase the risk of water spillage at Terzaggi. To mitigate this risk the following treatment plan would be executed: - for pole replacements that are not heli-access use live line work methods (residual safety risk though) - piggy back on Seton Generator station outages if possible - find ways to hire Xaxlip for field work in order to gain their support and access the ROW without compromising broader access negotiations. -apply for permits early - complete pole replacements for line clearances (upgrade work) first	Financial Loss	S3 - $1M to $10M	L6: 10% (Possible - Could well occur)
15	Active	Delay to project schedule	Coronavirus Disease (COVID-19) Pandemic	Delay to In-Service Date	Mitigate	The treatment plan is to communicate the risk of delay to the project schedule and In-Service Date to the project team and hold regular meetings with project team member to understand the limitations and issues to their deliverables due to the pandemic and develop a plan to support their work.	Due to the Coronavirus Disease (COVID-19) Pandemic there is a risk of delay to the project schedule which may result in a delay to the In-Service Date.	Reliability - Supply	S3 - Require voluntary load reduction	L5: 1% (Remote - May occur)
1	Identified	First Nations opposition to project	Due to inadequate consultation, lack of alignment on alternatives, or lack of perceived benefits to First Nations, there is a risk of First Nations claiming that engagement or consultation has been inadequate on the Project.	Damage to relationship and/or opposition to the Project or the selected alternatives.	Mitigate	Early, respectful, and transparent collaboration with First Nations throughout the Project in addition to a project budget that will facilitate engagement will be essential to ensuring adequate consultation. In the Conceptual Design stage the Project team will seek involvement of First Nations in the review of alternatives, implementation of studies and assessments, and participation in the structured decision making process. All consultation efforts will be documented and an assessment to confirm we have met requirements for adequate consultations will be made prior to moving the project forward. For St'at'imc: BC Hydro's ongoing consultation requirements with St'át'imc are defined in the 2011 Relations Agreement between BC Hydro, St'át'imc, and the 10 participating St'át'imc communities. In addition to these ongoing consultation requirements, the Settlement Agreement and the Certainty Provisions Agreement address past, present and future infringements of BC Hydro's infrastructure on Aboriginal rights and title and provide certainty to BC Hydro for the operation and maintenance of existing facilities. As a result, BC Hydro's legal duty to consult (and accommodate) has been captured, contractually, in the Relations Agreement, which for the most part (with some exceptions), has been supplanted with an information-sharing and knowledge building intention, including provisions for BC Hydro to address any reasonable concerns raised by the St'át'imc regarding any operation and maintenance activities. It is intended as a "living agreement" that will evolve over time to create respectful and effective relations related to the Bridge-Seton generation facilities	Due to inadequate consultation, lack of alignment on alternatives, or lack of perceived benefits to First Nations, there is a risk of First Nations claiming that engagement or consultation has been inadequate on the Project. In addition to inadequate consultation First Nations may oppose the Project or the selected alternatives. Response: Lack of First Nation support could have a negative impact on BC Hydro long term relationships with strategic First Nations and could impact project timelines. Early, respectful, and transparent collaboration with First Nations throughout the Project in addition to a project budget that will facilitate engagement will be essential to ensuring adequate consultation. In the Conceptual Design stage the Project team will seek involvement of First Nations in the review of alternatives, implementation of studies and assessments, and participation in the structured decision making process. All consultation efforts will be documented and an assessment to confirm we have met requirements for adequate consultations will be made prior to moving the project forward.	Reputational	S4 - Many customers critical	L6: 10% (Possible - Could well occur)
2	Identified	Lack of input from FN delays schedule	Due to work load, capacity, or lack of resources First Nations may not be able to provide input to the proposed alternatives	Delays to the Project schedule.	Mitigate	The project team will seek to enter capacity funding agreements with specific deliverables and dates with key First Nations. Each First Nation will have a key Indigenous Relations contact on the Project team and we will seek regular updates on status and any concerns. The project team will maintain communications with other major capital projects within BCH to ensure work and demands on First Nations deliverables are appropriately prioritized. If First Nations provide information requests or suggestions, the Indgenous Relations contact will respond and if practicle the project tream will consider how to integrate suggestions or mitigations as appropriate.	Due to work load, capacity, or lack of resources First Nations may not be able to provide input to the proposed alternatives in line with the requirements of the Project schedule. Response: Indigenous Relations contact will seek regular updates on status and any concerns. The project team will maintain communications with other major capital projects within BCH to ensure work and demands on First Nations deliverables are appropriately prioritized. If First Nations provide information requests or suggestions, the Indgenous Relations contact will respond and if practicle the project tream will consider how to integrate suggestions or mitigations as appropriate.	Reputational	S1 - Limited Complaints to Company or Shareholder	L6: 10% (Possible - Could well occur)

3	Identified	Geotechnical uncertainties for ROS expansion	Due to the need to expand the existing ROS substation boundary, there is a risk that the expansion area includes challenging unknown geotechnical conditions.	Budget and schedule overrun to address the unknown geotechnical conditions.	Mitigate	Conduct desktop geotechnical review of the expansion area during the conceptual design stage. If this alternative is selected as a leading altnative then further site geotech investigations would be required.	Due to the need to expand the existing ROS substation boundary, there is a risk that the expansion area includes challenging unknown geotechnical conditions. If the geotechnical conditions remain unknown, it is likely that budget and schedule overrun will be encountered to deal with the unknown geotechnical conditions. To mitigate this risk, a desktop geotechnical review of the expansion area will be conducted during the conceptual design stage. If this alternative is selected as a leading altnative then further site geotech investigations would be required.	Financial Loss	S2 - $100K to $1M	L7: 60% (Likely - more than even chance to occur)
4	Identified	Uncertainties about the control building expansion	Due to the need for ROS expansion, there is a risk that this expansion requires additional control panels that can not be accomodated due to lack of space in the control building.	Lack of sufficient space in ROS control building requires expanding the control building which will result in budget and schedule overruns.	Mitigate	During the conceptual design stage, the potential need to expand the control building will be assessed to ensure this scope is identified during the conceptual design stage and is factored in the Structured Decision Making process.	Due to the need to expand ROS Substation, there is a risk that this expansion requires additional control panels that can not be accomodated due to lack of space in the existing control building. Lack of sufficient space in ROS control building would require expanding the control building which will result in budget and schedule overruns. During the conceptual design stage, the potential need to expand the control building will be assessed to ensure this scope is identified during the conceptual design stage and is factored in the Structured Decision Making process.	Financial Loss	S2 - $100K to $1M	L6.5: 30% (Fairly Likely - Often occurs)
5	Identified	Fire risk for 2L90 impacts the lines reliability	Due to the fact that 2L90 passes through high fire risk area and have encountered numerous fire events in the past, there is a risk that fire events will cause lengthy forced outages to the circuit.	Fire events can cause damages to wood pole structures and forced outage to the circuit.	Mitigate	This risk will be managed by conducting a fire risk assessment study and produce recommendations for the structures type and clearing scope during the conceptual design stage.	Due to the fact that 2L90 passes through high fire risk area and there has been fire events in the past, there is a risk that fire events will damage the wood pole structures. This will result in lengthy forced outages that may necessitate the need to curtail generation and result in water conveyance challenges. This risk will be managed by conducting a fire risk assessment study and produce recommendations for the structure types and clearing scope during the conceptual design stage.	Reliability - Supply	S4 - Localized load shedding	L6.5: 30% (Fairly Likely - Often occurs)
6	Identified	Operation and maintenance risk for 2L90	Due to the decision of abandoning 2L91 and the capacity increase on 2L90, there is a risk that the outage availability on 2L90 will be severely limited. Therefore it is crucial that the project will consider the operation and maintenance risk for 2L90.	Restrictions in the Field Operations crews ability to perform maintenance on 2L90 and the need to perform live line operations.	Mitigate	This risk can be mitigated via upgrading the existing access roads, construction of new access to helicopter accessible sites when feasible and conducting sufficient maintenance works with the objective of leaving the circuit in a near maintenance free condition for as long as possible after the in-service-date.	Due to the decision of abandoning 2L91 and the capacity increase on 2L90, there is a risk that the outage availability on 2L90 will be severely limited. Therefore it is crucial that the project will consider the operation and maintenance risk for 2L90. Restrictions in the Field Operations crews ability to perform maintenance on 2L90 and the need to perform live line operations. This risk can be mitigated via upgrading the existing access roads, construction of new access to helicopter accessible sites when feasible and conducting sufficient maintenance works with the objective of leaving the circuit in a near maintenance free condition for as long as possible after the in-service-date.	Reliability - Supply	S3 - Require voluntary load reduction	L6: 10% (Possible - Could well occur)
7	Identified	Constructability and outage staging risks for ROS expansion	Due to the need to perform expansion in ROS substation, there is a risk that the expansion requires a complex cutover process to ensure the grid operation risks and considered and the worker's safety issues are addressed.	The complex cutover process will result in schedule and budget overruns. If not addressed properly, this can cause grid operation problems and workers safety issues.	Mitigate	This risk will be mitigated by producing a conceptual outage staging plan and discuss it with FVO during the conceptual design stage.	Due to the need to perform expansion in ROS substation, there is a risk that the expansion requires a complex cutover process to ensure the grid operation risks and considered and the worker's safety issues are addressed. The complex cutover process will result in schedule and budget overruns. If not addressed properly, this can cause grid operation problems and workers safety issues. This risk will be mitigated by producing a conceptual outage staging plan and discuss it with FVO during the conceptual design stage.	Financial Loss	S2 - $100K to $1M	L7: 60% (Likely - more than even chance to occur)

9	Identified	Change in scope or number of Alternatives	Due to changes in system conditions, including load and generation forecasts, the scope or amount of alternatives being reviewed in the Conceptual phase could change.	Change to alternatives being reviewed and the scope of these alternatives could impact the Conceptual Design stage work and schedule, and may trigger requirement for new consultation on the options.	Mitigate	Work with planners to capture any potential for changes to the Project scope the will impact the conceptual design and associated engagement and consultation.	RISK: Due to change in system conditions the alternative being reviewed during conceptual design stage could change resulting in impacts to the Project schedule. RESPONSE: Work closely with AIM Planner and engineering teams to identify any changes to alternatives early.	Reputational	S1 - Limited Complaints to Company or Shareholder	L6: 10% (Possible - Could well occur)
10	Identified	Decision Making Risk	Due to the variety of the different alternatives for this project there is a risk that the project team will challenged to compare the alternatives among themselves and substantiate the selection of a preferred alternative.	Which may result in prolonged analysis to determine the preferred alternative for the Project and impact the project schedule and cost for investigation of the project alternatives.	Mitigate	The structured decision making (SDM) process provides a means to compare alternatives that have different objectives and measures. If the different alternatives are still considered to be viable throughout the conceptual design stage a technique within SDM called swing-weighting can be used to facilitate the comparing the objectives of the different alternatives. The decision frame will be constructed early in the project lifecycle to identify key objectives which will be important to differentiate the alternatives so that the project work packages include the appropriate scope to fully populate the consequence table.	Due to the diverse set of alternatives there is a risk that there will be a prolonged analysis in the selection of a preferred alternative which may impact the project cost and schedule. The treatment plan is twofold: 1.) to implement the SDM process early in the project lifecycle to identify the key objectives for the alternatives so that the project work packages work packages include the appropriate scope to fully populate the consequence table; and 2.) to use swing-weighting to facilitate the comparing the objectives of the different alternatives if all the alternatives are still considered to be viable throughout the conceptual design stage.	Financial Loss	S1 - $10K to $100K	L6: 10% (Possible - Could well occur)
11	Identified	Catastrophic Failure of ROS T1	ROS T1 is more than 60 year old. The oil contains PCB higher than 50 ppm. The transformer has no oil containment pit and no firewalls between the single phase units.	Due to the age of ROS T1 the risk of T1 suffering a (possibly catastrophic) failure is relatively high, and the situation is aggravated by the lack of oil containment. None of the single-phase units is equipped with oil containment pit and there are no fire walls installed between the phases	Mitigate	Two options are being studies, option 1 is to remove T1 and replace it with a new transformer. Option 2 is to refurbish T1 to extend its expected life time.	Due to the age of ROS T1 the risk of T1 suffering a (possibly catastrophic) failure is relatively high, and the situation is aggravated by the lack of oil containment. None of the single-phase units is equipped with oil containment pit and there are no fire walls installed between the phases. This may result in large scale site contamination and large scale safety and operation risks. The treatment plan is to either remove T1 and replace it with a new transformer or refurbish T1 to extend its epected life time.	Financial Loss	S3 - $1M to $10M	L6: 10% (Possible - Could well occur)
12	Identified	encountering archaeological sites within the 2L090 alignment	The Heritage screening identified 221 archaeological and 3 historical heritage sites located within 1km of the 2L090 alignment. Seven archaeological sites are potentially in direct conflict with the 2L090 alignment including the following site: EeRl-1, EeRl-222, EeRl-266, EeRl-68, EfRk-44, EeRl-179, and EeRk-65. A potential model developed for the Lillooet Forest District in 1999 indicates there are areas of both moderate and high potential in the project area.	Violation of the Heritage Conservation Act through impact upon archaeological materials	Mitigate	An AOA is requried to further delineate the archaeological risk to support decisions around access. The AOA should be prepared and shared with First Nations. If the 2L090 is selected an AIA would be required.	Due to identified archaeological potential, there is a risk of encountering archaeological material, which may result in a violation of the Heritage Conservation Act. The treatment plan is to undertake an AOA clarify the risk of the 2L090 alternative. If the 2L090 is selected an AIA would be required.	Environmental	S4 - High Impact	L6: 10% (Possible - Could well occur)
13	Identified	Encountering contaminated soil at Rosedale sub	due to lack of sufficient/existing oil containment, age of equipment, and previous use of PCB oil at Rosedale there is a risk to encountering contaminated soils within the Rosedale sub	Contaminated soils	Mitigate	Review equipment history and investigate soils	Due to the lack of transformer oil containment and age of equipment, there is a risk of encountering contaminated soils at Rosedale, which may result in hazardous waste. The treatment plan is investgate soils	Environmental	S3 - Moderate Impact	L6.5: 30% (Fairly Likely - Often occurs)

REDACTED

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Appendix I
Structured Decision Making Table

Legend
Leading Alternative
Better than the Leading Alternative
Approximately Similar to the Leading Alternative
Worse than the Leading Alternative

Revision 3.0

Objectives	Measure	Alternative 1	Alternative 2a	Alternative 2b	Alternative 2c	Alternative 3
Minimize Total Costs						
BRT Project Capital Costs	$-million	66.2	115.4	117.1	104.9	57.7
Present Value Total Lifecycle Costs	$-million	75.1	85.3	88.6	79.8	108
Likelihood of achieving Oct-2025 in-service-date	High/Med/Low	High	High	High	High	High
Maximize System Reliability and Flexibility						
System flexibility	High/Med/Low	High	High	High	High	High
System operational risk	High/Med/Low	Low	Low	Low	Low	Low
Likelihood of system being damaged by fire	High/Med/Low	High	High	High	High	High
Minimize Environmental Impacts and Impacts to St'at'imc Core Interests						
Risk of Impacts on aquatic species and habitat	High/Med/Low	Low	Low	Low	Low	Low
Risk of impacting heritage sites	High/Med/Low	Med	Low	Low	Low	Low
Risk of impacts to terrestrial species and habitat	High/Med/Low	Med	Low	Low	Low	Low
Risk of impacts on vegetation	High/Med/Low	Low	Low	Low	Low	Low
Risk of impacts from hazardous wastes	High/Med/Low	Med	Low	Low	Low	Med
Likelihood of incremental flow into Lower Bridge River	High/Med/Low	Low	Low	Low	Low	Low
Minimize Occupational Health and Safety Risks						
Risks during construction	High/Med/Low	High	High	High	High	High
Minimize Impacts to Stakeholders						
Impacts to stakeholders	High/Med/Low	Low	Low	Low	Low	Low
Regulatory and Permitting						
Likelihood of not obtaining permits or access to right-of-way	High/Med/Low	Med	Med	Med	Med	Med

BC Hydro Bridge River Projects

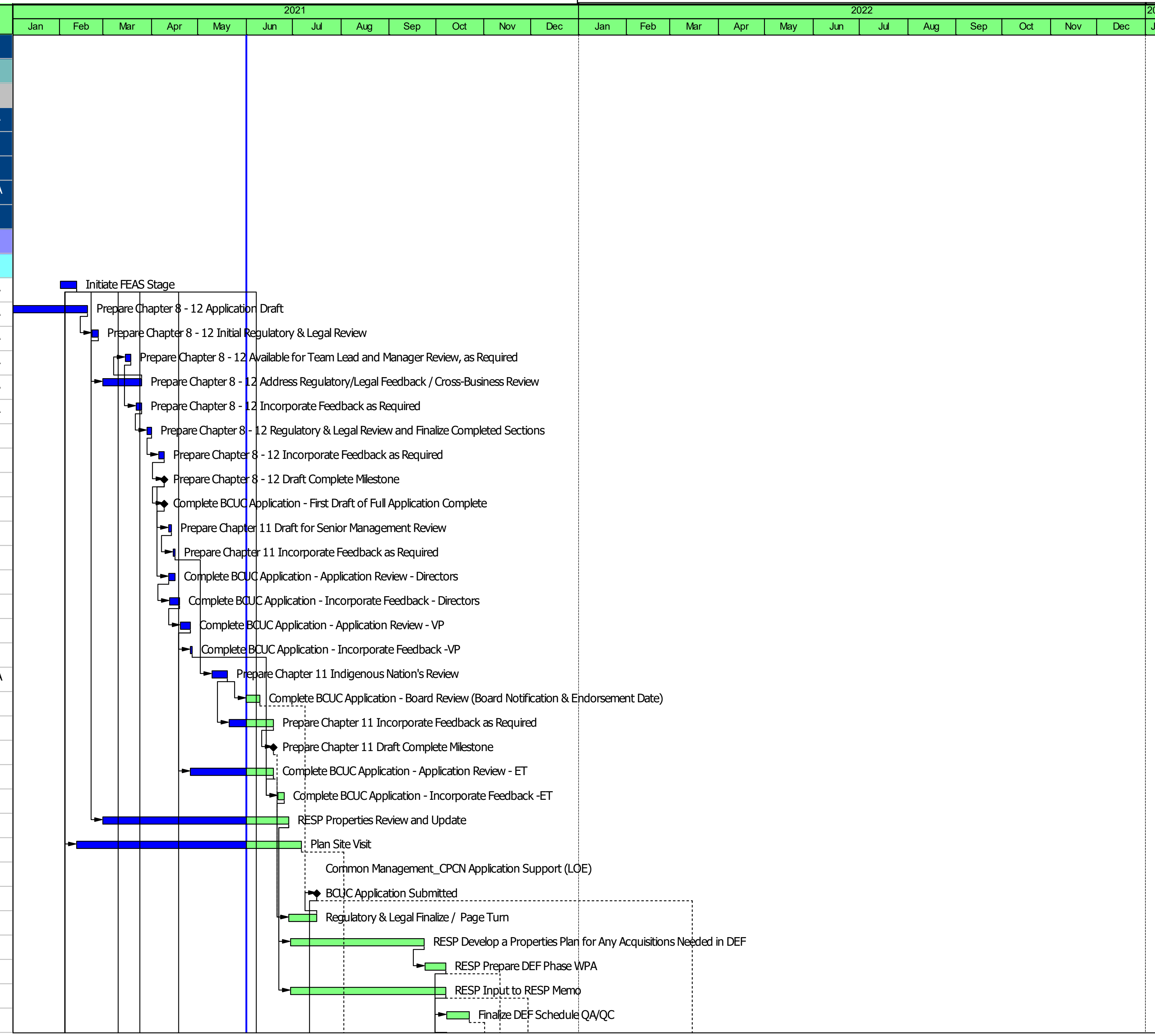
Bridge River Transmission Project

Appendix C-5

BRT Project Schedule

Project:BRTP Bridge River Trans Project	Update Schedule Print Layout	Printed On:23-Jun-21 Data Date:01-Jun-21

Activity ID	Activity Name	Original Duration	Start	Finish
BRTP Bridge River Trans Project		2233	03-Aug-17 A	21-Aug-26
BRTP Bridge River Trans Project		2233	03-Aug-17 A	21-Aug-26
Identification Phase - IDN L2		1122	03-Aug-17 A	22-Mar-22
Needs - IDN L3		207	03-Aug-17 A	19-Jun-18 A
Conceptual Design - IDN L3		705	19-Jun-18 A	29-Jan-21 A
Other Funds - IDN L3		906	19-Jun-18 A	22-Mar-22
Future Phase Estimate IDN L3		845	29-Jun-18 A	03-Aug-20 A
Feasibility Design - IDN L3		313	30-Nov-20 A	22-Mar-22
Project Management - IDN_FEA L4		304	30-Nov-20 A	22-Mar-22
Project Management - IDN_FEA L5		304	30-Nov-20 A	22-Mar-22
TM0287-9290	Initiate FEAS Stage	9	01-Feb-21 A	11-Feb-21 A
TM0287-9942	Prepare Chapter 8 - 12 Application Draft	60	30-Nov-20 A	19-Feb-21 A
TM0287-9944	Prepare Chapter 8 - 12 Initial Regulatory & Legal Review	5	22-Feb-21 A	26-Feb-21 A
TM0287-9948	Prepare Chapter 8 - 12 Available for Team Lead and Manager Review, as Required	5	15-Mar-21 A	19-Mar-21 A
TM0287-9946	Prepare Chapter 8 - 12 Address Regulatory/Legal Feedback / Cross-Business Review	10	01-Mar-21 A	26-Mar-21 A
TM0287-9952	Prepare Chapter 8 - 12 Incorporate Feedback as Required	5	22-Mar-21 A	26-Mar-21 A
TM0287-9954	Prepare Chapter 8 - 12 Regulatory & Legal Review and Finalize Completed Sections	4	29-Mar-21 A	01-Apr-21 A
TM0287-9956	Prepare Chapter 8 - 12 Incorporate Feedback as Required	4	06-Apr-21 A	09-Apr-21 A
TM0287-9958	Prepare Chapter 8 - 12 Draft Complete Milestone	0		09-Apr-21 A
TM0287-9974	Complete BCUC Application - First Draft of Full Application Complete	0		09-Apr-21 A
TM0287-9962	Prepare Chapter 11 Draft for Senior Management Review	3	12-Apr-21 A	14-Apr-21 A
TM0287-9964	Prepare Chapter 11 Incorporate Feedback as Required	2	15-Apr-21 A	16-Apr-21 A
TM0287-9975	Complete BCUC Application - Application Review - Directors	5	12-Apr-21 A	16-Apr-21 A
TM0287-9976	Complete BCUC Application - Incorporate Feedback - Directors	5	13-Apr-21 A	19-Apr-21 A
TM0287-9977	Complete BCUC Application - Application Review - VP	4	20-Apr-21 A	26-Apr-21 A
TM0287-9978	Complete BCUC Application - Incorporate Feedback -VP	2	26-Apr-21 A	27-Apr-21 A
TM0287-9966	Prepare Chapter 11 Indigenous Nation's Review	9	10-May-21 A	20-May-21 A
TM0287-9984	Complete BCUC Application - Board Review (Board Notification & Endorsement Date)	7	01-Jun-21	09-Jun-21
TM0287-9968	Prepare Chapter 11 Incorporate Feedback as Required	6	21-May-21 A	18-Jun-21
TM0287-9972	Prepare Chapter 11 Draft Complete Milestone	0		18-Jun-21
TM0287-9979	Complete BCUC Application - Application Review - ET	5	26-Apr-21 A	18-Jun-21
TM0287-9980	Complete BCUC Application - Incorporate Feedback -ET	5	21-Jun-21	25-Jun-21
TM0287-9430	RESP Properties Review and Update	60	01-Mar-21 A	28-Jun-21
TM0287-9600	Plan Site Visit	88	12-Feb-21 A	06-Jul-21
TM0287-9701	Common Management_CPCN Application Support (LOE)	284	29-Jan-21 A	16-Jul-21
TM0287-9985	BCUC Application Submitted	0		16-Jul-21
TM0287-9986	Regulatory & Legal Finalize / Page Turn	14	28-Jun-21	16-Jul-21
TM0287-9440	RESP Develop a Properties Plan for Any Acquisitions Needed in DEF	60	29-Jun-21	23-Sep-21
TM0287-9450	RESP Prepare DEF Phase WPA	10	24-Sep-21	07-Oct-21
TM0287-9460	RESP Input to RESP Memo	70	29-Jun-21	07-Oct-21
TM0287-9580	Finalize DEF Schedule QA/QC	10	08-Oct-21	22-Oct-21



Remaining Work | Actual Work | Critical Remaining Work | ◆ | ◆ Milestone

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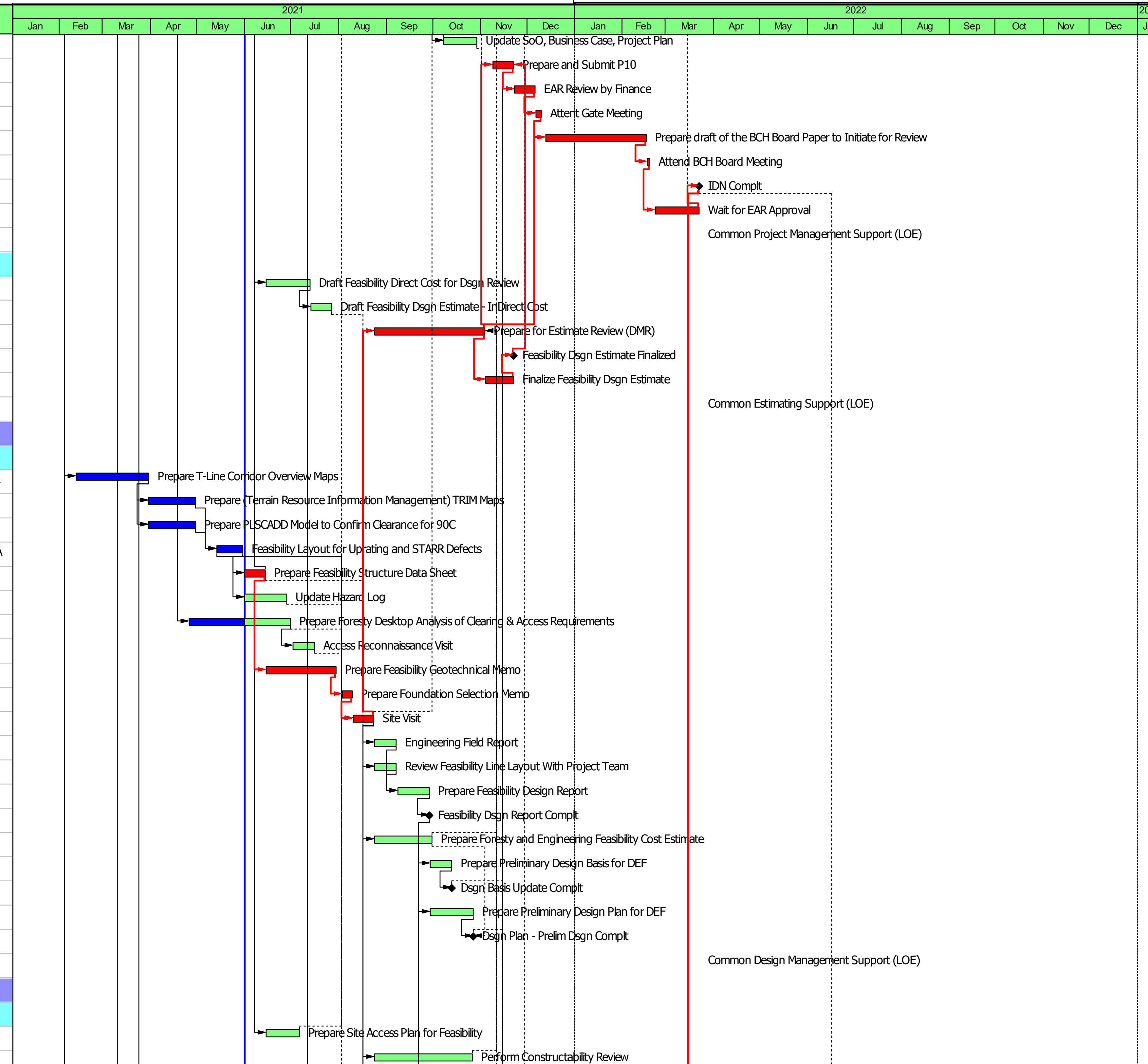
TASK filter: All Activities

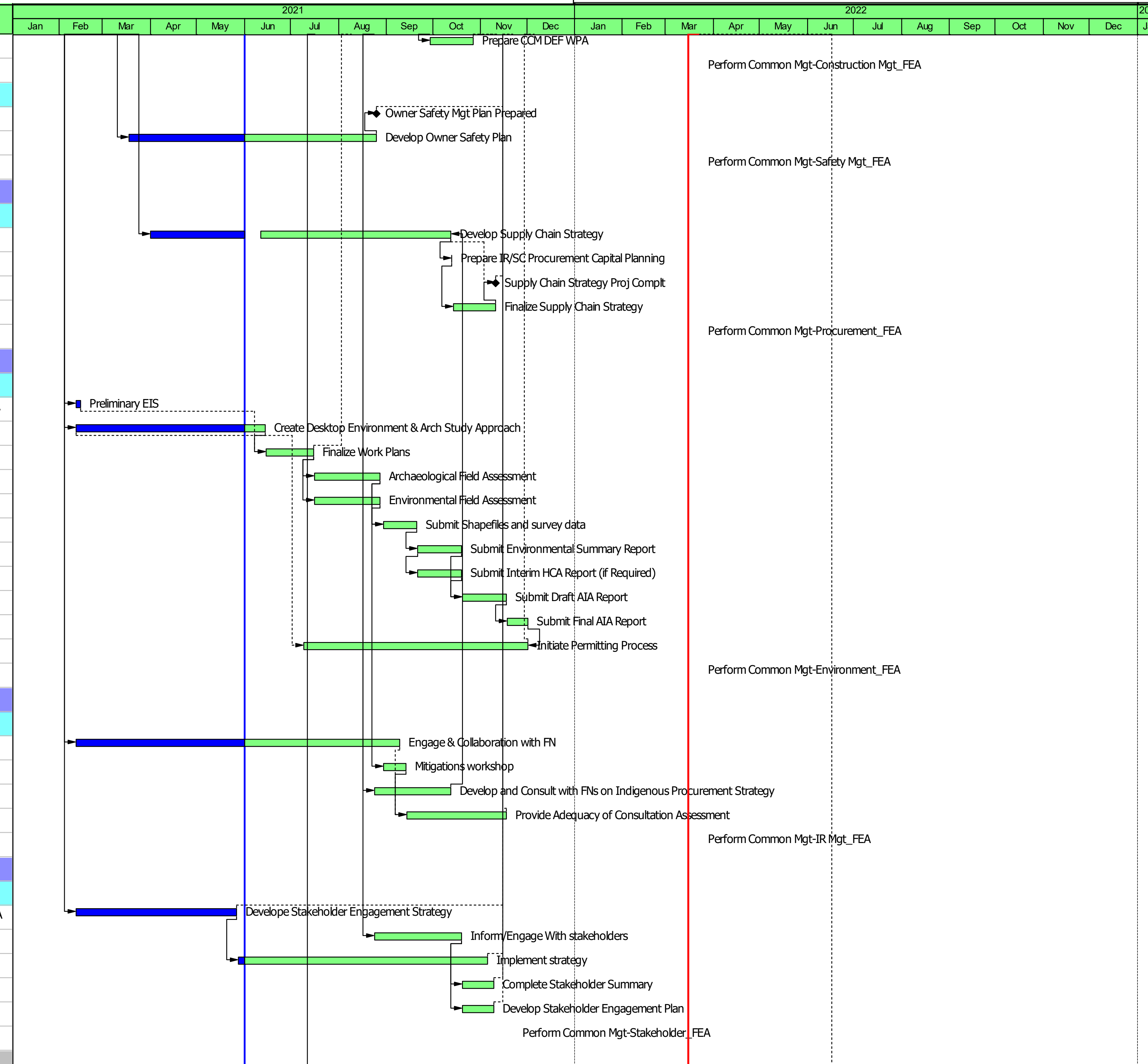
Project:BRTP Bridge River Trans Project | Update Schedule Print Layout | Printed On:23-Jun-21 Data Date:01-Jun-21

Activity ID	Activity Name	Original Duration	Start	Finish
TM0287-9610	Update SoO, Business Case, Project Plan	15	08-Oct-21	29-Oct-21
TM0287-9660	Prepare and Submit P10	9	09-Nov-21	22-Nov-21
TM0287-9730	EAR Review by Finance	10	23-Nov-21	06-Dec-21
TM0287-9670	Attent Gate Meeting	4	07-Dec-21	10-Dec-21
TM0287-9370	Prepare draft of the BCH Board Paper to Initiate for Review	45	13-Dec-21	16-Feb-22
TM0287-9330	Attend BCH Board Meeting	2	17-Feb-22	18-Feb-22
TM0287-9060	IDN Complt	0		22-Mar-22
TM0287-9570	Wait for EAR Approval	21	22-Feb-22	22-Mar-22
TM0287-9700	Common Project Management Support (LOE)	284	29-Jan-21 A	22-Mar-22
Estimating - IDN_FEA L5		**284**	**29-Jan-21 A**	**22-Mar-22**
TM0287-9940	Draft Feasibility Direct Cost for Dsgn Review	20	15-Jun-21	13-Jul-21
TM0287-9310	Draft Feasibility Dsgn Estimate - InDirect Cost	10	14-Jul-21	27-Jul-21
TM0287-9280	Prepare for Estimate Review (DMR)	50	24-Aug-21	03-Nov-21
TM0287-9220	Feasibility Dsgn Estimate Finalized	0		22-Nov-21
TM0287-9240	Finalize Feasibility Dsgn Estimate	12	04-Nov-21	22-Nov-21
TM0287-9970	Common Estimating Support (LOE)	284	29-Jan-21 A	22-Mar-22
Design Management - IDN_FEA L4		**284**	**29-Jan-21 A**	**22-Mar-22**
Feasibility Design - IDN_FEA L5		**284**	**29-Jan-21 A**	**22-Mar-22**
TM0287-9530	Prepare T-Line Corridor Overview Maps	10	12-Feb-21 A	31-Mar-21 A
TM0287-9550	Prepare (Terrain Resource Information Management) TRIM Maps	5	31-Mar-21 A	30-Apr-21 A
TM0287-9640	Prepare PLSCADD Model to Confirm Clearance for 90C	10	31-Mar-21 A	30-Apr-21 A
TM0287-9780	Feasibility Layout for Uprating and STARR Defects	20	14-May-21 A	31-May-21 A
TM0287-9790	Prepare Feasibility Structure Data Sheet	10	01-Jun-21	14-Jun-21
TM0287-9820	Update Hazard Log	20	01-Jun-21	28-Jun-21
TM0287-9910	Prepare Foresty Desktop Analysis of Clearing & Access Requirements	82	26-Apr-21 A	30-Jun-21
TM0287-9912	Access Reconnaissance Visit	11	02-Jul-21	16-Jul-21
TM0287-9800	Prepare Feasibility Geotechnical Memo	33	15-Jun-21	30-Jul-21
TM0287-9810	Prepare Foundation Selection Memo	5	03-Aug-21	09-Aug-21
TM0287-9620	Site Visit	10	10-Aug-21	23-Aug-21
TM0287-9630	Engineering Field Report	10	24-Aug-21	07-Sep-21
TM0287-9850	Review Feasibility Line Layout With Project Team	10	24-Aug-21	07-Sep-21
TM0287-9860	Prepare Feasibility Design Report	15	08-Sep-21	28-Sep-21
TM0287-9865	Feasibility Dsgn Report Complt	0		28-Sep-21
TM0287-9930	Prepare Foresty and Engineering Feasibility Cost Estimate	27	24-Aug-21	30-Sep-21
TM0287-9830	Prepare Preliminary Design Basis for DEF	10	29-Sep-21	13-Oct-21
TM0287-9835	Dsgn Basis Update Complt	0		13-Oct-21
TM0287-9890	Prepare Preliminary Design Plan for DEF	20	29-Sep-21	27-Oct-21
TM0287-9900	Dsgn Plan - Prelim Dsgn Complt	0		27-Oct-21
TM0287-9690	Common Design Management Support (LOE)	284	29-Jan-21 A	22-Mar-22
Construct & Contract Mgmt - IDN_FEA L4		**284**	**29-Jan-21 A**	**22-Mar-22**
Construct & Contract Mgmt - IDN_FEA L5		**284**	**29-Jan-21 A**	**22-Mar-22**
TM0287-9390	Prepare Site Access Plan for Feasibility	15	15-Jun-21	06-Jul-21
TM0287-9380	Perform Constructability Review	44	24-Aug-21	26-Oct-21



Project:BRTP Bridge River Trans Project | Update Schedule Print Layout | Printed On:23-Jun-21 Data Date:01-Jun-21

Activity ID	Activity Name	Original Duration	Start	Finish
TM0287-9400	Prepare CCM DEF WPA	20	29-Sep-21	27-Oct-21
TM0287-9540	Perform Common Mgt-Construction Mgt_FEA	284	29-Jan-21 A	22-Mar-22
Safety - IDN_FEA L5		284	29-Jan-21 A	22-Mar-22
TM0287-9260	Owner Safety Mgt Plan Prepared	0		25-Aug-21
TM0287-9270	Develop Owner Safety Plan	20	18-Mar-21 A	25-Aug-21
TM0287-9950	Perform Common Mgt-Safety Mgt_FEA	284	29-Jan-21 A	22-Mar-22
Procurement Mgmt - IDN_FEA L4		284	29-Jan-21 A	22-Mar-22
Procurement Mgmt - IDN_FEA L5		284	29-Jan-21 A	22-Mar-22
TM0287-9360	Develop Supply Chain Strategy	136	01-Apr-21 A	12-Oct-21
TM0287-9740	Prepare IR/SC Procurement Capital Planning	1	13-Oct-21	13-Oct-21
TM0287-9230	Supply Chain Strategy Proj Complt	0		10-Nov-21
TM0287-9650	Finalize Supply Chain Strategy	20	14-Oct-21	10-Nov-21
TM0287-9760	Perform Common Mgt-Procurement_FEA	284	29-Jan-21 A	22-Mar-22
Environmental Management - IDN_FEA L4		274	12-Feb-21 A	22-Mar-22
Environment - IDN_FEA L5		274	12-Feb-21 A	22-Mar-22
TM0287-9301	Preliminary EIS	5	12-Feb-21 A	15-Feb-21 A
TM0287-9300	Create Desktop Environment & Arch Study Approach	124	12-Feb-21 A	14-Jun-21
TM0287-9302	Finalize Work Plans	22	15-Jun-21	15-Jul-21
TM0287-9303	Archaeological Field Assessment	30	16-Jul-21	27-Aug-21
TM0287-9304	Environmental Field Assessment	30	16-Jul-21	27-Aug-21
TM0287-9305	Submit Shapefiles and survey data	15	30-Aug-21	20-Sep-21
TM0287-9306	Submit Environmental Summary Report	20	21-Sep-21	19-Oct-21
TM0287-9307	Submit Interim HCA Report (if Required)	20	21-Sep-21	19-Oct-21
TM0287-9308	Submit Draft AIA Report	20	20-Oct-21	17-Nov-21
TM0287-9309	Submit Final AIA Report	10	18-Nov-21	01-Dec-21
TM0287-9320	Initiate Permitting Process	100	09-Jul-21	01-Dec-21
TM0287-9750	Perform Common Mgt-Environment_FEA	274	12-Feb-21 A	22-Mar-22
IR Management - IDN_FEA L4		284	29-Jan-21 A	22-Mar-22
IR Management - IDN_FEA L5		284	29-Jan-21 A	22-Mar-22
TM0287-9590	Engage & Collaboration with FN	124	12-Feb-21 A	09-Sep-21
TM0287-9420	Mitigations workshop	10	30-Aug-21	13-Sep-21
TM0287-9560	Develop and Consult with FNs on Indigenous Procurement Strategy	34	24-Aug-21	12-Oct-21
TM0287-9410	Provide Adequacy of Consultation Assessment	45	14-Sep-21	17-Nov-21
TM0287-9770	Perform Common Mgt-IR Mgt_FEA	284	29-Jan-21 A	22-Mar-22
Other Management - IDN_FEA L4		112	11-Feb-21 A	22-Nov-21
Stakeholder Engagement - IDN_FEA L5		112	11-Feb-21 A	22-Nov-21
TM0287-9704	Develope Stakeholder Engagement Strategy	1	12-Feb-21 A	27-May-21 A
TM0287-9710	Inform/Engage With stakeholders	39	24-Aug-21	19-Oct-21
TM0287-9705	Implement strategy	5	28-May-21 A	05-Nov-21
TM0287-9712	Complete Stakeholder Summary	15	20-Oct-21	09-Nov-21
TM0287-9714	Develop Stakeholder Engagement Plan	15	20-Oct-21	09-Nov-21
TM0287-9680	Perform Common Mgt-Stakeholder_FEA	1	11-Feb-21 A	22-Nov-21
Definition Phase - DEF L2		487	19-Jul-21	30-Jun-23



Project:BRTP Bridge River Trans Project

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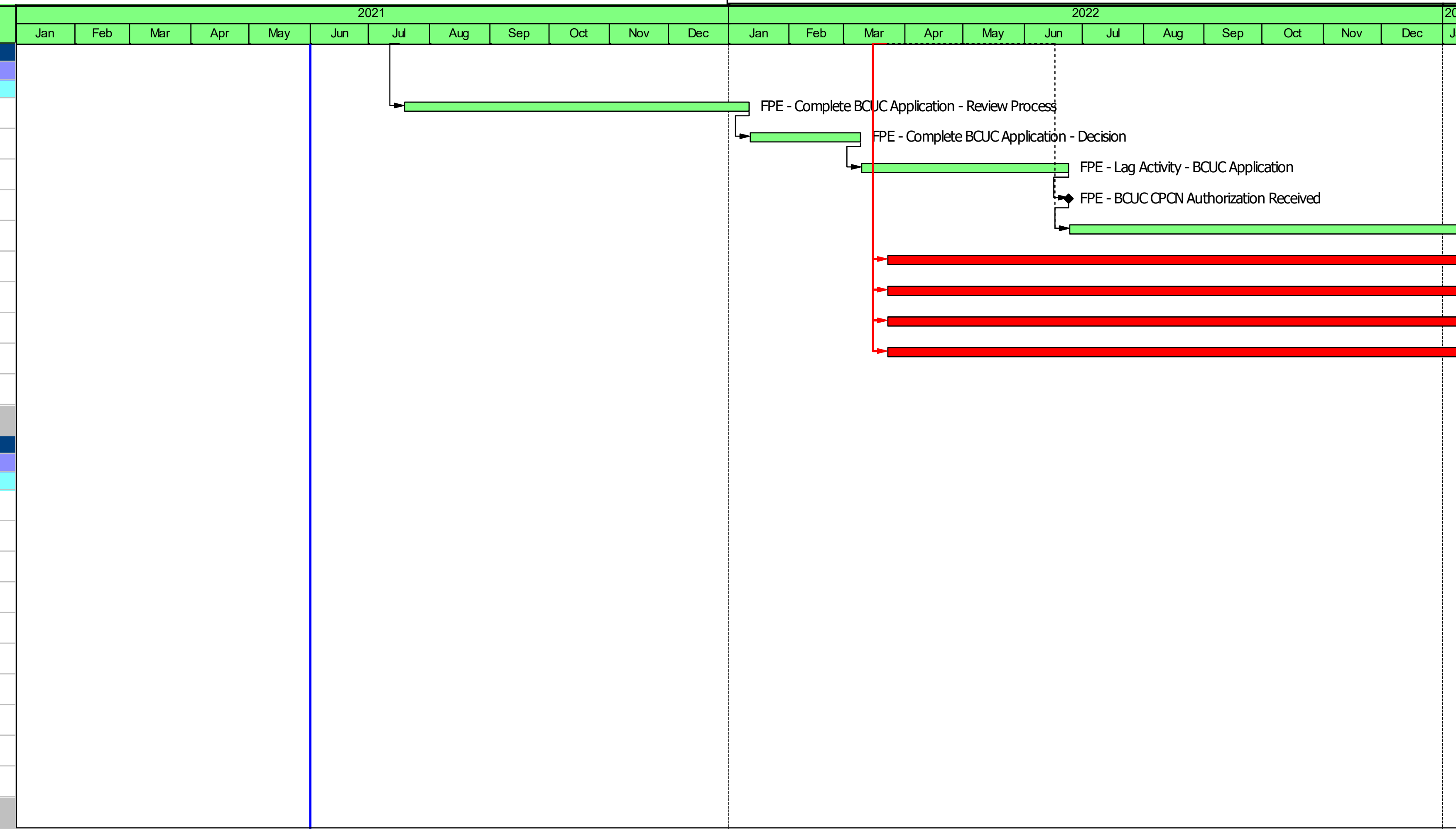
Activity ID	Activity Name	Original Duration	Start	Finish
Future Phase Estimate DEF L3		487	19-Jul-21	30-Jun-23
Future Phase Estimate DEF L4		487	19-Jul-21	30-Jun-23
Future Phase Estimate DEF L5		487	19-Jul-21	30-Jun-23
TM0287-9991	FPE - Complete BCUC Application - Review Process	120	19-Jul-21	11-Jan-22
TM0287-9992	FPE - Complete BCUC Application - Decision	40	12-Jan-22	09-Mar-22
TM0287-9993	FPE - Lag Activity - BCUC Application	73	10-Mar-22	23-Jun-22
TM0287-9994	FPE - BCUC CPCN Authorization Received	0		23-Jun-22
TM0287-9090	FPE - DEF Construction	253	24-Jun-22	29-Jun-23
TM0287-9070	FPE - DEF Engineering	318	23-Mar-22	30-Jun-23
TM0287-9080	FPE - DEF Contracts Equipment	318	23-Mar-22	30-Jun-23
TM0287-9100	FPE - DEF Other	318	23-Mar-22	30-Jun-23
TM0287-9110	FPE - DEF Project Management	318	23-Mar-22	30-Jun-23
TM0287-9120	FPE - DEF Complt	0		30-Jun-23
Implementation Phase - IMP L2		782	04-Jul-23	21-Aug-26
Future Phase Estimate IMP L3		782	04-Jul-23	21-Aug-26
Future Phase Estimate IMP L4		782	04-Jul-23	21-Aug-26
Future Phase Estimate IMP L5		782	04-Jul-23	21-Aug-26
TM0287-9130	FPE - IMP Engineering	100	04-Jul-23	24-Nov-23
TM0287-9140	FPE - IMP Contracts Equipment	482	27-Nov-23	31-Oct-25
TM0287-9150	FPE - IMP Construction	482	27-Nov-23	31-Oct-25
TM0287-9160	FPE - IMP Other	482	27-Nov-23	31-Oct-25
TM0287-9170	FPE - IMP Project Management	582	04-Jul-23	31-Oct-25
TM0287-9180	FPE - ISD	0		31-Oct-25
TM0287-9190	FPE - Perform Project Close-Out	120	03-Nov-25	28-Apr-26
TM0287-9200	FPE - Project Complt & Eval Rpt Accepted	0		28-Apr-26
TM0287-9340	FPE - Project Financial Close	0		21-Aug-26
TM0287-9470	FPE - Close Project Level System Status in SAP	80	29-Apr-26	21-Aug-26
IDC and OH		3256	01-Jun-21 A	01-Aug-26



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Bridge River Transmission Project

Appendix C-6

BRT Project Expenditure Breakdown by Year

Bridge River Transmission Project **Project Expenditures - $ Thousands**	**FY2020**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**FY2026**	**Total Expected**
				Fiscal Years				
Direct Construction Cost				9,237.6	9,455.4	8,097.3	4,727.7	31,517.9
Project Management and Engineering				769.1	887.3	778.8	522.4	2,957.6
Other Indirect Construction Costs				625.0	655.0	655.0	565.0	2,500.0
Subtotal: Implementation (Construction, Project Management and Engineering Costs Before Contingency)				**10,631.7**	**10,997.7**	**9,531.1**	**5,815.1**	**36,975.5**
Project Contingency on Expected Amount				3,189.5	3,440.3	3,000.4	1,885.6	11,515.8
Dismantling and Removal					705.2	705.2	705.2	2,115.5
Inflation				654.6	1,034.5	1,187.1	890.8	3,767.1
Subtotal: Implementation Phase Cost (Direct)				**3,844.1**	**5,180.0**	**4,892.6**	**3,481.5**	**17,398.3**
Capital Overhead				553.8	584.2	516.4	319.8	1,974.2
IDC				186.0	577.7	952.5	542.1	2,258.4
Subtotal: Implementation Phase Cost (Loaded)				**739.8**	**1,161.9**	**1,469.0**	**861.9**	**4,232.6**
Identification Phase Cost	498.3	1,404.8	981.2					2,884.3
Definition Phase Cost			1,385.0	1,385.0				2,770.0
Project Contingency on Identification and Definition Phase		160.3	386.5	226.2				773.0
Inflation		13.0	73.9	76.4				163.3
Capital Overhead	19.1	60.4	108.1	64.5				252.0
IDC	7.4	24.1	91.8	150.7	155.4	160.2	165.2	754.8
Identification and Definition Phase Cost (Loaded)	**524.8**	**1,662.6**	**3,026.5**	**1,902.8**	**155.4**	**160.2**	**165.2**	**7,597.5**
Total Project Cost	**524.8**	**1,662.6**	**3,026.5**	**17,118.4**	**17,495.0**	**16,052.8**	**10,323.7**	**66,203.9**

BC Hydro Bridge River Projects

Bridge River Transmission Project

Appendix C-7

BRT Project Rate Impact

REFER TO LIVE SPREADSHEET MODEL

Provided in electronic format only

(Accessible by opening the Attachments Tab in Adobe)

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Bridge River Transmission Project

Appendix C-8

BRT Project Preliminary Environmental Impact Statement

Bridge River Transmission Project
Preliminary Environmental Impact Statement

Photo Credit: BC Hydro

Prepared for:

BC Hydro
6911 Southpoint Drive
Burnaby, BC V3N 4X8

Prepared by:

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Lillooet, BC V0K 1V0

Project No. 105580-01

March 19, 2021

210319_BRTP_preEIS_Final_v2.0.docx

PROFESSIONAL CERTIFICATION

The following provides a list of qualified professionals that contributed to this report.

Report Section	Qualified Professional			
	Company	Name and Title	Accreditation	Area of Expertise
1.0 Introduction				
Project Description, Senior Review	BC Hydro	Lauren Simpson Senior Environmental Coordinator	R.P. Bio., PMP	Terrestrial and Wildlife Biology, Environmental Impact Assessments
2.0 Scope of Assessment, 3.0 Environmental Assessment and 5.0 Socio-Economic Assessment				
Vegetation and Wildlife and Wildlife Habitat	Hemmera	Ryan Gill Technical Specialist	R.P. Bio	Terrestrial and Wildlife Biology
Water Quality and Fish and Fish Habitat	Hemmera	Sarah Bowie Business Leader	R.P. Bio., M.Sc	Aquatic Environments and Hydrology
Socio-economic Assessment	Hemmera	Vilma Gayoso-Haro Technical Expert	M.Sc.	Human Environment, Socio-economics
Senior Review	Hemmera	Ruth Hardy Technical Expert	P. Ag., M.Sc.	Environmental Impact Assessments.
4.0 Heritage Assessment				
Heritage	SGS	Nadine Gray, Heritage Project Coordinator	M.A.	Archaeology
Heritage	SGS	Talicia Kane, GIS Technician	B.A.,G.I.S	Physical Geography GIS

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
AIA	Archaeological Impact Assessment
AOA	Archaeological Overview Assessment
BC	British Columbia
BCUC	British Columbia Utilities Commission
BEC	biogeoclimatic
BG	Bunchgrass
BGC	biogeoclimatic
BRGMON	Bridge River WUP monitoring program
BRT	Bridge River Terminal substation
CMT	culturally modified tree
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CMP	Construction Management Plan
HCA	*Heritage Conservation Act*
HWY	highway
IDF	Interior Douglas-fir
KLY	Kelly Lake substation
LAA	Local Assessment Area
MS	Montane Spruce
NIMMIWG	National Inquiry into Missing and Murdered Indigenous Women and Girls
OCP	Official Community Plan
PC	Pathway Component
PP	Ponderosa Pine
RAA	Regional Assessment Area
ROW	Right-of-way
RV	recreational vehicle
SGS	St'at'imc Government Services
SLRD	Squamish Lillooet Regional District
UWR	Ungulate Winter Range
VC	Valued Component
WHA	Wildlife Habitat Area
WUP	Water Use Plan

LIST OF SYMBOLS AND UNITS OF MEASURE

Symbol / Unit of Measure	Definition
km	kilometre
m	metre
m^3/s	cubic metres per second
masl	metres above sea level
mg dry wt/m^2	milligrams of dry weight per square metre
mm	millimetre
MW	megawatt
µg/L	microgram per litre

1.0 INTRODUCTION

The Bridge River Transmission Project (the Project) is required to expand the capacity of the Bridge River Transmission System to avoid transmission overloads during normal system conditions, during the summer months and to refurbish existing infrastructure to address poor asset health. The Project will uprate the 2L90 circuit so that the full generation from surrounding areas can be transmitted to the Lower Mainland, at all times of the year, under normal system conditions and will refurbish several structural components of 2L90 circuit on the Bridge River Transmission System to maintain operational reliability.

This report has been prepared to support an application for an order from the British Columbia Utilities Commission (BCUC), pursuant to Section 45 and 46 of the *Utilities Commission Act* and demonstrates BC Hydro's consideration of environmental and social effects of the Project. The scope of the report encompasses baseline information and preliminary identification of potential Project effects and mitigation measures. BC Hydro will complete field studies in 2021 to fill information gaps, finalize identification of Project effects and develop site specific mitigation measures to address these Project effects.

This Work was performed in accordance with Environmental Consulting Services Agreement RFSQ 1422 between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and BC Hydro (Client), dated May 1, 2013 (Contract). This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by BC Hydro. In performing this Work, Hemmera has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

1.1 Project Background

The Bridge River Generation System is in the Coast Mountains of southern BC, northeast of Pemberton and west of Lillooet. The Bridge River Generation System, built between 1948 and 1960, is a cascading system that includes three facilities: the La Joie facility, the Bridge River facility, and the Seton facility. The total power generated from the three Bridge River facilities is transmitted to Bridge River Terminal substation (BRT). The Bridge River Transmission System is made up of three main paths from BRT:

- Path 1 (circuit 2L90): from Bridge River Terminal Substation to Kelly Lake Substation
- Path 2: from Bridge River Terminal Substation to Clayburn Substation
- Path 3: from Bridge River Terminal Substation to Cheekye Substation.

Path 1 is comprised of the 2L90 transmission line, which is a 230kV, 76 km circuit that runs from BRT, east along the south side of Seton Lake to Lillooet, then continues northeast following Highway 99 until Pavilion where it joins a right-of-way (ROW) terminating at the Kelly Lake substation (KLY) near Clinton, BC. The Project is located west and north of Lillooet, BC, within the Regional District of Squamish-Lillooet.

The 2L90 transmission line requires refurbishment to address structural and thermal deficiencies. Refurbishing the structural components will ensure safe and reliable operation. Uprating the line will increase the thermal capacity and reduce the risk of overloads.

1.2 Project Description

The Bridge River Transmission Project currently consists of the following Project activities:

- Replacement and/or reinforcement of transmission towers (replace 98 overhead structures and address deficiencies for approximately 33 structures)
- Upgrade ~63 km of existing access roads and construct ~7 km of new access, as required for the Project
- Ground recontouring at up to 4 locations to address clearance violations
- Hazard tree removal and management
- Other as-yet undetermined construction activities at various locations along the entirety of the 2L90 transmission line.

BC Hydro is currently reviewing the scope of work and BC Hydro engineers will undertake a field assessment in early 2021 to determine/confirm the specific Project activities to be undertaken at each location. Following this field assessment BC Hydro will provide a detailed scope of work for each location.

2.0 SCOPE OF THE ASSESSMENT

2.1 Scope of Issues and Valued Components

Valued components (VCs) are environmental, social, cultural, or economic elements deemed important or valuable and are therefore assessed for potential project-related effects. For the Project, VCs were selected based on Project team's experience with similar-sized transmission projects and informed by years of engagement with St'át'imc Nation to understand critical issues. Other factors considered include public engagement, knowledge and review of existing government standards and guidelines, legislation, and regulations, and input from BC Hydro. Both presence in the Project area and the potential for Project-related effects are required for an element to be considered a VC.

A Pathway component (PC) is defined as a component of a dynamic system that supports one or more VCs as part of a larger pathway of effect. PCs are intermediate components of the pathway of effect and are therefore integral to understanding potential effects on end receptors (i.e., VCs).

2.2 Spatial Boundaries

Local and regional spatial boundaries were determined for the effects assessment based on the characteristics of each VC and their anticipated interactions with the proposed Project. Spatial boundaries were identified through a review of the spatial extent of the environmental, cultural, and socio-economic resources potentially affected by the Project. Local and regional assessment areas are defined below.

Local Assessment Area (LAA): the spatial area within which there is a reasonable potential for the Project or Project-related activities to cause effects during the Project (i.e., within close proximity to the action where direct and indirect effects are anticipated).

Regional Assessment Area (RAA): an area beyond the LAA, for which information may provide context for assessing the effects of the Project.

Local assessment areas and RAAs (if applicable) for each VC are identified and presented (including the provision of maps where appropriate) in **Section 3.0, Section 4.0** and **Section 5.0**. A description of the rationale used to define the boundaries is also provided.

2.3 Temporal Boundaries

Temporal boundaries are defined based on the timing and duration of Project activities that could induce environmental, heritage or socio-economic effects. Temporal boundaries for the proposed Project were based on a construction and commissioning schedule, including removal of temporary construction-related facilities and restoration of disturbed areas. Currently construction activities are planned to occur between June 2023 to October 2025.

At the end of construction and commissioning, the Project will return to service as per existing conditions with improved reliability and operational certainty. Operations and maintenance of the Project will continue to be provided by BC Hydro's staff, who will continue to perform routine inspection and maintenance and equipment repairs. Operations activities will result in no additional interactions with the biological, heritage or socio-economic environment and will be undetectable from baseline conditions; therefore, the operation phase is not considered further in this analysis.

2.4 Environmental Assessment Methodology

Environmental assessments are tools used to examine potential project-related effects and benefits during the planning stages of a project, allowing for refinements in project design and development of appropriate measures to mitigate potential adverse effects.

An assessment of potential direct and indirect effects related to the proposed Project was conducted through completion of the following steps:

- Describe existing conditions for each selected VC.
- Identify the potential for an interaction between Project activities and each VC.
- Describe potential effects from Project-VC interactions.
- If possible, describe mitigation measure(s) to avoid, minimize, or reduce potential adverse effects; propose mitigation measure(s) to enhance positive effects, or describe methods to fill information gaps to determine appropriate mitigation measures.

This preliminary assessment provides the existing conditions based on desktop research, and a preliminary review of the potential effects of the Project and mitigation measures. As noted earlier, field studies will be completed in 2021 to fill information gaps, finalize identification of Project effects and develop mitigation measures to address these Project effects.

3.0 ENVIRONMENT ASSESSMENT

This section describes existing environmental conditions in the vicinity of the proposed Project, including a rationale for the selection of the environmental VCs. The potential for Project-related interactions is considered, potential effects are identified and methods to address data gaps are proposed.

3.1 Issues Scoping

The purpose of Issues Scoping is to focus the assessment on key issues that have the potential to affect environmental components in proximity to the Project. These key issues were determined through the identification of the potential interactions of the Project components and activities with the biophysical environment, past projects of similar size and scope, engagement with St'át'imc Nation, input from key stakeholders, and use of professional judgement and scientific and regulatory considerations.

A list of candidate VCs that were identified for the Project is provided in **Table 3.1**. The table also describes the rationale for selection and subsequent inclusion or exclusion of the candidate VC in the effects assessment. For those VCs carried forward in the assessment, indicators are provided.

Table 3.1 Rationale for selection of Environmental Valued Components

Candidate VC	Rationale	Indicators
Environment		
Water Quality	Project activities may temporarily affect water quality where the 2L90 transmission line crosses streams near pole replacements and access route upgrades. Erosion and sediment control issues and accidental release of hazardous substances (e.g., fuel and oil) during Project construction has the potential to change surface water quality in watercourses in close proximity to the 2L90 transmission line. Project activities associated with the 2L90 transmission line are not anticipated to affect the water quality in Seton River, Seton Lake, or the Fraser River. **Included as a Pathway Component**	Changes in water quality parameters (e.g., total suspended solids)
Water Quantity	Project activities associated with upgrading the 2L90 transmission line may require the line to be out of service for short durations (up to three weeks). Curtailment of generation at Bridge 1 and 2 powerhouses is not anticipated and flows in the Bridge-Seton system should not be impacted. **Excluded**	N/A
Fish and Fish Habitat	Project activities may result in localized affects to water quality in smaller streams crossed by the transmission line and access routes. Changes in water quality may affect fish adjacent to and downstream of the disturbance. Project activities associated with the 2L90 transmission line are expected to have minimal to no effect on the existing fish and fish habitat in the Seton Lake, Seton River, Bridge River, Fraser River, and ancillary tributaries. **Included as Valued Component**	Loss and disturbance of fish habitat, including riparian in areas.
Vegetation	Project activities may require the removal of vegetation within the 2L90 ROW and along access roads. Movement of equipment throughout the project area may spread of invasive species. **Included as Valued Component**	Presence of invasive vegetation species. Presence of at-risk species

Candidate VC	Rationale	Indicators
Wildlife and Wildlife Habitat	Project activities may result in interactions with Wildlife and Wildlife Habitat. The replacement of wooden utility poles may impact Lewis's woodpecker nest sites. Improvements or replacement to bridges and culverts could affect barn swallow nest sites or bat roosts. Activities such as ground recontouring and installing new roads may affect nest sites for ground-nesting birds, hibernacula for snakes and dens. The removal of trees and other vegetation during construction activities may affect the availability of habitat for multiple species. Construction activities may also cause sensory disturbance (noise and vibration) to wildlife. Multiple federally and provincially listed species have the potential to be present within the project area. The LAA for Wildlife and Wildlife Habitat overlaps Critical Habitat for Lewis's woodpecker, Wildlife Habitat Areas (WHAs) for spotted owl, and Ungulate Winter Range (UWR) for mule deer. **Included as Valued Component**	Presence of species at risk and or their residence (nests). Changes in wildlife habitat quality. Presence of wildlife habitat features.

3.2 Spatial Boundaries

The assessment boundaries for the proposed VCs are presented below.

3.2.1 Water Quality and Fish and Fish Habitat

The proposed LAA for the Water Quality and Fish and Fish Habitat VC is defined as the 2L90 transmission line right-of-way with a 100 m buffer on either side (**Figure 3.1**). This encompasses the area where the Project is expected to interact with, and potentially create direct or indirect effects on the aquatic environment. All waterbodies including lakes, rivers, streams, wetlands, and others within the LAA will be considered. Drinking water wells, groundwater wells, and aquifers will also be identified and considered. The LAA may be refined based on anticipated site-specific impacts.

To provide regional context for the assessment, the proposed RAA is defined as the 2L90 transmission line right-of-way with a 500 m buffer on either side (**Figure 3.1**).

3.2.2 Vegetation

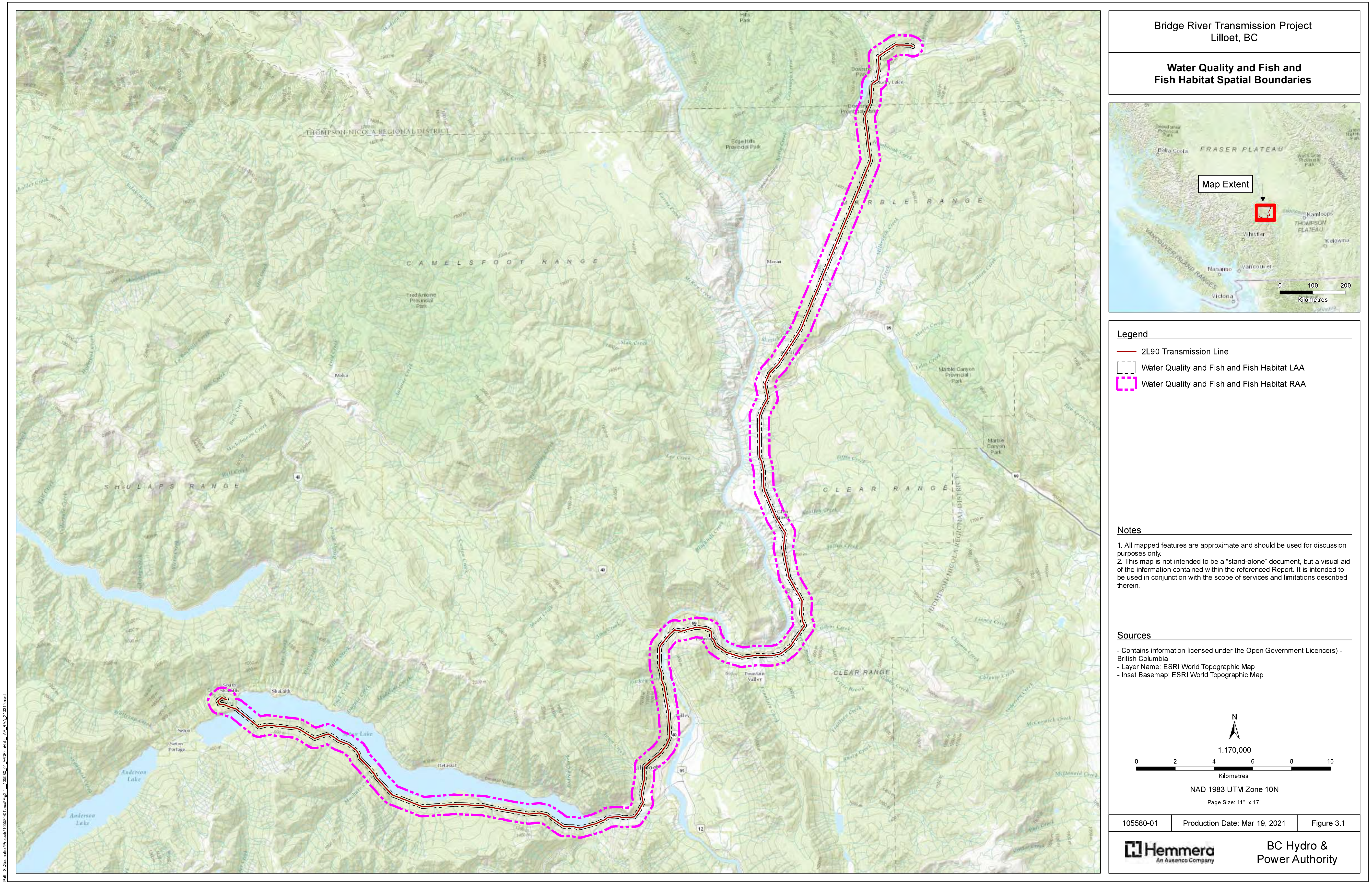
The proposed LAA for the Vegetation VC is defined as the transmission line right-of-way with a 50 m buffer on either side (**Figure 3.2**). This encompasses the area where the Project is expected to interact with, and potentially create direct or indirect effects on the terrestrial environment. The LAA may be refined based on anticipated site-specific impacts.

To provide regional context for the assessment, the proposed RAA is defined as the Pavilion Ranges and Southern Chilcotin Ranges ecosections combined (**Figure 3.2**).

3.2.3 Wildlife and Wildlife Habitat

The proposed LAA for the Wildlife and Wildlife Habitat VCs is defined as the 2L90 transmission line right-of-way with a 50 m on either side (**Figure 3.2**). This encompasses the area where the Project is expected to interact with, and potentially create direct or indirect effects on the terrestrial environment. The LAA may be refined based on anticipated site-specific impacts.

To provide regional context for the assessment, the proposed RAA is defined as the Pavilion Ranges and Southern Chilcotin Ranges ecosections combined (**Figure 3.2**).


Bridge River Transmission Project
Lilloet, BC
Water Quality and Fish and
Fish Habitat Spatial Boundaries
FRASER PLATEAU
Bella Coola
Map Extent
Kamloops
THOMPSON PLATEAU
Whistler
Kelowna
VANCOUVER ISLAND RANGES
Nanaimo
Vancouver
Victoria
0 100 200
Kilometres
Legend
2L90 Transmission Line
Water Quality and Fish and Fish Habitat LAA
Water Quality and Fish and Fish Habitat RAA
Notes
1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.
Sources
- Contains information licensed under the Open Government Licence(s) - British Columbia
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- Inset Basemap: ESRI World Topographic Map
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Figure 3.1
Hemmera
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BC Hydro & Power Authority
THOMPSON-NICOLA REGIONAL DISTRICT
CAMELSFOOT RANGE
SHULAPS RANGE
CLEAR RANGE
MARBLE RANGE
Edge Hills Provincial Park
Fred Antoine Provincial Park
Marble Canyon Provincial Park
Moran
Fountain Valley
Seton Portage
Anderson Lake
Shalalth

Bridge River Transmission Project
Lillooet, BC

Vegetation and Wildlife and Wildlife Habitat Spatial Boundaries

Legend

- 2L90 Transmission Line
- Vegetation and Wildlife and Wildlife Habitat LAA
- Vegetation and Wildlife and Wildlife Habitat RAA

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

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- Layer Name: ESRI World Imagery
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An Ausenco Company

BC Hydro & Power Authority

3.3 Temporal Boundaries

Temporal boundaries are defined based on the timing and duration of Project activities that could induce environmental or socio-economic effects. Temporal boundaries for the proposed Project were based on a construction schedule, including removal of temporary construction-related facilities and restoration of disturbed areas. Currently, construction is expected to occur over 2-3 years. At the end of construction and commissioning, the Project will return to service as per existing conditions with improved reliability and operational certainty. Operations and maintenance of the Project will continue to be provided by BC Hydro's staff, who will continue to perform routine inspection and maintenance and equipment repairs.

3.4 Water Quality

The 2L90 transmission line crosses and borders major watercourses including Seton Lake, Fraser River, and Bridge River. This section assesses potential effects of the Project on the Water Quality VC, including a description of the existing conditions in the LAA and potential mitigation.

3.4.1 Existing Conditions

As a Pathway Component, Project-related effects to Water Quality are considered in terms of their potential to cause effects to the Fish and Fish Habitat VC (i.e., end receptor).

The 2L90 transmission line begins at BRT at South Shalath and terminates at KLY near Clinton. It crosses Seton Lake located south of the BRT substation and heads in an eastbound direction, bordering the southern shoreline of Seton Lake until Seton Dam. Past Seton Dam, at the confluence of Seton River and Fraser River, the 2L90 transmission line proceeds north through Lillooet, bordering the western side of the Fraser River for approximately 7.9 km. Here, the 2L90 transmission line turns eastward at the confluence of Bridge River and Fraser River, and continues to run parallel along the southern shoreline of the Fraser River, curving north with the Fraser River and Highway (HWY) 99. The 2L90 transmission line crosses Pavilion Creek and continues in a northeast direction terminating at KLY near Clinton. Along its path, the 2L90 transmission line crosses a number of watercourses that stem from or drain into Seton Lake or the Fraser River, within the Seton River watershed or Middle Fraser River watershed, with varying characteristics described in **Table 3.2**. The notable named watercourses were observed through a desktop study through iMapBC (2021). The table also notes the fish bearing status of each of the watercourses, in support of **Section 3.4**.

Table 3.2 Watercourses crossings with 2L90 transmission line

Stream Name	Watershed Code	Characteristics	Fish Bearing	Classification
Seton Lake	100-235900	2L090 transmission line crosses Seton Lake at South Shalath southeast of the BRT substation and proceeds westward, bordering the southern shoreline of Seton Lake.	Y	L1-A
Machute Creek	100-235900-31000	Machute Creek drains into Seton Lake north of the 2L090 transmission line, and extends into a larger stream network southwest of the transmission line in the Machute Creek watershed, which is part of the larger Seton River watershed group	Y	S2
Seton River	100-235900	2L090 transmission line crosses the Seton River approximately 1 km west of Seton Dam at the confluence of Cayoosh Creek and Seton River. Cayoosh Creek extends southwestward into a larger stream network, passing through 3 small lake bodies that are too small for classification. Seton River drains into Seton Lake westward and connects with the Fraser River to the east.	Y	S1-B
Town Creek	100-236600	Passes through developed/residential area before draining into Fraser River southeast of the 2L090 transmission line. Extends northwest into a larger network of tributaries, part of the Seton Lake group watershed.	Y	S2/S3
Dickey Creek	100-240600	Drains into the Fraser River eastward, extends to a large network of tributaries westward within the larger watershed group of Seton Lake watershed.	Y	S2/S3
Bridge River	100-241900	At point of confluence with Fraser River. Mapped fish points include Pink, Sockeye, Chinook, Coho Salmon, Bull trout, Steelhead, Dolly Varden, etc.	Y	S1-B
Fraser River	100	Crossing just above the confluence of Bridge River and Fraser River in Northeast bound direction.	Y	S1-A
Fountain Creek	100-247400	Rapids point mapped at confluence of Fountain creek and Fraser River. Large southern network of tributaries connecting to wetland area and Frantzen Creek approximately 5.7 km south of 2L090 transmission line.	Y	S3
Gibbs Creek	100-248600	Drains into Fraser River west of 2L090 transmission line and extends to a larger network of tributaries eastward within the larger watershed group, Big Bar Creek watershed.	Y	S2/S3
Sallus Creek	100-251400	Drains into Fraser River west of 2L090 Transmission line and extends into large network of tributaries eastward into the Sallus Creek watershed.	Y	S2/S3
Keatley Creek	100-252000	Connects to Fraser River southwest of transmission line. Extends northeast, part of the Keatley Creek watershed.	Y	S2

Stream Name	Watershed Code	Characteristics	Fish Bearing	Classification
Tiffin Creek	100-256700	Connects to Fraser River westward. Extends to larger network eastward and connects to wetland area approximately 6.6km southeast of 2L090 transmission line.	Y	S2/S3
Pavilion Creek	100-258600	Connects to Fraser River towards the west. Large network northeast, connecting to wetland area and Big Bar Creek watershed.	Y	S2/S3
Gillon Creek	100-258600-29300	Tributary of Gillon Creek and Gillon Creek watershed that connects to a wetland area southeast of 2L090 transmission line.	Y	S2
Hambrook Creek	100-266300-69600	Connects with Kelly Creek, Kelly Lake, and wetland area.	Y	S2

Seton Lake exhibits oligotrophic water quality chemistry and experiences changes in water quality related to diversion of glacially turbid water from Carpenter Reservoir through the Bridge 1 and Bridge 2 Powerhouses and from the glacial fines from the alpine tributaries that drain into Portage Creek (Limnotek 2015). The pH of Seton Lake is slightly alkaline (Shortreed et al. 2001, Limnotek 2015), with a total alkalinity of 34.1 mg $CaCO_3$/L and a mean pH of 7.3 (Shortreed et al. 2001). Seton Lake also appears to follow a dimictic circulation pattern, with mixing occurring in the spring and fall, and the thermal stratification in the summer. In May, the thermocline is not well established and heats over the spring until a well-defined thermocline is established (at approximately 25 m) and remains until late October (Roscoe et al 2010, Limnotek 2015). Surface water temperatures in Seton Lake were found to increase from 9°C in May to 18°C in August, and cool to 12°C by October (Sneep 2015b, Limnotek 2015). As water temperature from the inflow increases over the summer, the inflow water flows to the epilimnion of Seton Lake without mixing in the hypolimnion. Temperature of the epilimnetic layer is cool at 13.5°C (Shortreed et al. 2001). Seton Lake is a nutrient-deficient lake; therefore, various forms of nitrogen and phosphorus tend to occur at low concentrations (Limnotek 2015). Nitrate concentrations were 30 µg/L in the spring turnover and declined to 2.6 µg/L in late summer (Shortreed et al. 2001). Total phosphorus concentration was 10 µg/L during spring turnover, indicating the lake was mesotrophic (medium-nutrient) at that time (Shortreed et al. 2001). Fall is the optimum time for biological production in Carpenter Reservoir, which could also be the case for Seton Lake due to the diversion of water from Carpenter Reservoir to Seton Lake (Perrin et al. 2016).

Evidence compiled to date (Limnotek 2015) for Seton Lake suggests that water quality results for pH and phosphorus meet provincial guidelines for drinking water, recreation water use, aquatic life, and irrigation and livestock. Water quality in watercourses crossed by the Project is expected to be reflective of natural water quality conditions in the region.

3.4.2 Methods

Surveys will be conducted in the LAA and RAA (as required) at identified watercourses where Project activities have potential to impact water quality. Surveys will determine baseline conditions of water quality in the identified watercourses. Post-construction surveys may also be required if Project-related effects associated with sediment run-off, spills, or accidental release of hazardous substances, are identified during construction, in or near watercourses.

3.4.3 Preliminary Effects Assessment

Project activities and the potential impacts on Water Quality are outlined in **Table 3.3**.

Table 3.3 Potential impacts on Water Quality

Project Activity	Potential Effect on Water Quality
Install or improve tower access roads, culverts, and bridges	Work at bridges and culverts as part of access road construction or upgrades may impact water quality through erosion of soils and/or spills of deleterious substances into or near watercourses and waterbodies.
Replace and reinforce transmission towers Ground re-contouring (to create more space between the line and the ground)	Excavation and alteration of ground substrate or vegetation structure during tower installation and ground re-contouring may impact water quality as sedimentation from exposed soils may flow into nearby watercourses and waterbodies.
Potentially other as-yet undetermined construction activities.	Further construction activities such as use of industrial equipment, site preparation, and placement of material or structures in or near watercourses and waterbodies may impact surface water quality.

Effects resulting from erosion of soils or accidental release of deleterious substances are expected to be localized and temporary. In addition, erosion and spills are generally preventable, and if they do occur, they are expected to be promptly reported and responded to with appropriate actions. Major watercourses are not expected to be affected.

Based on the desktop review of existing conditions and the preliminary effects assessment, the following mitigation measures may be required to reduce Project effects on Water Quality:

- Implementation of erosion and sediment control measures during construction activities.
- Silt curtains to be implemented where necessary to protect nearby watercourses and waterbodies.
- Spill response and mitigation measures and spill response kits available at construction sites.

Mitigation measures will be detailed in the Project's Environmental Management Plan. Additional mitigation measures may be added once a more detailed Project design is available and pending the results of field surveys.

3.5 Fish and Fish Habitat

The 2L90 transmission line crosses some large, fish-bearing watercourses including Seton Lake, Fraser River, and Bridge River. This section assesses potential effects of the Project on the Fish and Fish Habitat VC, including a description of the existing conditions in the LAA and potential mitigation.

3.5.1 Existing Conditions

Resident salmonids, anadromous salmonids, and instream fish habitat were selected as indicators for the Fish and Fish Habitat VC as both resident and anadromous salmonids reside in the assessment area for all or part of their life cycle and in-stream fish habitat is important in sustaining fish populations.

Anadromous fish species are those that spawn in freshwater and out-migrate to the ocean as juveniles, living most of their adult lives in the ocean, before returning to freshwater to spawn. Seton Lake, Seton River, and its tributaries are known to provide habitat for several fish species. Fish passage at Seton Dam provides anadromous fish access to Seton Lake from Seton River. Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*Oncorhynchus kisutch*), Sockeye Salmon (*Oncorhynchus nerka*), Pink Salmon (*Oncorhynchus gorbuscha*) and Steelhead (*Oncorhynchus mykiss*) are species of anadromous salmonids present in the Seton Lake. **Table 3.4** discusses the fish present in the assessment area observed through desktop study (iMapBC 2021, BC SES 2021). Fish bearing watercourses are noted in **Table 3.2**.

Table 3.4 Fish species of concern

Common Name	Scientific Name	SARA Status	Provincial List	Presence
Chinook Salmon (Seton River Watershed pop.)	Oncorhynchus tshawytscha	Threatened	Yellow	Seton River, Seton Lake, Bridge River
Coho Salmon (Lower Fraser River pop.)	Oncorhynchus kisutch	Threatened	None	Seton River, Seton Lake, Bridge River
Sockeye Salmon (Seton Lake pop.)	Oncorhynchus nerka	Endangered	None	Seton River, Seton Lake, Bridge River
Steelhead	Oncorhynchus mykiss	None	Yellow	Cayoosh Creek, Seton River, Kelly Lake, Fraser River, Pavilion Creek, Seton Lake, Fountain Creek, Bridge River, Machute Creek
Bull Trout	Salvelinus confluentus	Special Concern	Blue	Bridge River, Seton River, Seton Lake, Machute Creek
Brook Trout	Salvelinus fontinalis	None	None	Kelly Lake
Dolly Varden	Salvelinus malma malma	None	Yellow	Seton River, Cayoosh Creek, Bridge River
Nooksack Dace	Rhinichthys cataractae	Endangered	Red	Seton River
White Sturgeon	Acipenser transmontanus	Threatened	Red	Fraser River
Coastrange Sculpin	Cottus aleuticus	None	Yellow	Bridge River, Seton River

3.5.2 Methods

Surveys to characterize water quality at identified watercourse crossing where Project activities have potential to impact water quality will also assess fish presence and habitat quality. Post-construction surveys may also be required if Project-related effects associated with sediment run-off, spills, or accidental release of hazardous substances, are identified during construction, in or near fish-bearing watercourses.

3.5.3 Preliminary Effects Assessment

Project activities and the potential impacts on Fish and Fish Habitat are outlined in **Table 3.5**.

Table 3.5 Potential impacts on Fish and Fish Habitat

Project Activity	Potential Effect on Fish and Fish Habitat
Install or improve tower access roads, culverts, and bridges	Work at bridges and culverts as part of access road construction or upgrades may impact fish and fish habitat through changes in water quality (**Table 3.3**) as well as alteration or removal of riparian vegetation. In-water construction activities may also result in mortality of individuals or cause sensory disturbance to fish.
Replace and reinforce transmission towers Ground re-contouring (to create more space between the line and the ground)	Excavation and alteration of ground substrate or vegetation structure during tower installation and ground re-contouring may impact fish and fish habitat through changes in water quality (**Table 3.3**) as well as alteration or removal of riparian vegetation.
Potentially other as-yet undetermined construction activities.	Further construction activities such as site preparation, use of industrial equipment, and placement of materials or structures in or near watercourses and or waterbodies may have a direct impact on fish and fish habitat or impact fish and fish habitat through changes in water quality (**Table 3.3**).

As described in **Section 3.4.3**, erosion and spills are generally preventable and any effects are expected to be localized and temporary, as such potential effects to fish and fish habitat anticipated to be negligible.

Similar to the potential mitigation measures for water quality as discussed in **Section 3.4.3**, the following mitigation measures may be required to reduce Project effects on Fish and Fish Habitat:

- Minimal disturbance or complete avoidance to fish habitat and maintenance of fish habitat during construction activities.
- Avoid removing riparian vegetation during construction activities.

Mitigation measures will be detailed in the Project's Environmental Management Plan. Additional mitigation measures may be added once a more detailed Project design is available and pending the results of field surveys for fish species of concern and fish habitat.

3.6 Vegetation

The 2L90 transmission line is a maintained right-of-way dominated by early successional stage ecosystems. This section assesses potential effects of the Project on the Vegetation VC, including a description of the existing conditions in the LAA and potential mitigation.

3.6.1 Existing Conditions

The LAA ranges from approximately 200 to 1,600 m in elevation and overlaps four biogeoclimatic (BGC) zones: Bunchgrass (BG), Ponderosa Pine (PP), Interior Douglas-fir (IDF), and Montane Spruce (MS).

Proposed Critical Habitat for whitebark pine overlaps the LAA along the south side of Seton Lake and overlaps the transmission line at the east end the lake. No at-risk ecological communities or plant species are known to occur in the LAA, however, there is potential for occurrence within the BGC zones present. Numerous known occurrences of invasive vegetation occur in the LAA (iMap BC 2020).

3.6.2 Methods

A screening exercise to assess potential for at-risk ecological communities or at-risk plant species within the LAA will be conducted in advance of any field studies. Field surveys will be conducted by a biologist or ecologist with experience identifying ecosystems, native species, and invasive vegetation. Surveys for invasive species will be conducted along access roads to determine presence of invasive species and the potential for distribution. Surveys may also be required for at-risk plant species or ecological communities, depending on the extent of vegetation removal associated with the Project and the results of the at-risk plant and ecological community screening exercise. All occurrences of at-risk and invasive vegetation will be recorded using a handheld GPS and photo-documented.

3.6.3 Preliminary Effects Assessment

Project activities and the potential impacts on Vegetation are outlined in **Table 3.6**.

Table 3.6 Potential impacts on Vegetation

Project Activity	Potential Effect on Vegetation
Install or improve tower access roads, culverts, and bridges Replace and reinforce transmission towers Ground re-contouring (to create more space between the line and the ground)	Project activities may require vegetation clearing, which has the potential to result in the removal of at-risk vegetation species or degradation of habitat.
Potentially other as-yet undetermined construction activities.	It is uncertain if tree clearing and other vegetation removal will be required, but removal of vegetation could reduce the quality and biodiversity of native and existing vegetation. Use of mobile industrial equipment and vehicles also has the potential to result in the introduction and spread of invasive species.

Based on the desktop review of existing conditions and the preliminary effects assessment, the following mitigation measures may be required to reduce Project effects on vegetation:

- Vegetation clearing will be minimized to the extent possible.
- Ensuring vehicles traveling from an area with invasive species are washed prior to moving to new areas.

Mitigation measures will be detailed in the Project's Environmental Management Plan. Additional mitigation measures may be added once a more detailed Project design is available and pending the results of field surveys.

3.7 Wildlife and Wildlife Habitat

The 2L90 transmission line provides habitat for multiple wildlife species, some of which are species of concern. This section assesses potential effects of the Project on the Wildlife and Wildlife Habitat VC, including a description of the existing conditions in the LAA and potential mitigation.

3.7.1 Existing Conditions

Wildlife species of concern with potential to occur within the LAA and be affected by Project activities (either directly or through impacts to their habitat) are listed in **Table 3.7**.

Table 3.7 Wildlife species of concern with potential to be affected by Project activities

Common Name	Scientific Name	SARA Status	Provincial List	Rationale
Amphibians				
Coastal tailed frog	*Ascaphus truei*	Special Concern	Yellow	Amphibians may be present within the LAA and could be affected if work on bridges or culverts impacts wetlands and watercourses. Project activities could also cause mortality from increased vehicle traffic.
Western toad	*Anaxyrus boreas*	Special Concern	Yellow	
Birds				
Bald eagle	*Haliaeetus leucocephalus*	None	Yellow	Nests are protected year-round, whether occupied or not, under the BC *Wildlife Act* Section 34b. Eagles are known to nest on transmission towers.
Barn swallow	*Hirundo rustica*	Threatened	Blue	Work on bridges and culverts may impact nest sites.
Common nighthawk	*Chordeiles minor*	Threatened	Yellow	Work on access roads or ground re-contouring may impact nest sites.
Flammulated owl	*Psiloscops flammeolus*	Special Concern	Blue	Removal of vegetation (particularly trees) may affect potential breeding habitat.
Golden eagle	*Aquila chrysaetos*	None	Yellow	Nests are protected year-round, whether occupied or not, under the BC *Wildlife Act* Section 34b. Eagles are known to nest on transmission towers.
Lark sparrow	*Chondestes grammacus*	None	Blue	Work on access roads and ground re-contouring or vegetation removal may impact breeding habitat.
Lewis's woodpecker	*Melanerpes lewis*	Threatened	Blue	Critical Habitat for this species extensively overlaps the LAA. Nest site availability and foraging habitat may be affected by the removal of wooden utility poles or trees with cavities.
Long-billed curlew	*Numenicus americanus*	Special Concern	Blue	Work on access roads or ground re-contouring may impact breeding habitat.
Olive-sided flycatcher	*Contopus cooperi*	Threatened	Blue	Vegetation (tree) removal may impact breeding habitat.

Common Name	Scientific Name	SARA Status	Provincial List	Rationale
Osprey	*Pandion haliaetus*	None	Yellow	Nests are protected year-round, whether occupied or not, under the BC *Wildlife Act* Section 34b. Osprey are known to nest on transmission towers.
Spotted owl	*Strix occidentalis*	Endangered	Red	It is unlikely that spotted owl is currently present within the LAA, however, there are wildlife habitat areas designated for spotted owl along the south side of Seton Lake. These could be impacted by vegetation removal or alteration.
Western screech-owl	*Megascops kennicotti macfarlanei*	Threatened	Blue	Screech owls have been detected within the LAA. Vegetation (tree) removal may impact breeding habitat.
Mammals				
Bighorn sheep	*Ovis canadensis*	None	Blue	Sheep can be affected by auditory and visual disturbance due to construction activities. Road improvements and increased traffic could lead to human/wildlife conflicts.
Mule deer	*Odocoileus hemionus*	None	Yellow	Ungulate winter range for mule deer is present near the north end of the 2L90 transmission line. Road improvements along ROW could lead to increased hunting pressure outside of the UWR.
American badger	*Taxidea taxus jeffersonii*	Endangered	Red	Project activities could contribute to mortality from vehicle traffic. Ground disturbance and recontouring could result in impacts to important denning habitat or affect the availability of prey species.
Fringed myotis	*Myotis thysanodes*	Data deficient	Blue	Removal of wooden utility poles or trees and work at bridges could impact roost availability. Foraging sites may be impacted by vegetation removal and ground re-contouring. Northern myotis, fringed myotis, and spotted bat were captured during previous inventory studies in 2010 and 2014.
Little brown myotis	*Myotis lucifugus*	Endangered	Yellow	
Northern myotis	*Myotis septentrionalis*	Endangered	Blue	
Pallid bat	*Antrozous pallidus*	Threatened	Red	
Spotted bat	*Euderma maculatum*	Special Concern	Blue	
Reptiles				
Gopher snake	*Pituophis catenifer deserticola*	Threatened	Blue	Project activities could contribute to mortality due to increased vehicle traffic along the ROW. Ground disturbance and recontouring could result in impacts to important habitat such as hibernacula.
North American racer	*Coluber constrictor*	Special Concern	Blue	
Northern rubber boa	*Charina bottae*	Special Concern	Yellow	

3.7.2 Methods

The following surveys are proposed to determine species presence and, where present, to develop mitigation measures to avoid or minimize the effects for species within the LAA:

- Point counts at helipads, laydown, and staging areas to determine the presence and potential nesting areas of at-risk birds: Lewis's woodpecker, lark sparrow, olive-sided flycatcher, long-billed curlew.
- Visual surveys for potential Lewis's woodpecker nest cavities and other protected nest sites (e.g., stick nests) on all wooden utility poles and trees slated for replacement or removal.
- Visual assessment of all large trees scheduled to be removed. Assess for potential cavities, roosts, nests, and bear dens.
- Visual surveys for barn swallow nest sites and bat roosts at any bridges requiring upgrades (to be determined).
- Visual surveys for American badger dens at all wooden utility poles slated for replacement or removal, in areas where there will be access road upgrades, and at ground recontouring sites.
- Evening call-playback surveys for common nighthawk in potential nesting areas where ground recontouring will occur.
- Roost watch with use of handheld acoustic monitors at high potential roost trees slated for removal.
- Surveys for potential snake hibernacula if disturbance is expected near rock outcrops.

3.7.3 Preliminary Effects Assessment

Project activities and the potential impacts on Wildlife and Wildlife Habitat are outlined in **Table 3.8**.

Table 3.8 Potential impacts on Wildlife and Wildlife Habitat

Project Activity	Potential Effect on Wildlife and Wildlife Habitat
Replace and reinforce transmission towers	Removal of wooden utility poles may impact Lewis's woodpecker nest sites. It is also possible other bird or bat species may use cavities for nesting or roosts, respectively, and removal could also result in direct mortality of individuals. Additionally, any large stick nests present on transmission towers could be impacted. Construction activities may also cause sensory disturbance to wildlife.
Install or improve tower access roads, culverts, and bridges	Work at bridges or culverts may impact barn swallow nests or bat roosts on the structures. Work at bridges and culverts may also affect amphibians or amphibian habitat if there are impacts to the waterbodies or their edges (i.e., riparian vegetation). Construction activities may also result in mortality of individuals or cause sensory disturbance to wildlife.
Ground re-contouring (to create more space between the line and the ground)	Altering ground substrate or vegetation structure may affect nest sites for ground-nesting birds such as common nighthawk, lark sparrow, or long-billed curlew and could also result in direct mortality, particularly of young if birds are nesting in these areas. Disturbing the ground cover may also impact snake hibernacula if there is suitable habitat present. Construction activities may also cause sensory disturbance to wildlife.

Project Activity	Potential Effect on Wildlife and Wildlife Habitat
Potentially other as-yet undetermined construction activities.	It is uncertain if tree clearing and other vegetation removal will be required, but removal of vegetation could reduce the availability of nest sites for multiple bird species, as well as decrease the quality of Lewis's woodpecker Critical Habitat and spotted owl WHAs. Removal of trees could also affect the availability of bat roosts. Vegetation removal in riparian areas may reduce foraging habitat for bats and cover for amphibians. Vehicle traffic could lead to increased road mortality of all wildlife species. Auditory and visual disturbance from construction activities may affect the use of the nearby habitat by wildlife. Improved road access for construction work may increase human wildlife interactions for bighorn sheep and mule deer.

Based on the desktop review of existing conditions and the preliminary effects assessment, the following mitigation measures may reduce Project effects on Wildlife and Wildlife Habitat:

- Wildlife habitat features (nests, dens, roosts) identified during the surveys described in **Section 1.1.1** will be protected to the greatest extent possible and activities near these features will be minimized. When animals are present at these features, they will not be disturbed.
- Vegetation clearing will take place outside of the bird nesting season. If this is not possible, then pre-clearing bird nest surveys will be conducted by qualified personnel prior to clearing. If active nests are discovered, activities within the nesting area will be postponed until nesting is complete.
- Construction activities should be conducted during least-risk windows for all wildlife to the extent possible.
- Any excavations will be backfilled as soon as is reasonably possible, to avoid potential for wildlife injury.
- Construction activities will minimize the volume levels, duration, and frequency of noise sources, to the extent possible.
- All waste will be managed in a way that it is not a bear attractant. It will be temporarily stored in bear-proof containers until it is properly disposed in a waste management facility.
- Bear safety training will be provided to all on-site personnel.
- Vehicle traffic will adhere to speed limits and drivers will be alert for the presence of wildlife on access roads.

Mitigation measures will be detailed in the Project's Environmental Management Plan. Additional mitigation measures may be added once a more detailed Project design is available and pending the results of field surveys for wildlife of concern and their habitat features.

4.0 HERITAGE ASSESSMENT

The landscape of the LAA spans the Bunchgrass (BG), Ponderosa Pine (PP), Interior Douglas-fir (IDF), and Montane Spruce (MS) biogeoclimatic zones and includes Seton Lake, the Seton River, the lower Bridge River, and the Fraser River. These biogeoclimatic zones and watercourses have been intensively utilized by St'át'imc for thousands of years. The use of the landscape of this mid-Fraser Region is indicative of a larger cultural use pattern amongst the Interior Plateau populations including the St'át'imc, Secwépemc and Nlaka'pamux.

St'át'imc use and stewardship of this landscape is evident in a range of archaeology sites including; habitation sites (villages, camps, temporary shelters, rock shelters), cultural depressions (housepits and storage pits), artifact scatters (surface and subsurface), subsistence features (hearths, cooking and drying pits) burial places, rock art (pictographs, petrographs, petroforms), forest utilization sites including culturally modified trees (CMT), trails, spiritual places and historic remains. These heritage resources are protected by the *Heritage Conservation Act* (HCA). The HCA provides protection to heritage resources that pre-date 1846. There are also traditional use activities which may not be encompassed in the site types identified in the HCA. Traditional use sites or historic place which post date 1846 may also be present in the LAA.

BC Hydro acknowledges that in compliance with the HCA, no site, nor any part of a site, may be altered or disturbed in any way without a Section 12 or 14 permit issued by the Archaeology Branch. BC Hydro recognizes that heritage sites of Aboriginal origin not automatically protected by the HCA may be regarded as part of the fiduciary responsibility of provincial governments for protecting First Nations' cultural heritage. Therefore, BC Hydro will conduct assessments to ensure management of heritage resources that may potentially be impacted during the project and future work conducted by BC Hydro in the project area.

4.1 Issues Scoping

The purpose of Issues Scoping is to focus the assessment on key issues that have the potential to affect environmental components in proximity to the Project. These key issues were determined through the identification of the potential interactions of the Project components and activities with the biophysical environment, past projects of similar size and scope, engagement with St'át'imc Nation, input from key stakeholders, and use of professional judgement and scientific and regulatory considerations.

A list of candidate VCs that were identified for the Project is provided in **Table 4.1**. The table also describes the rationale for selection and subsequent inclusion or exclusion of the candidate VC in the effects assessment. For those VCs carried forward in the assessment, indicators are provided.

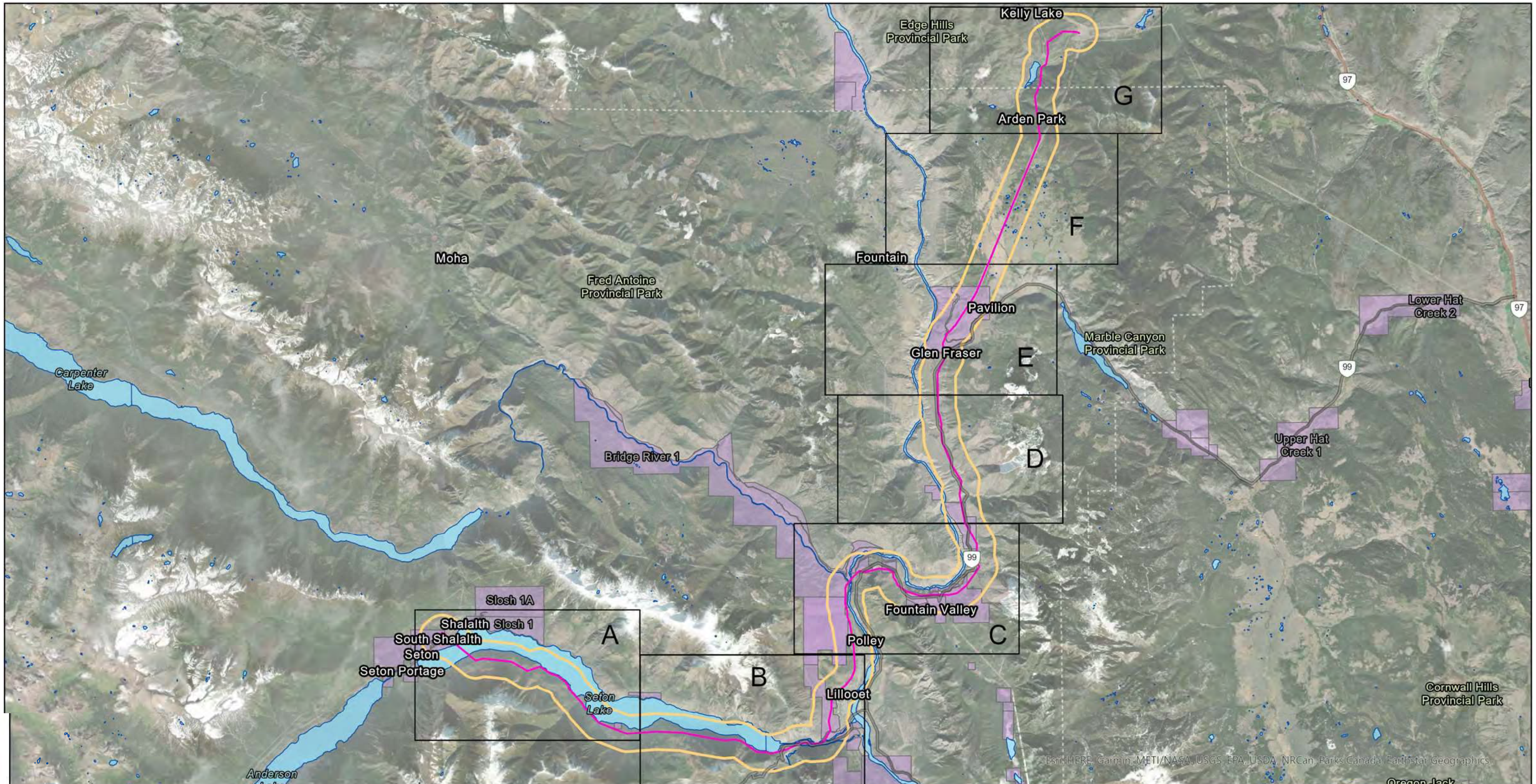
Table 4.1 Rationale for selection of Heritage Valued Components

Candidate VC	Rationale	Indicators
Heritage	Project activities may result in interactions with heritage resources. Ground disturbing activities including utility pole replacement, access road upgrades, improvement or replacement of bridges and culverts, tree or vegetation removal and ground recontouring have the potential to impact protected heritage resources. There is also the potential for unknown archaeological sites to be identified in the project area. **Included as Valued Component**	Presence of an archaeological site, registered or previously unknown, within the project activity area

4.2 Spatial Boundaries

The proposed LAA for Heritage is defined as the 2L90 transmission line right-of-way with a 50 m buffer on either side. Due to the 76 km length of the transmission line, the project area has been arranged into seven segments, identified as Segments A to F, ranging from 7 to 16 km in length (**Figure 4.1**).

To provide regional context for the assessment, the proposed RAA is defined as the 2L90 transmission line ROW with a 1,000 m buffer. The RAA captures the project area where ground disturbances for road upgrades and staging areas may impact heritage resources.



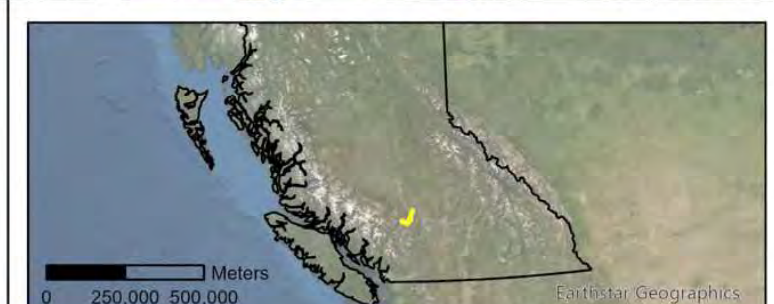
- 2L090 Transmission Line
- 2L090 Transmission Line 1000m Buffer
- Waterbody
- First Nation Federal Reserve

Data Reference:
DataBC - Open Government License
(data.gov.bc.ca)

0 3,000 6,000 12,000 Meters

N

Scale: 1:210,000



2L090 Transmission Line Overview Map

Project: 2L090 Transmission Line Upgrade

Figure 4.1

Prepared for:
BC Hydro

Prepared by: Talicia Kane

Date: 2021-02-09

Spatial Reference:
NAD 1983 UTM Zone 10N

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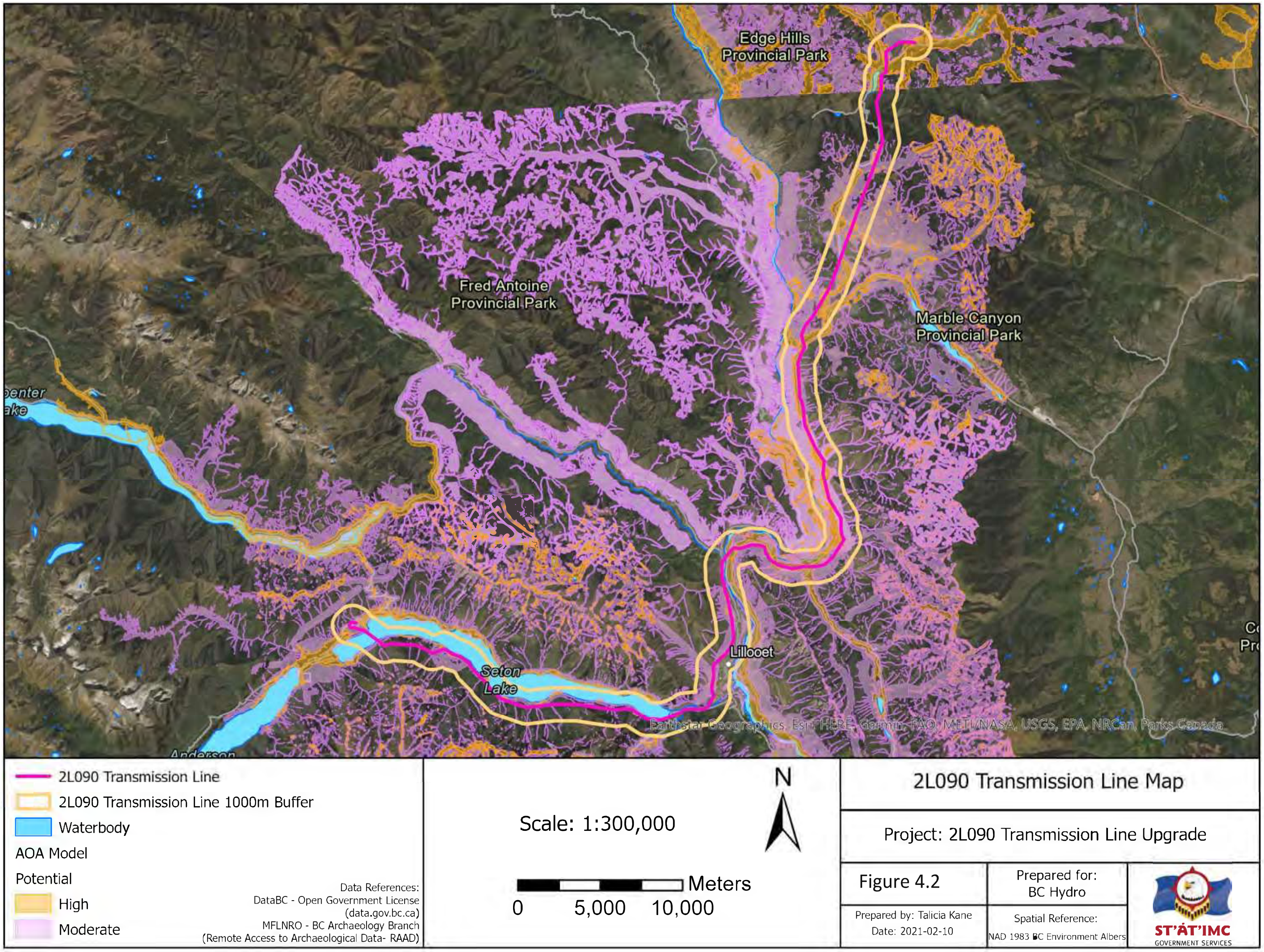
Edge Hills
Provincial Park
Fred Antoine
Provincial Park
Marble Canyon
Provincial Park
Seton
Lake
Lillooet
Earthstar Geographics, Esri, HERE, Garmin, FAO, METI/NASA, USGS, EPA, NRCan, Parks Canada
2L090 Transmission Line
2L090 Transmission Line 1000m Buffer
Waterbody
AOA Model
Potential
High
Moderate
Data References:
DataBC - Open Government License
(data.gov.bc.ca)
MFLNRO - BC Archaeology Branch
(Remote Access to Archaeological Data- RAAD)
Scale: 1:300,000
N
Meters
0 5,000 10,000
2L090 Transmission Line Map
Project: 2L090 Transmission Line Upgrade
Figure 4.2
Prepared for:
BC Hydro
Prepared by: Talicia Kane
Date: 2021-02-10
Spatial Reference:
NAD 1983 BC Environment Albers
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4.3 Existing Conditions

Archaeological site locations are often correlated with particular landscape attributes, their presence or absence can be used to identify lands with greater or lesser archaeological potential. Thus, the assessment of archaeological resource potential is based upon a consideration of topographical and biophysical characteristics that favour or inhibit the distribution of archaeological resources, in addition to the locations of documented sites, ethnographic and historic settlement information. The attributes considered include:

- Proximity to aquatic features, particularly the Fraser River, but also its tributary streams and associated lakes in landward settings.
- Proximity and environmental setting of documented archaeological and historic heritage resources.
- Modern vegetation patterns, as a reflection of the extent of industrial timber harvesting.
- Integrity of the modern landscape as a reflection of historic land use practices.

Two GIS based archaeological potential models were developed in the 1990's which indicate the probability of whether unrecorded or unregistered archaeology sites exist in the LAA or RAA in areas that could be affected by proposed development activities. These models include the Lillooet Forest District (1999) and the Northern Secwepemc Traditional Territory (1998) Archaeological Overview Assessments (AOA). Both models have been assessed by the BC Archaeology Branch and are available on the Provincial RAAD system (**Figure 4.2**). In general, the assessments conform to 1996 AOA model standards.

An archaeological potential models' performance is calculated using Kvamme's Gain Statistic (Kv gain) which is a statistic that measures the performance based on the percentage of known archaeology sites captured compared to the overall land area. A high Kv gain (maximum of 1.0) indicates a good model, a number around zero indicates the model performs no better than random, and a negative number indicates worse than random. A Kv gain of 0.8 or better indicates a non-random, highly predictive model. The Provincial standard for an efficient model requires that no less than 70% of known archaeology sites are captured in less than 10% of the land area with a minimum Kv gain of 0.8 (British Columbia Archaeology Branch 2009). The Lillooet Forest District model assessment indicates 85% of known archaeological sites were identified over 15% of the land mass with a Kv gain of .82 and is a highly predictive model. The Northern Secwepemc Traditional Territory model assessment indicates 90% of known archaeological sites were identified over a 57.9% of the land mass with a Kv gain of -4.31 and is an inefficient model.

Both AOA models categorize lands as having "High", "Moderate", or "Low" archaeological resource potential. The varying classes of potential ratings affect the scope and level of effort recommended as follow-up actions. In general, the higher the archaeology potential, the greater is the level of effort expected by regulatory authorities. However, considering the Lillooet Forest District AOA (1999) and the Northern Secwepemc Traditional Territory AOA (1998) models have not been updated to adhere to the present standards of AOA modelling by the Provincial Archaeology Branch, the category of moderate potential will be considered to have high potential and all areas modelled as having high or moderate potential should be assessed to the same standard. For the project area, the potential values are defined in the AOA models as follows:

- High Potential: Lands exhibiting topographic and biophysical attributes highly supportive of traditional cultural activities that would have left archaeological evidence. These lands exhibit the highest archaeological sensitivity within a landscape, and an archaeological impact assessment is recommended for lands exhibiting such characters.

- Moderate Potential: Lands exhibiting fewer attributes that would have supported traditional cultural activities, then the preceding category. Moderate potential lands may require follow-up archaeological investigation in the form of a field reconnaissance to verify whether such settings are actually of high or low potential. Such information also may be determined by review of higher-resolution imagery, such as LiDAR mapping or low-elevation aerial photography.
- Low Potential: Lands that exhibit few characteristics supportive of traditional cultural activities. Further field investigations are not normally recommended for lands categorized as having low archaeological potential. However, an area modelled as low potential does not signify that these areas have no archaeology potential.

Previous Archaeology Studies in the Study Area

Numerous studies have taken place in the LAA/RAA. However, the archaeological resources in the project area cannot be considered to have been thoroughly investigated as not all studies were carried out to modern standards. For example, studies conducted prior to the mid 90's would have generally focussed on areas that were low elevation, in valley bottoms, and/or near large bodies of water. Whereas studies after GIS models were developed in the late 1990's would generally be guided by survey strategies that cover all parts of the landscape.

Nineteen permitted and two unpermitted studies have taken place in the LAA/RAA (**Table 4.2**). Of these, thirteen were conducted prior to 1999 when GIS potential modelling was available to guide studies. Six of studies include past assessment work on the 2L090 line and three of these were conducted after 1999.

Table 4.2 Summary of previous studies in the local and regional assessment areas

Type of Study	Direct Overlap with Assessment Area? (Y/N)	Distance, Direction from Proposed Assessment Area	Year Assessed	HCA Permit #8	Comments Relevant to this Study
Recording	Y	Within the permit area	1974	1974-031	Recording of sites in the vicinity of the project area but no detailed assessment of sites in the transmission corridor
AIA	Y	Within the permit area	2010	2010-006	AIA was conducted within the project area for a trail project. There was no archaeology assessment of the transmission corridor or the transmission towers, only a recreational trail to the SE of the transmission line
AIA	Y	Within 500 m of the permit area	2007	2007-236	AIA was conducted for a Telus submarine line in Seton and Anderson Lake. There is no overlap in the project areas
AIA	Y	Intersects current project at three locations in Segment C	2015	2014-315	AIA for relocation of portion of 60L020; intersects current project in three locations
AIA	Y	Intersects current project at three locations in Segment C	2016	2016-368	AIA for relocation of portion of 60L020;
Recording	N	>500 m east of the permit area	1976	1976-009	The recovery of human remains from EeRl-169; the site is outside of the project area, will not be impacted by this project
AIA	N	>500 m from the project	1991	1991-067	This AIA addressed proposed Highways upgrades in the South Cariboo and Lillooet area
PFR	Y	Within the permit area	2005	N/A	This project was an assessment of direct and ongoing impacts to St'at'imc archaeological sites resulting from BC Hydro developments. Some sections of the 2L090 transmission line were inspected but management recommendations and site reports were not submitted to the Archaeology Branch.
AIA	Unknown	>500 m from project	1972	Unknown	This AIA was an archaeological survey of the Lillooet- Big Bar Area. No sites were recorded in the 2L090 project area.

Type of Study	Direct Overlap with Assessment Area? (Y/N)	Distance, Direction from Proposed Assessment Area	Year Assessed	HCA Permit #8	Comments Relevant to this Study
AIA	Y	Within permit area	2012	2012-0222	An AIA interim report for proposed 2L090 upgrades was prepared and provided to BC Hydro. Final report has not been completed.
AIA	N	100 m north of ROW	1999	1999-296	AIA of water system development near Seton Lake, outside of the 2L090 Project area
Recording	N	250 m east of project	1973	1973-022	This report summarizes excavations at EeRk-4. This site is located outside of the 2L090 project area and will not be impacted during this project
AIA	N	200 m north of ROW	1982	1982-026	No report available
AIA	Y	Within permit area	2001	2001-326	No report available
AIA	N	Unknown	1977	1977-017 (see report 1977-17K)	Overview of the ethnohistory and archaeological resources of the Fraser Canyon and Bridge River Regions. No archaeological inspections were conducted
AIA	N	500 m south of project	2007	2007-318	This project was monitoring of the installation of a submerged Telus cable in Seton and Anderson Lake, outside of the 2L090 permit area
AIA	Y	Encompasses project area from foot of Seton Lake to Pavilion Creek	1960 1968 1969	1968-19	Survey of the Fraser River from Big Bar to Lillooet
AIA	Y	Unknown	1961	1961-006	This work was Sanger's survey of burial sites along the Fraser River, adjacent to Lillooet and northward
AIA	N	<500 m from project	1984	1984-030	Lillooet-Pioneer Road Upgrading Project did not address specific locations in the 2L090 project
AIA	Y		1986	1986-020	Investigation of burial recorded at EeRl-19
Investigation	Y	1 site within project & 2 sites <100m from project, both in Segment C; 2 sites not in project area	1970	1970-002	Investigation of 5 archaeological sites by Arnoud Stryd (UCalgary)

Registered Archaeology Sites in the LAA

There are 57 registered archaeology sites in the LAA with 13 of these sites located with the statutory ROW. The 44 remaining registered sites in the LAA may potentially be impacted by project activities. To ensure protection of heritage resources in the LAA, archaeology assessments should consider the registered archaeology sites along with the AOA model for each segment and confirmation through field assessments. The AOA model indicates a probability that unrecorded and unregistered archaeology sites exist in all segments of the LAA. The complete range of archaeology site types documented for the Interior Plateau are expected to occur in the LAA. **Table 4.3** provides the number and types of registered archaeology site in each segment of the LAA.

Table 4.3 Summary of registered archaeology sites within 100 m of the Project area

Segment	Segment Length (km)	No. of Registered Sites in LAA	No. of Sites within the ROW/Direct Overlap	Site Type (s)
A	14	5	2	Cultural Depressions
B	16.2	8	2	Cultural Depressions, Human Remains, Surface and Subsurface artifacts, Rock Art
C	15.8	30	5	Cultural Depressions, Human Remains, Surface and Subsurface artifacts, Historic Cemetery
D	7.44	4	1	Surface Artifacts
E	8.14	3	0	Human Remains, Surface and Subsurface Artifacts, Traditional Use (CMT)
F	7.86	5	3	Surface artifacts, Subsistence Feature (hearth)
G	7.32	2	0	Trail, Cultural Depressions, Surface Artifacts, Human Remains
TOTALS	**76.76**	**57**	**13**	

The registered archaeology sites in **Table 4.3** represent sites that have been recorded as a result of work conducted for past projects (BC Hydro, Forestry, Municipal and private developments) dating from the 1950's to the present. There may be a range of error in the location plotting and size of archaeology sites in the BC Provincial Heritage Database/RAAD system. There is the potential to encountered additional heritage resources at registered sites which sometimes results in changes to the dimensions of an archaeological site.

Registered Archaeology Sites in the RAA

There are 255 registered archaeology sites in the RAA. **Table 4.4** documents the number and types of archaeology sites by segments in the RAA. There is a high to moderate probability that unrecorded and unregistered archaeology sites exist in the Project Area. For the RAA, there is potential to impact heritage resources with project activities including access roads, vegetation clearing, lay down and staging areas.

Table 4.4 Summary of registered archaeology sites within 1,000 m of the Project area

Segment	No. Registered Sites	Site Type (s)
A	25	Cultural depressions, Human Remains, Surface, and Subsurface Artifacts
B	57	Cultural depressions, Rock Art, Human Remains, Surface, and Subsurface Artifacts
C	109	Cultural depressions, Rock Art, Human Remains, Surface and Subsurface Artifacts, Rock Shelter
D	16	Cultural depressions, Rock Art, Human Remains, Surface, and Subsurface Artifacts
E	30	Cultural depressions, Human Remains, Surface and Subsurface Artifacts, Traditionally Modified Tree, Trail, Subsistence Feature (Hearth)
F	11	Cultural depressions, Surface and Subsurface Artifacts, Traditionally Modified Tree, Trail, Subsistence Feature (Hearth)
G	7	Cultural Depression, Surface and subsurface lithics, Human Remains, Trail
Total	255	

4.4 Methods

An application for a Heritage Investigation Permit (Section 14) has been sent to the Provincial Archaeology Branch. The Archaeological Impact Assessment (AIA) work conducted in accordance with the terms and conditions of this permit will assess areas where potential conflicts have been identified between archaeological resources and ground disturbing activities due to project activities. AIA work will assess all areas where project work is proposed. The AIA work will include:

- A review of the existing AOA modelled areas and studies to identify areas exhibiting potential for archaeological resources that have not been previously assessed to modern standards.
- Assessment of all areas with archaeology potential that could be disturbed by the project activities.
- Documenting any newly identified archaeology sites in the project area.
- Conducting site visits to registered archaeology sites in the LAA/RAA that could be disturbed by the project activities to confirm site location, site description, site dimensions and update mapping.
- Pedestrian survey and subsurface testing to locate unknown archaeological deposits within the LAA and RAA that could be disturbed by the project activities in advance of ground disturbance.

The study area will be surveyed for archaeological features (e.g., cultural depressions, trees with modifications that may pre-date AD 1846), and areas exhibiting potential for archaeological resources (e.g., landforms and exposures). Surveyed terrain will be mapped in relation to the development footprint and described in the report.

Survey coverage will minimally address areas of anticipated archaeological potential identified by the AOA study (where they exist) and may be modified based on in-field observations. Areas of potential that are not surveyed will be mapped and rationale provided for why the area was not assessed and why it was evaluated to contain potential.

There may be additional heritage information and knowledge held by St’át’imc that is not included in the BC Provincial Heritage Database/RAAD system. Engagement with St’át’imc prior to the AIA fieldwork may assist with potential data gaps. Utilizing the established BC Hydro/SGS St’át’imc points of contact, the Heritage Project Coordinator from SGS and the BC Hydro archaeologist can conduct a meeting with each St’át’imc Community to discuss specific locations in the project area that may contain unrecorded heritage resources or be of cultural importance. These areas will be documented and confidentially stored on the SGS GIS system. A site visit to each identified location in the project area will be conducted during the AIA.

4.5 Preliminary Effects Assessment

Project activities, including pole replacements, development of staging or laydown areas, access road upgrades and re-contouring could result in impacts to heritage resources. The AIA reporting will include recommendations to manage and mitigate expected impact of heritage resources in the project area. These recommendations may include:

- Avoiding the site.
- Recovering archaeological site information prior to land altering activities.
- Monitoring for additional archaeological site information during land altering activities.

BC Hydro will utilize the results of the AIA to avoid or manage impacts to protected heritage resources. If changes can not be made to project design to avoid impacts to heritage sites, BC Hydro will:

- Develop a heritage management plan.
- Obtain a Section 12.4 Site Alteration Permit from the Provincial Archaeology Branch.
- Conduct an impact assessment concurrent with ground disturbing activities.

5.0 SOCIO-ECONOMIC ASSESSMENT

This section describes existing socio-economic conditions in the vicinity of the proposed Project, including a rationale for the selection of the socio-economic VCs. The potential for Project-related effects is considered and preliminary mitigation measures are proposed.

The information provided in this section was gathered through ongoing engagement with St’át’imc Nation, and from publicly available sources. For each community, there is a variable amount of publicly available information, therefore, some of the sections below have more information than others, and additional context may be gathered through community review and further engagement. In addition, Statistics Canada supresses data for small populations to protect anonymity.

5.1 Issues Scoping

The purpose of Issues Scoping is to focus the assessment on key issues that have the potential to affect the socio-economic environment of communities and populations in proximity to the Project. These key issues were determined through the identification of the potential interactions of the Project activities with the socio-economic environment, input received from St’at’imc Nation on past BC Hydro projects and use of professional judgement and scientific and regulatory considerations.

BC Hydro has been working with the St’át’imc Nation and the St’át’imc communities for several decades in regard to their interests and concerns related to BC Hydro infrastructure in St’át’imc territory. While more recent projects have focused on upgrades at generating stations, work along transmission lines, and in particular work along 2L90, has been limited to regular annual maintenance, targeting certain areas, and rarely the lines in their entirety. Over the years, concerns have been raised by St’at’imc regarding work on transmission lines that include community safety and privacy, disturbance to cultural activities, increased public access and nuisance, and poor worksite management. There are also concerns related to an influx of workers, their interactions with local communities, and associated impacts on housing and other infrastructure. These safety concerns extend across St’át’imc communities and Lillooet. With the recent COVID-19 pandemic, there are additional concerns related to an influx of workers and potential impacts on community health. This background has informed the understanding of issues and concerns and the potential socio-economic impacts of this project.

The Project construction is anticipated to create employment and procurement opportunities for local residents and businesses but will also likely require workers from outside the study area, which would create a temporary influx of workers to the area. This influx of workers may, in turn, increase the pressure on local services and infrastructure, such as temporary accommodation, health services and policing and emergency services. The presence of non-local workers may also interfere with cultural practices and community wellbeing should their presence have a negative influence on community activities. In addition, Project transportation activities may create additional vehicle traffic and additional demand on regional transportation infrastructure. Project-related hazards may also increase pressure on local emergency services, including fire, ambulance, and police if accidents occur.

The rationale for the selection of socio-economic VCs and their indicators are provided in **Table 5.1** for each VC.

Table 5.1 Rationale for selection of socio-economic Valued Components

Candidate VC	Rationale	Indicators
Labour Force	Construction of the Project is expected to provide employment and procurement opportunities for local workers and businesses, as well workers from outside the local area. Local employment and procurement are community benefits arising from the Project. The presence of non-local workers can, in turn, have adverse effects as discussed in community safety and wellbeing. Local stakeholders and St'át'imc Nation have expressed interest in employment opportunities from the Project. **Included as Valued Component**	Changes in demand for local labor Demand for non-local labor
Housing and Accommodation	Non-local workers will require temporary accommodation while working on the Project. Increased demand for accommodation could affect rental prices and or availability of temporary accommodation (e.g., hotel, motel, rental accommodation). Due to the extent (76 km) of the 2L90 transmission line, impacts to accommodation and housing are not expected to be localized (i.e., not limited to one community) **Included as Valued Component**	Changes in demand for local accommodation Change in local accommodation availability
Community Safety and Wellbeing	The influx of non-local workers has the potential to affect local community sense of safety and well-being by potentially interfering with cultural activities or by increasing negative social behaviors (e.g., substance abuse, etc.). This could result in additional harm to already vulnerable populations. The influx of non-local workers can also have negative effects on community services (e.g., emergency, health, and policing). Local stakeholders and the St'át'imc Nation have raised concerns related to workers coming into the local area, including inappropriate and illegal activities and cultural insensitivity. **Included as Valued Component**	Influx of non-local workers Changes in community safety and wellbeing Change in demand for local emergency, health, and policing services
Transportation and Traffic	Transportation of workers, equipment and materials could create additional traffic on highways and local roads and increase congestion and the potential for motor vehicle accidents. Access road upgrades could improve existing roads available to residents, but also create new access to remote, pristine areas where access by non-local users may increase, which in turn could increase competition for resources and negatively affect community privacy. Increase in traffic during construction activities, and associated effects on road safety, were raised as a concern by local stakeholders and the St'át'imc Nation. **Included as Valued Component**	Changes in traffic volumes Changes in access

5.2 Spatial Boundaries

BC Hydro's Bridge River Generation System is located entirely in St'át'imc Territory and in the Squamish Lillooet Regional District (SLRD). The 2L90 transmission line begins at BRT at South Shalath and terminates at KLY near Clinton, just outside of St'át'imc territory.

The proposed LAA for the Socio-Economic VCs includes the communities located along the 2L90 transmission line corridor. Specifically, the LAA includes the St'át'imc Nation communities of Tsal'alh, T'it'qet, Sekw'el'was, Xaxl'ip, Ts'kw'aylaxw and Xwísten; the unincorporated community of Seton Portage; the rural Electoral Area B of the SLRD; and the District of Lillooet, and encompasses the area where the Project is expected to interact with and potentially create direct or indirect effects on socio-economic conditions, such as demand for employment and accommodation and increase in traffic on local roads and highways (**Figure 5.1**).

The proposed RAA for the Socio-Economic VCs is defined as the SLRD, including Seton Portage, Electoral Area B, and the District of Lillooet; and includes the identified St'át'imc communities of Tsal'alh, T'it'qet, Sekw'el'was, Xaxli'p, Ts'kw'aylaxw and Xwísten (**Figure 5.1**).

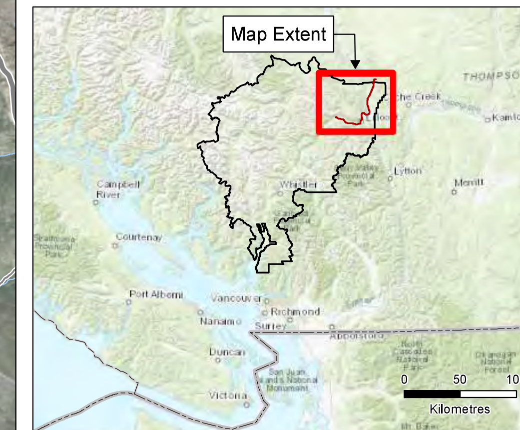
5.3 Temporal Boundaries

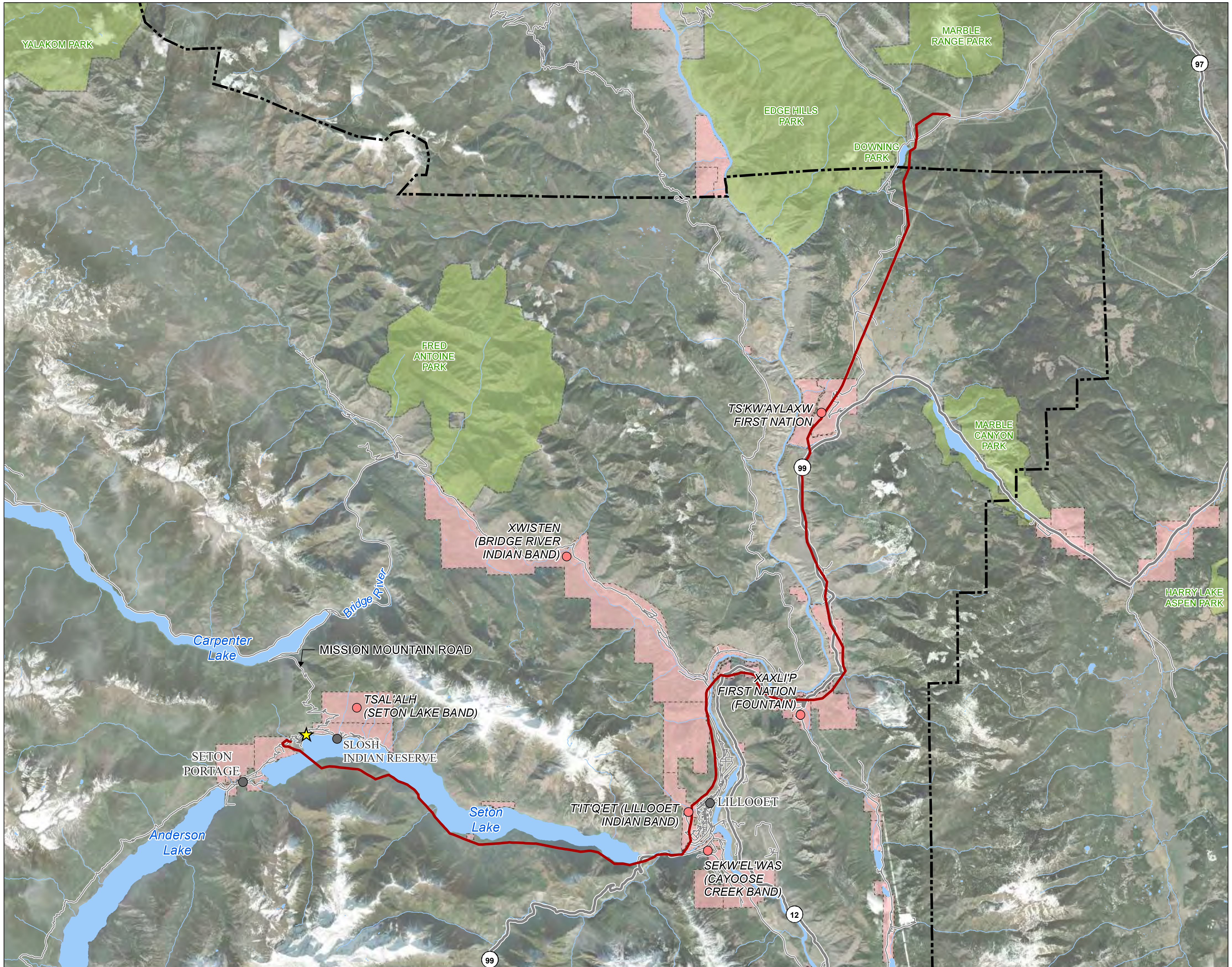
Temporal boundaries are defined as the approximately 2- to 3-year construction and commissioning schedule for the proposed Project.

At the end of construction and commissioning, the Project will return to service as per existing conditions with improved reliability and operational certainty. Operations and routine maintenance of the Project will continue to be provided by BC Hydro's staff. Operations activities will result in no additional interactions with the socio-economic environment and will be undetectable from baseline conditions; therefore, the operation phase is not considered in this analysis.

Bridge River Transmission Project
Lilloet, BC

Socio-Economic Spatial Boundaries





Legend

- 2L90 Transmission Line
- Bridge River 1 Generating Station
- Populated Place
- First Nations Community
- First Nations Reserve
- Park or Protected Area
- Highway
- Road
- Watercourse
- Waterbody
- Socio-Economic RAA

Socio-Economic LAA Communities:
- Sekw'el'was
- T'it'qet
- Tsal'alh
- Ts'kw'aylaxw
- Xaxl'ip
- Xwisten
- Seton Portage
- District of Lillooet
- Squamish-Lillooet Rural Electoral Area B

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licence(s) - British Columbia
- Basemap: ESRI World World Imagery
- Inset Basemap: ESRI World Topographic Map

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Hemmera An Ausenco Company
BC Hydro & Power Authority

5.4 Labour Force

The Project has the potential to interact with socio-economic conditions in those communities most likely affected by Project construction activities. The Project will require a construction workforce as well as the procurement of goods and services, which may create employment and business opportunities in the LAA. Project labour demands would also require bringing workers from outside the local area, which may create an influx of non-local residents to the LAA.

This section assesses potential effects of the Project on the Labour Force VC, including a description of the existing labour force conditions in the LAA and RAA. This section also identifies potential interactions with the labour force during Project construction, identifies potential effects and proposes mitigation measures to address potential Project-related effects.

5.4.1 Existing Conditions

5.4.1.1 *Population*

The Project is located in the St'át'imc Territory and in the rural Electoral Area B of the SLRD.

The District of Lillooet is the largest population centre in the LAA and functions as the economic and services hub for the communities in SLRD Area B. The District of Lillooet is located in the middle section of the Project and is expected to be an important services centre for the Project.

Tsal'alh (formerly known as Seton Lake Band) is located adjacent to the Bridge River Terminal substation and Seton Lake and has nine reserves (IR): Mission 5, Necait 6, Nzaw't 4A, Seton Lake 5A, Seton Lake 7, Silicon 2 and Slosh 1, Slosh 1A and Whitecap 1 (INAC 2021a). The main populated reserve of the Tsal'alh is Slosh 1. Data availability on Statistics Canada is limited to Slosh 1, and therefore only Slosh 1 is used in the tables below. Seton Portage is a small rural community located between Anderson Lake and Seton Lake, approximately 7 km south-west of Slosh 1. It has a mix of permanent residents and seasonal homes.

T'it'q'et (formerly known as Lillooet Indian Band) is located near Lillooet and has seven reserves in the Lillooet area, Kilchult 3, Lillooet 1, Lillooet 1A, McCartney's Flat 4, Riley Creek 1B, Seton Lake 5, and Towinock 2 (First Nations Land Management Resource Centre 2020, INAC 2021b). The main populated reserve of the T'it'q'et community is Lillooet 1 IR. Data availability on Statistics Canada is limited to the Lillooet 1 IR, and therefore only Lillooet 1 IR is used in the tables below.

Sekw'el'was (formerly Cayoosh Creek Indian Band) is located near to Lillooet and has three reserves in the Lillooet area, Cayoosh Creek 1, Pashilqua 2 and Pashilqua 2A. The main community is Cayoosh Creek 1 which services the three Sekw'el'was reserves (Stl'atl'imx Tribal Police Service 2020). For Sekw'el'was, data from Cayoosh Creek 1 reserve is the only data available on Statistics Canada and was used to inform the tables below.

Xaxli'p (formerly Fountain Indian Band) is located 15 km from Lillooet on Highway 99 North. The Xaxli'p has 17 reserves, of which the project interacts with 3 populated reserves: Fountain 1, Fountain 1B, and Fountain 3 (INAC, 2021c). The project also passes through the unpopulated reserve of Dry Salmon 7. The main communities of the Xaxli'p are Fountain 1 IR and Fountain 1B IR (Xaxli'p 2021). Data availability on Statistics Canada is limited for Fountain 3 IR given the small population size, and unavailable for Dry Salmon 7, so this report has used data for Fountain 1 IR and Fountain 1B IR to inform the assessment.

Ts'kw'aylaxw (formerly Pavilion Indian Band) is located approximately 40 km northwest of Lillooet and 70 km west of Cache Creek. Ts'kw'aylaxw has 8 reserves: Leon Creek 2, Leon Creek 2A, Marble Canyon 3, Pavilion 1, Pavilion 1A, Pavilion 3A, Pavilion 4 and Ts'kw'aylaxw 5 (INAC 2021d, BCAFN 2021). The project overlaps with the Pavilion 1 IR. Statistics Canada data for Pavilion 1 IR was used t inform the tables below.

Xwísten (formerly Bridge River Indian Band) is located approximately 9km northwest of the town of Lillooet. Xwísten has three reserves, Bridge River 1, Bridge River 2, and Lillooet 1A (shared with T'it'q'et) (INAC 2020e, Xwísten 2013). The main community of the Xwísten is the Bridge River 1 IR. Statistics Canada data for this reserve was used to inform the tables below.

Population data for the communities in the LAA and RAA are summarized in **Table 5.2**.

Table 5.2 Population of communities in the local and regional assessment areas

Community	Population (2016 Canadian Census)	Percent Change (2011 to 2016)	Percentage of Indigenous Population
District of Lillooet	2,275	-1.02	25.8
Slosh 1 IR (Tsal'alh)	177	-20.6	95.5
Lillooet 1 IR (T'it'qet)	243	9.5	95.2
McCartney's Flat 4 IR (T'it'qet)	26	NA	NA
Bridge River 1 IR (Xwísten)	241	+2.1	97.9
Cayoosh Creek 1 IR (Sekw'el'was)	66	+22.2	76.9
Pavilion 1 IR (Ts'kw'ay lax w)	52	+2.0	100.0
Fountain 1 IR (Xaxli'p)	111	-14.6	99.1
Fountain 1B IR (Xaxli'p)	73	+43.1	95.9
Fountain 3 IR (Xaxli'p)	10	0.0	NA
Seton Portage, Unincorporated Community/Shalath	46	-17.9	44.4
Squamish Lillooet Regional District Electoral Area B	363	-19.5	15.2
Squamish Lillooet Regional District	42,665	+11.8	12.2

Source: Statistics Canada 2017

In general, population in the LAA communities have decreased since 2011. With the exception of Cayoosh Creek 1 IR (Sekw'el'was), Bridge River 1 IR (Xwísten) and Fountain 1B IR (Xaxli'p), all other communities in the LAA have experienced population decreases since the previous census. The population of Lillooet was reported as 2,275 in the 2016 Canadian census, which represented a slight decrease from 2011 when the population was reported as 2,321 (Statistics Canada 2016l). Lillooet has been experiencing declines in population for the last thirty years but is projected to grow by approximately 11% by 2036, reaching 2,530 residents (Squamish Lillooet Regional District 2019).

5.4.1.2 *Labour Force Characteristics*

Labour force participation in the LAA communities ranges from 47.2% in Lillooet 1 IR to 75.0% in Pavilion 1 IR; these values are below the regional district average of 75.7%. The participation rate is below the provincial average of 63.9% for the majority of communities; the exceptions are Pavilion 1 IR (75.0%) and Fountain 1 IR (72.2%). In general, unemployment rates in the LAA communities are higher than those in the overall regional district (6.1%) or in the province (6.7%). Unemployment rates in the St'át'imc communities tend to be higher than in Lillooet (10.0%) and in BC.

Lillooet has a diverse range of industries in which residents work. In Lillooet, approximately 14.8% of the population works in retail trade, 11.4% works in transportation and warehousing, and 11.4% works in health care and social assistance. Education, agriculture, forestry, fishing, and hunting, manufacturing, public administration, and accommodation and food services are other common industries in Lillooet. The areas of employment in the St'át'imc communities are varied, with public administration, educational services, health care and social assistance, agriculture, forestry, fishing, and hunting, manufacturing and construction forming significant proportions of community employment (Statistics Canada 2017). Because of data suppression the full range of industries of employment for Indigenous communities is likely not fully represented by Statistics Canada data.

In recent years, Lillooet, and other northern communities in the SLRD have been challenged with facilitating economic growth. Lillooet economy has been greatly affected by decades of forestry industry downturns, the pine beetle infestation, and provincial government cutbacks. In 2001 forestry accounted for 20% of jobs in the Lillooet area, and currently accounts for less than 10% of jobs (Squamish Lillooet Regional District 2008b, Statistics Canada 2017). This has contributed to economic hardship in the northern areas of the SLRD along with a trend of younger community members moving away to find work (Squamish Lillooet Regional District 2012). The SLRD reported that the local economy is impeded by infrastructure constraints such as transportation links, poor road conditions, and limited commercial attractions and amenities. Recently, Lillooet and St'át'imc Nation local government have joined together to discuss community economic development and to create an action plan (Squamish Lillooet Regional District 2015).

Most recent economic development drivers in Lillooet include the emerging wine industry, specialized agricultural crops (such as hops for brewing beer), expanded operations at the Bralorne Mine, the developing arts, culture and heritage sector, and progressive initiatives by the St'át'imc Nation (Squamish-Lillooet Regional District 2008a, 2019).

Labour force characteristics of the LAA and RAA communities are summarized in **Table 5.3**.

Table 5.3 Labour force characteristics, 2016

Community	Main Industries of Employment[3]	Participation Rate[1]	Unemployment Rate[2]
District of Lillooet	Retail trade - 14.8% Transportation and warehousing – 11.4% Health care and social assistance – 11.4%. Education Services – 9.0% Public administration – 8.1% Accommodation and food services – 7.6% Agriculture, forestry, fishing, and hunting -7.6% Manufacturing – 5.2%	57.7%	10%
Slosh 1 IR (Tsal'alh)	Public administration – 26.7% Educational service – 26.7% Construction – 13.3%	53.6%	13.3%
Lillooet 1 IR (T'it'qet)	Public administration – 26.7% Health care and social assistance – 13.3% Construction – 13.3% Retail and trade – 13.3%	47.2%	29.4%
Bridge River 1 IR (Xwísten)	Public administration – 27.8% Health care and social assistance – 16.7% Agriculture, forestry, fishing, and hunting – 11.1% Construction – 11.1% Retail Trade – 11.1%;	52.8%	26.3%
Cayoosh Creek 1 IR (Sekw'el'was)	Health care and social assistance – 40% Retail trade – 40%	50%	n/a
Pavilion 1 IR (Ts'kw'ay lax w)	Manufacturing – 33.3% Accommodation and food services – 33.3%	75.0%	33.3%
Fountain 1 IR (Xaxli'p)	Public administration – 15.4% Manufacturing – 15.4% Transportation and warehousing – 15.4% Professional; scientific and technical services – 15.4% Administrative and support; waste management and remediation services – 15.4%	72.2%	23.1%

Community	Main Industries of Employment[3]	Participation Rate[1]	Unemployment Rate[2]
Fountain 1B IR (Xaxli'p)	Public administration – 28.6% Construction – 28.6% Retail Trade – 28.6% Transportation and warehousing – 28.6% Health care and social assistance – 28.6%	63.6%	28.6%
Seton Portage, Unincorporated Community/Shalath	Utilities; Retail trade; Transportation and warehousing; and Public administration	50%	0%
Squamish Lillooet Regional District Electoral Area B	Accommodation and food services – 18.0% Construction – 11.2% Retail Trade – 9.6% Health care and social assistance – 8.4% Professional; scientific and technical services – 7.2% Educational services – 6.0% Public administration – 5.4%	44.1%	0%
Squamish Lillooet Regional District	-	75.7%	6.1%
British Columbia	-	63.9%	6.7%

Note: (1) "Participation Rate" refers to the number of people in the labour force in the week prior to Census Day, as a percentage of the population 15 years and over.

(2) "Unemployment Rate" refers to the number of people unemployed in the week prior to Census Day expressed as a percentage of the labour force.

(3) Totals may not add up to 100% due to rounding at the source.

Source: Statistics Canada 2017

5.4.1.3 *Educational Attainment*

To identify the potential for local labour integration in Project activities, available information on Educational attainment is also summarized in **Table 5.4.** Statistics Canada data shows that relative to the Province, residents of the LAA are more likely to have incomplete high school education and are less likely to have post secondary degrees. The percentage of the adult population (15 years and older) with no certificate, diploma or degree ranged from 21.5% of adults in Lillooet to 62.5% of adults in Seton Portage, compared to 15.5% for adults in BC.

Table 5.4 Highest educational attainment (percent of population 15 years and over)

Community	No Certificate, Diploma or Degree	Secondary School Diploma or Equivalency Certificate	Apprenticeship or Trades Certificate	Post Secondary Certificate, Diploma, or Degree
District of Lillooet*	21.5%	29.9%	13.9%	34.9%
Slosh 1 IR (Tsal'alh)	28.6%	28.6%	11.4%	28.6%
Lillooet 1 IR (T'it'qet)	31%	28.6%	11.9%	28.6%
Pavilion 1 IR (Ts'kw'ay lax w)	44.1%	22.2%	0.0%	22.2%
Fountain 1 IR (Xaxli'p)	31.6%	21.1%	10.5%	47.4%
Fountain 1B IR (Xaxli'p)	27.3%	45.5%	0.0%	27.3%
Bridge River 1 IR (Xwísten)	33.3%	36.1%	5.5%	25%
Cayoosh Creek 1 IR (Sekw'el'was)	41.7%	25%	16.7%	16.7%
Seton Portage / Shalalth*	62.5%	25%	0%	25%
Squamish Lillooet Regional District Electoral Area B	20.8%	26.4%	19.4%	51.4%
BC	15.5%	29.4%	8.8%	46.3%

Note: *Totals do not add up to 100% due to rounding at the source.
Source: Statistics Canada 2017

5.4.2 Methods

At this early stage, detailed labour and cost information is not available for the Project. As a result, estimates for direct employment during construction are not yet possible. BC Hydro is currently reviewing the scope of work and BC Hydro engineers will undertake a field assessment in early 2021 to determine/confirm the specific work activities to be undertaken at each location. Following this field assessment, BC Hydro will provide a detailed scope of work for each location including labour requirements.

Once additional information is available, BC Hydro will review the labour and cost information to confirm the effects assessment, as described below.

5.4.3 Preliminary Effects Assessment

The Project will require a labour force comprised of a range of tradespeople, engineers, heavy equipment operators, labourers, and others. Filling the labour-force requirements arising from the Project presents an opportunity to create employment and business opportunities for local communities. In addition to direct jobs, other indirect and induced jobs would be created in local supplier industries (e.g., equipment rentals, fuel suppliers, transportation services, accommodation etc.) and as a result of increased consumer spending. The ability of local residents and St'át'imc members to benefit from these opportunities would depend on their skills and occupational training, as well as ongoing engagement between BC Hydro and St'át'imc to identify opportunities.

It is expected that BC Hydro will define specific work packages and contract out the majority of the work during the construction phase either through a public tendering process or direct awards to St'át'imc designated businesses through an agreed process (BC Hydro, 2019). Personnel hiring decisions would ultimately rest with the contractors; however, BC Hydro will work closely with contractors and local communities to identify local hire opportunities.

The LAA has a relatively limited labour force that is unlikely to meet all the needs of the Project, so it is anticipated that a proportion of workers will come from outside the LAA. The overall effects of the Project on local employment and businesses are anticipated to be positive, but relatively small. While mitigation is not required, BC Hydro will enhance local benefits by identifying opportunities to increase employment and procurement from local suppliers. BC Hydro recognizes commitments in the 2011 Settlement Agreements and the 2019 High Flow Settlement Agreement between BC Hydro and St'át'imc Nation, and will continue working on their implementation, including by supporting information sharing and collaboration on business, employment, education, and training opportunities.

5.5 Housing and Accommodation

As discussed in the previous section, some of the labour force is expected to be sourced from communities outside of the LAA and, therefore, will require local accommodation while working on the Project. Given the duration of the construction activities and the rotation schedules in the construction industry, it is not anticipated that workers would bring their families or relocate to the study area permanently. Instead, non-local contractors are expected to use temporary accommodations (e.g., hotels, motels, guesthouses) and rental accommodations (e.g., apartments) in the LAA.

This section assesses potential effects of the Project on the Housing and Accommodation VC, including a description of the existing conditions in the LAA. This section also identifies potential interactions with the housing and accommodation market during Project construction, identifies potential Project effects and proposes mitigation measures to address potential Project-related effects.

5.5.1 Existing Conditions

Temporary accommodation in the LAA includes hotels, motels, bed-and-breakfasts, as well as campgrounds and recreational vehicle (RV) sites. Temporary accommodation serves the tourism industry, but also short-term housing needs of business travellers.

The larger community of Lillooet has the greatest capacity for accommodating out-of-town workers. Lillooet has approximately 150 hotel rooms and a limited number of private residences available for rent for visitors to the community. Generally, the accommodations have good internet, landline, and television services (BC Hydro 2019a).

The smaller LAA communities generally have limited temporary accommodation capacity. Accommodation for visitors is available in Seton Portage at Lil'tem Mountain Hotel and Crane's Landing Recreational Vehicle (RV) park with rental RVs available, both owned and operated by Tsal'alh Development Corp. The Lil'tem Mountain Hotel has 42 rooms available for rent. The accommodation is generally of good quality and units typically contain a TV and landline, have access to internet, and many have kitchenettes (Lil'tem' Mountain Hotel 2021). The Crane's Landing RV Park features 20 RV sites, 9 sites with fully self-contained RVs for rent. All sites have electrical, sewer and water hookups and are within walking distance the Lil'tem' Mountain Hotel (Lil'tem' Mountain Hotel 2021). There are also eight rental houses in Shalalth (BC Hydro 2019a). Additional accommodation is available at Bonnie and Trev's Rentals and Accommodation locally owned by a Sekw'el'was member (St'át'imc 2020).

T'it'q'et own and operate the Retasket Lodge and RV Park Ltd, a 20-room motel and 8-site RV park located in Lillooet (St'át'imc 2020). All units have 2 queen beds, high-speed internet, air conditioning, HDTV, microwave, bar fridge, and in-room coffee/tea (Retasket Lodge, 2021).

Ts'k'waylaxw operate the Ts'k'waylaxw Sky Blue Water Resort on the shore of Pavilion Lake. It offers 7 cabins and camp sites during the summer moths (St'át'imc 2020).

BC Hydro regularly utilizes Lil'tem Hotel and works closely with the hotel to ensure capacity for its projects and other staff. If this accommodation is full, BC Hydro tries to maximize the accommodation in Seton Portage, and then looks to accommodation in Lillooet (BC Hydro 2019a).

5.5.2 Methods

At this early stage, detailed accommodation requirements are not available for the Project. As a result, estimates for assessments on the potential impacts to housing are not yet possible. BC Hydro is currently reviewing the scope of work and BC Hydro engineers will undertake a field assessment in early 2021 to determine/confirm the specific work activities to be undertaken at each location. Following this field assessment BC Hydro will provide a detailed scope of work for each location, including accommodation requirements.

Once additional information is available, BC Hydro will review the local accommodation requirements to confirm the effects assessment, as described below. This could include a housing impact study and review of a housing needs assessments currently being undertaken by the district of Lillooet.

5.5.3 Preliminary Effects Assessment

A portion of the construction workers are anticipated to be sourced from communities outside the LAA and therefore will require local accommodation while working on the Project.

BC Hydro encourages the use of local facilities to accommodate workers and typically requires contractors to use the Lil'tem Hotel for work at the Bridge River Generating Stations. This is anticipated to be the preferred accommodation for Project activities in proximity to Seton Portage. The vacancy rate in Seton Portage is dependant on the amount of activity that is happening in and around the Bridge River Generating stations.

While the number of workers who will require accommodation is not known at this stage, we anticipate that the number will be limited, and increased demand is not expected to result in considerable strain on existing vacancy and availability of short-term accommodation in the study area. The local area of Seton Portage can accommodate up to 92 temporary workers between a combination of hotels, RVs, and rental houses. In addition, there are approximately 150 hotel rooms in Lillooet that could accommodate non-local workers. Construction crews will commute from either community to work sites along the transmission line corridor.

The arrival of workers will create an increase in the demand for temporary accommodation that is within the existing capacity of the LAA. BC Hydro will assist contractors to the greatest extent possible to achieve efficient booking and use of available local accommodation. If shortages of accommodation are foreseen at any point, BC Hydro will plan ahead and identify alternative solutions such as split shifts and/or schedule extension where possible to minimize interference with local communities.

While staying in the local area, workers and contractors will be required to follow the *Bridge River Contract Worker Conduct Requirements,* or conduct requirements developed specific to this Project, to ensure respectful behaviors and minimize conflicts with local residents. Refer to **Section 5.6** for additional analysis on Community Safety and Wellbeing.

5.6 Community Safety and Wellbeing

The influx of temporary workers to the project area has the potential to affect the community's sense of safety, wellbeing, and privacy. In the past, some communities have expressed concern with the conduct of BC Hydro workers and contractors staying in or travelling through their communities. The St'át'imc community of Tsal'alh, adjacent to the Bridge River Terminal Substation, has previously raised concerns related to workers coming into the local area, including inappropriate and illegal activities, cultural insensitivity, and traffic safety. More recently, St'át'imc Government Services raised concerns related to cultural awareness and respect at BC Hydro job sites. These safety concerns also extend to other St'át'imc communities and Lillooet. With the recent COVID-19 pandemic, there are additional concerns related to an influx of workers and potential impacts on community health.

Large construction projects in remote, rural areas of BC are often found to result in adverse social and cultural effects on local communities and disproportionately affect Indigenous communities. The final reports of the Truth and Reconciliation Commission of Canada and of the National Inquiry into Missing and Murdered Indigenous Women and Girls (NIMMIWG) documented adverse effects on Indigenous communities from land and resource development activities. Indigenous communities in remote areas of BC may be socio-economically disadvantaged and therefore vulnerable to the effects of temporary population increases from project workforces (Truth and Reconciliation Commission 2015, NIMMIWG 2019). The NIMMIWG report included specific Calls for Extractive and Development Industries, one of which was to consider the safety of Indigenous women and girls (NIMMIWG 2019). The report also included calls for equitable benefits from development, and for gender-based socio-economic assessment of proposed development projects.

This section assesses potential effects of the Project on the Community Safety and Wellbeing VC, including a description of the existing conditions, identification of potential project effects, and proposes mitigation measures to address potential Project-related effects.

5.6.1 Existing Conditions

The understanding of safety and well-being on the LAA and RAA draws from available indicators of health and safety service provision and local perspectives about community safety.

In general, the local St’át’imc communities and the community of Lillooet are safe places to live and visit. The communities are remote, and residents know and rely on each other. Crime rates are low, and people generally go about their lives unencumbered by worries that may affect more populated or urbanized areas.

Previous BC Hydro projects at the Bridge River Generating Stations resulted in concerns related to community safety and wellbeing for local residents, particularly for the community of Tsal’alh, but likely similar for other St’at’imc communities. Concerns include reports of disruptive parties in Seton Portage, and allegations of illicit drug use and possible drug dealing, inappropriate and offensive behaviour, including racism towards local residents. Tsal’alh and St’át’imc leadership raised these concerns with BC Hydro, and the issues spoke to a general sense of unease and fear as a result of the temporary workforce staying in the community. An increase in partying and associated negative behaviour can lead to a culture change that has lasting negative effects after the temporary workers leave (BC Hydro 2019a).

In early 2021, St’át’imc Government Services raised concerns related to lack of cultural awareness and respect from BC Hydro workers and contractors at BC Hydro job sites. Action required from BC Hydro included a commitment to a safe and respectful workplace, development of an incident reporting tracking system, confirmation of Heritage Awareness Training for all employees and contractors, implementation of harassment and respectful workplace training, and a commitment to cultural awareness training. BC Hydro is continuing to work to address these concerns, and actions taken will be directly applicable to this Project.

There is little public information available on community safety and wellbeing for St’át’imc communities. Crime rate is generally used as an indicator for evaluating community safety. The crime rates observed in Stl’atl’imx Tribal Police jurisdiction are recorded by the Government of BC. In recent years, Stl’atl’imx jurisdictions have seen a decrease in crime rates. The crime rate based on total criminal code offences per 1,000 people (including property, violent, and other crimes) recorded for 2019 was 48.4% less than the number recorded for 2010 (BC 2020).

Similarly, in recent years, Lillooet has experienced a drop in crime. Total criminal code offences per 1,000 people (including property, violent, and other crimes) recorded for 2019 was 39% less than the number recorded for 2010. The rate dropped from 168.6 offences per 1,000 people in 2010 to 102.9 offences per 1,000 people in 2019. The number of violent crimes in Lillooet almost halved during this period, from a total of 120 in 2010 to 66 in 2019. While the number of drug offences decreased from 77 in 2010 to 7 in 2020 (BC 2020).

In terms of overall socio-economic wellbeing, the SLRD was ranked 8th out of 26 regions in BC’s 2015 socio-economic indicators index. The socio-economic index summarizes key social and economic information for all areas of BC and indicates that SLRD compares well to other regions (Squamish-Lillooet Regional District 2015).

The District of Lillooet is currently updating its Official Community Plan (OCP) to better meet the needs of their community. Lillooet’s current Official Community Plan was adopted in 2009, with the SLRD Regional Growth Strategy adopted in 2008 and updated in 2019. Since 2008, there have been significant changes in Lillooet's context. The updated Official Community Plan will define the District vision, clear goals, objectives, and policies to set the direction for Lillooet's sustainable future in a range of integrated topics, including economic development, walkability, green infrastructure, housing, collaboration with St'at'imc communities, and other related topics (District of Lillooet, 2021).

Policing Services

Policing Services in the LAA and RAA are generally provided by St'al'imx Tribal Police or the local RCMP detachments.

There are RCMP detachments located in Pemberton and in Lillooet. The Lillooet RCMP services Seton Portage and surrounding rural area. The Stl'atl'imx Tribal Police services Indigenous lands in Mount Currie, Lillooet, and Shalalth, out of their offices in Lillooet (T'it'q'et) or Mount Currie (Lil'wat). Lillooet is policed both by the RCMP and Stl'atl'imx Tribal Police, depending on the area of town. First Nations territory in Lillooet is managed by the Tribal Police (BC Hydro 2019a, BC211 2020, Stl'atl'imx Tribal Police 2021).

There is no cell phone service along much of the 2L90 transmission line; therefore, a satellite phone or communication device such as InReach is required. Local residents are accustomed to using these devices for emergency communication (BC Hydro 2019a).

Health Services

The main health facility in the LAA is in Lillooet. Lillooet has a hospital and health centre that offers a wide range of services, including 24-hour emergency service. The hospital and health centre is classified as a Community Level 1 Hospital and is the smallest type of hospital in the Interior Health Region (Interior Health 2021). The hospital serves a local health area that encompasses Shalalth and Seton Portage, and includes a population of 4,564. Of all hospitalizations, 85% come from the Lillooet area, suggesting that this facility is not hugely burdened with providing care to people from other areas (Interior Health 2021a, Provincial Health Services Authority 2019).

St'át'imc Outreach Health Services delivers primary health services to Indigenous peoples on and off reserve in Northern St'át'imc territory, providing both mental health and wellness services (St'át'imc Outreach Health Services 2020).

The Ts'kw'aylaxw Cultural and Community Health Centre is a multi-purpose facility, serving the Ts'kw'aylaxw First Nation as a community and health centre and gathering place (Naturally:wood 2021).

Across the wider regional district there is a further hospital in Squamish. Squamish General Hospital is a 20-bed facility that provides acute, community and primary health services (Vancouver Coastal Health 2021). Ambulatory health services are also provided in Lillooet, Squamish, and Whistler (Statistics Canada 2020). Beyond the regional district the Royal Inland Hospital in Kamloops is approximately 2 hours drive from Lillooet. The Royal Inland Hospital in the Thompson Cariboo Shuswap health service area is one of two Interior Health tertiary referral hospitals (Interior Health 2021b).

Emergency Services

Many of the LAA communities have limited capacity to accommodate emergencies. Instead, the larger district provides centralized emergency services for the surrounding communities. In the Northern area, fire emergency services are dispatched by the Surrey Fire Communications Centre to Lillooet and Seton Valley, among other locations. Fire Services for the south are dispatched by Emergency Communications for British Columbia Incorporated (ECOMM) to Pemberton, Whistler, and Squamish, among other locations (BC Hydro 2019a). Emergency 911 Services are available in Lillooet (Lillooet 2021).

The Lillooet Fire Department provides fire services to approximately 1,300 properties with a population of an estimated 2,500 citizens. The Department also provides fire protection to the neighbouring communities T'it'q'et and Sekw'el'was. There are 26 personnel that operate the department, consisting of a fire chief, deputy fire chief, 2 captains, 2 lieutenants, a clerk and 19 fire fighters (Lillooet 2021).

Helicopter companies (e.g., Caribou Chilcotin Helicopters) based out of Lillooet are used for emergency search and rescue services as well as for transportation to remote locations (BC Hydro 2019a).

The District of Lillooet has an Emergency Management Program. The Emergency Management Program is responsible for the direction and control of coordinated response to and recovery from major emergency events or disasters. In case of major events that overwhelms the capabilities of the District, the province will assist by activating the provincial emergency management structure to support local emergency operations centers. In an emergency event, regional and municipal staff, volunteers, first responders, First Nations and non-government agencies would all be involved in the emergency response. The Lillooet Emergency Management Program does not coordinate or facilitate daily emergency response activities under the jurisdiction of the RCMP, Fire Department or BC Ambulance Service (Lillooet 2021).

The Emergency, Health and Policing Services available in the LAA and RAA communities are summarized in **Table 5.5**.

Table 5.5 Emergency, health, and policing services by community

Community	Policing	Health Services	Fire Department	Other safety considerations
District of Lillooet	Lillooet RCMP Detachment Stl'atl'imx Tribal Police	Lillooet District Hospital and Health Centre - Hospital and health centre with 24-hour emergency service -	Lillooet Fire Department -Serves Lillooet and T'it'q'et and Sekw'el'was	• Seven officers assigned to the RCMP Detachment • First Nations territory in Lillooet is managed by the Tribal Police
Tsal'alh	Stl'atl'imx Tribal Police Services	-	-	• Nearest office is located in Lillooet • There is no cell phone service in Shalalth and Seton Portage
T'it'qet	Stl'atl'imx Tribal Police Services	-	-	• Nearest office is located in Lillooet
Sekw'el'was	Stl'atl'imx Tribal Police Services	-	-	• Nearest office is located in Lillooet
Xwísten	RCMP	-		• Nearest office is located in Lillooet
Ts'kw'ay lax w	Stl'atl'imx Tribal Police Services	Ts'kw'aylaxw Cultural and Community Health	-	• Nearest office is located in Lillooet
Xaxli'p	Stl'atl'imx Tribal Police Services	-	-	• Nearest office is located in Lillooet
Shalalth/Seton Portage, Unincorporated Community	Stl'atl'imx Tribal Police Services		Seton Lake Volunteer Fire Department	• Nearest office is located in Lillooet • There is no cell phone service in Shalalth and Seton Portage

Community	Policing	Health Services	Fire Department	Other safety considerations
Squamish Lillooet Regional District	RCMP Stl'atl'imx Tribal Police	Lillooet District Hospital and Health Centre (Lillooet) – Hospital Squamish General Hospital (Squamish) – Hospital Sea to Sky Walk in Clinic (Squamish) – Ambulatory Health Care Services Town Plaza Medical Clinic (Whistler) – Ambulatory Health Care Services Whistler Medical Clinic (Whistler) – Ambulatory Health Care Services Coast Medical (Whistler) – Ambulatory Health Care Services	SLRD manages two volunteer fire departments and provides financial contributions to other smaller established volunteer fire services SLRD managed fire departments: Britannia Beach Volunteer Fire Department (Howe Sound East Fire Protection Service) Garibaldi Volunteer Fire Department (Garibaldi Fire Protection Service) Fire services where SLRD provides a financial contribution: Birken Volunteer Fire Service Bralorne Volunteer Fire Service Gun Lake Fire Protection Society Seton Lake Volunteer Fire Department	• The Lillooet RCMP services Seton Portage. The Stl'atl'imx Tribal Police services Indigenous lands in Mount Currie, Lillooet, and Shalalth. The.

5.6.2 Methods

At this early stage, detailed workforce numbers and support requirement information are not available for the Project. As a result, estimates on the number of non-local workers required for construction are not yet possible. BC Hydro is currently reviewing the scope of work and BC Hydro engineers will undertake a field assessment in early 2021 to determine/confirm the specific work activities to be undertaken at each location. Following this field assessment BC Hydro will provide a detailed scope of work for each location including workforce requirements.

Once additional information is available, BC Hydro will review the workforce requirements information to confirm the effects assessment, as described below. BC Hydro will also review and update the *Bridge River Contract Worker Conduct Requirements* to ensure all concerns are addressed and requirements are relevant to a linear transmission project.

5.6.3 Preliminary Effects Assessment

The Project may influence community safety and well-being through multiple pathways including the influx of workers to temporary accommodation in Seton Portage and Lillooet, potential strain on healthcare and emergency services, and potential increase in traffic and road accidents. Project-related traffic safety aspects are discussed in **Section 5.7**.

The influx of temporary workers to the LAA has the potential to affect the population's sense of safety, wellbeing, and community if external workers are involved in negative social behaviors (e.g., substance abuse, illegal practices) or are disrespectful of the local ways. This effect is often exacerbated by high disposable income, which can lead to socially irresponsible or reckless behaviours and thereby increase demands on health, social and policing services.

The presence of temporary, non-local workers may also place strain on local emergency services if non-local workers need access to medical services during their stay in the local communities as they may use the emergency facility for basic medical attention.

BC Hydro recognises that their relationship with St'at'imc is integral to the ongoing operations of facilities in St'át'imc Territory and are committed to developing a collaborative and respectful working relationship with St'át'imc Nation.

BC Hydro and St'át'imc jointly developed the *Bridge River Contract Worker Conduct Requirements* (BC Hydro 2019b) for contractors working on the Bridge River Generation System. These requirements were developed together, in response to specific concerns raised by the St'at'imc community of Tsal'slh and include specific requirements for workers while in the Bridge River area, including when offsite or outside of working hours.

The *Bridge River Contract Worker Conduct Requirements* is currently being reviewed to determine if it can be applied successfully to all contractors working in St'át'imc Territory. If this approach is ineffectual a Project specific code of conduct will be developed. Requirements will be reviewed considering the Project activities and may be revised to improve cultural awareness and sensitivity of the Project workforce throughout the St'át'imc Territory. These requirements note that the work is taking place in St'át'imc Territory and supplement the *Contractor Standards for Ethical Conduct* that each contractor is required to comply with at all times by their contract with BC Hydro.

BC Hydro is meeting with the RCMP (Lillooet Detachment) and the St'at'imc Tribal Police on regular basis to determine the need for additional policing during peak construction period. BC Hydro will maintain ongoing communication with local policing and emergency service providers to ensure adequate provision of services to the local area.

To mitigate any effects on the provision of local health services, First Aid will be provided on site. The Bridge River area is equipped with First Aid Facilities, Level 3 First Aid Attendants, and transportation services such as industrial ambulances and emergency transport vehicles. In the event of an accident, patients will be transported to Lillooet Hospital. It is anticipated that Lillooet Hospital has the capacity to serve emergency situations. The Project Construction Management Plan (CMP) will include an Emergency Response Plan that outlines the planned response, equipment needed, and action plan for medical emergencies, fire or natural hazard events, and environmental spills.

5.7 Transportation, Traffic and Road Safety

Project activities (including transportation of construction materials, as well as the work-related and casual travel of workers) will rely on several local roads. Transportation and Traffic was selected as a VC to assess the capacity of local roads to accommodate the increased volume of traffic derived from project activities and to assess changes in access resulting from new access and access improvements.

This section assesses potential effects of the Project on the Transportation and Traffic VC, including a description of the existing conditions present in the vicinity of the Project. This section also identifies potential interactions with the surrounding road network during Project construction, identifies potential Project effects and proposes mitigation measures to address potential Project-related effects.

5.7.1 Existing Conditions

The current 2L90 transmission line runs between BRT and KLY near Clinton. The transmission line runs along the east side of Seton Lake to Lillooet, then continues northeast following Highway 99 until Pavilion where it joins a right-of-way terminating at KLY.

The Project is accessible from Kamloops to the north and from the Lower Mainland to the south:

Access from the North is:

- Via Kelly Lake Road south-west from Clinton to Kelly Lake
- Via Highway 97 to just north of Cache Creek and then Highway 99 west to Lillooet.

Access from the South is:

- Via the Trans Canada Highway to Lytton then Highway 12 to Lillooet
- Via the Duffy Lake Road to Lillooet then Highway 40 to Shalalth
- Via the Highline Service Road (seasonal) from D'arcy to Shalalth.

The main highway through the SLRD is Highway 99. This route, known as the Sea to Sky highway, connects the major urban centre of Vancouver with Pemberton, Mount Currie, and Lillooet. The highway continues east to meet with Highway 97, through which the region is connected to the BC interior. Highway 12 also connects Lillooet to Hope, providing additional access to southern and interior BC communities. There are smaller highways that connect the communities of Seton Portage, and Shalalth to either Pemberton or Lillooet. Additional highways and forest service roads run through the area and are used to access other rural settlements and recreation sites (Squamish Lillooet Regional District 2008a, BC Hydro 2019).

Transportation needs vary across the region. In the northern areas of the SLRD, safety, the need for highway service improvement, and the lack of public and/or private transportation options are the primary transportation issues. To address concerns in the northern areas, the SLRD's Regional Growth Strategy contains suggested improvements to Highway 99 between Pemberton and Lillooet and other northern routes including Highway 12, and the Highline Road that passes through Seton Portage and Shalalth. These improvements are suggested to improve accessibility, enhance safety, and support economic development (Squamish Lillooet Regional District 2008b).

The road from Shalalth to Seton Portage is fully paved and maintained by Dawson Road Maintenance through a highway maintenance agreement with the BC Government (Dawson Road Maintenance 2020). The road is approximately 7 km long and consists of winding sections and a few switchbacks. There is a public school located on the route, which has a school zone speed restriction of 30 km/hr (BC Hydro 2019a). The road is unmarked so travellers frequently cross over the centre line.

Additionally, T'it'q'et communities are accessed from Highway 99, though are not situated on the highway. Highway 99 also travels through Cayoosh Creek 1, Fountain 1, and Pavilion 1.

There are difficult driving conditions between some of the communities in the LAA, specifically between Lillooet and Shalalth. The drive is approximately 65 km and 1.5 hours long. The road is a mix of gravel and paved surfaces, has windy sections, steep climbs and descents and tight passages. Potholes, washboard texture, and large rocks are common. It is also common to encounter logging trucks while driving. It is possible to travel by boat between Lillooet and Shalalth. The distance by boat is about 20 km and takes about 25 minutes, depending on the watercraft. It is about a 10 km drive from the dock at the end of Seton Lake into downtown Lillooet (BC Hydro 2019a).

Natural hazards exist on SLRD highways due to their proximity to steep mountains and their high elevation. Avalanches are common during winter months, and some mountain passes require avalanche control. If an avalanche does cross a highway, it is typically cleaned up and traffic is restored within 24 hours. Other natural threats come from falling rock. Highway areas are designated where risk of falling rock is high and rocks are cleaned off roads daily to limit risk of incidents (BC Hydro 2019).

5.7.2 Methods

At this early stage, detailed traffic and access information is not available for the Project. As a result, estimates for traffic volume and extended access during construction are not yet possible. BC Hydro is currently reviewing the scope of work and BC Hydro engineers will undertake a field assessment in early 2021 to determine/confirm the specific work activities to be undertaken at each location. Following this field assessment BC Hydro will provide a detailed scope of work for each location including transportation requirements.

Once additional information is available, BC Hydro will review the transportation and traffic information to confirm the effects assessment, as described below. BC Hydro will also develop an access management plan in consultation with St'at'imc Nation and other local stakeholders to address potential impacts associated with improved and increased access during and after construction.

5.7.3 Preliminary Effects Assessment

The Project will use main highways and secondary roads for the transport of equipment, materials, and workers to and from the Project construction site, which could increase road traffic and the risk of motor vehicle accidents. All roads to 2L90 transmission line are maintained by the BC Ministry of Transportation and Infrastructure. The west portions of the Project can be accessed via Highway 99 to Lillooet, whereas the eastern parts are more remote with difficult road access over steep mountain terrain with unstable slope conditions. The Project is anticipated to require the upgrade of approximately 63 km of existing access roads and construction of approximately 7 km of new access roads. This will improve existing roads available to residents, but also create new access to remote, pristine areas. New access may increase access by non-local users, which in turn could create competition for harvesting resources and negatively affect community privacy.

BC Hydro has 3 small vessels that it uses to transport crews on Seton Lake from Bridge River to Lillooet with capacity of 11 passengers per vessel. This mode of transportation may be used to transport workers from Lillooet to the eastern portions of the Project, and to minimize road traffic and ensure safety. At this early stage, it is uncertain if this mode of transportation will be required.

During Project construction, there is expected to be a temporary increase in highway and secondary road traffic delivering materials and personnel to and from the construction sites. Transportation will be a combination of light trucks for personnel and heavy trucks for equipment and materials.

Increases in traffic volumes could affect road and traffic conditions and potentially the safety of road users. Vehicular collisions with wildlife can also increase. To reduce traffic in the area and reduce parking requirements at site, BC Hydro will require contractors to use carpooling or shuttle services. To minimize the risk of accidents and risk to public safety, appropriate traffic control measures and signage will be implemented according to WorkSafeBC's Operational Health and Safety Regulation and BC Hydro safety management policies. The Project CMP also considers safety protocols and incident management (e.g., Owners Safety Plan, Occupational Hazards Identification Risk Assessment, Environmental Management Plan, Travel to Site Protocol, Emergency Evacuation Protocols, and Accidents protocols) that contractors will be required to comply with at all times.

All workers and contractors will be required to follow the BC Hydro Travel Code of Conduct to ensure compliance with a basic set of rules created to maintain minimum safety requirements and respectful and lawful behaviour. In addition to the Travel Code of Conduct, the general Bridge River Contract Worker Conduct Requirements must also be followed which outlines unacceptable behaviour such as illegal drug use, racism, drinking, theft of any item, and any activity that could impede the operator's ability to operate a vehicle or vessel safely.

Further, all workers will be required to follow the applicable laws, including the *Motor Vehicle Act*, Domestic Vessel Regulatory Oversight and Boating Safety, and the Small Vessel Compliance Program. Any worker found to be violating these laws will be held accountable by the respective law or act.

BC Hydro is also proposing upgrades to approximately 63 km of access roads and construction of approximately 7 km of new access roads. Improved or increased access could make remote areas more accessible for hunting, fishing, and other recreational uses, increasing the pressure on these resources and negatively affect existing users[1]. To minimize competition for harvesting and recreational resources workers will not be allowed to hunt, fish, or participate in harvesting activities in reserve lands while on- and off-work. Workers will also have to follow the *Bridge River Contract Worker Conduct Requirements*, which has specific requirements for contractors engaging in recreational activities during non-working hours, including obeying road and property restrictions, following local restrictions, obtaining licenses, not hunting, fishing of harvesting on St'at'imc reserve lands. Workers who fail to comply with the *Bridge River Contract Worker Conduct Requirements* will be removed from the Project.

These requirements will be reviewed considering the Project activities and may be revised to improve cultural awareness and sensitivity of the Project workforce throughout the St'át'imc Territory. BC Hydro will also develop an access management plan in consultation with St'at'imc Nation and other local stakeholders to address potential negative impacts associated with improved and increased access.

1 Increase access could also affect availability of harvesting resources by affecting local wildlife/fish populations or prompting changes in the distribution of terrestrial populations. These potential effects in availability of resources are assessed in Sections 3.4, 3.5 and 3.6.

6.0 REFERENCES

Azimuth Consulting Group Partnership (Azimuth). 2015. *BRGMON-12: Possible Effects of WORKS1 Vegetation Program on Mercury Concentrations in Carpenter Reservoir*. Year 2. Prepared for St'át'imc Eco-Resources. March 2015.

British Columbia Assembly of First Nations. 2021. Ts'kw'aylaxw First Nation. Accessed February 2021. Available at: https://www.bcafn.ca/first-nations-bc/lower-mainland-southwest/tskwaylaxw-first-nation

BC Hydro. 1995. *Seton Project Overview Study of Downstream Fish Passage.* Maintenance, Engineering, and Projects. BC Hydro Report. No. H2768 p.+ 5 app.

BC Hydro. 2011. *Bridge River Power Development Water Use Plan*. Revised for Acceptance for the Comptroller of Water Rights. March 17, 2011.

BC Hydro. 2019a. Bridge River 1 Unit 1-4 Generator Replacements Construction Management Plan. Provided by BC Hydro to Hemmera March 2020.

BC Hydro. 2019b. Bridge River Contract Worker Conduct Requirements. Bridge River Management. December 2019.

BC211. 2020. RCMP Whistler. Accessed March 2020. Available at: http://redbookonline.bc211.ca/organization/9489107/rcmp___whistler

Bell, L.M. 1985. "A Fish Passage Problem at the Seton Hydroelectric Project in Southwestern British Columbia." *Canadian Water Resources Journal / Revue canadienne des ressources hydriques*. 10(1): 32-39. DOI: 10.4296/cwrj1001032. Accessed May 2017. http://dx.doi.org/10.4296/cwrj1001032.

British Columbia Conservation Data Centre (CDC). 2020. "Endangered Species and Ecosystems – Wildlife Species Inventory Incidental Observations – All." Accessed September 2020. https://catalogue.data.gov.bc.ca/dataset/wildlife-species-inventory-incidental-observations-all.

British Columbia Ministry of Environment (BCMOE). 2001. *Water Quality Guidelines for Temperature*. Victoria, BC: Water Protection and Sustainability Branch.

British Columbia (BC). 2020. Policing Jurisdiction Crime Trends: 2010-2019. Ministry of Public Safety and Solicitor General Policing and Security Branch. Accessed February 2021. Available at: https://www2.gov.bc.ca/assets/gov/law-crime-and-justice/criminal-justice/police/publications/statistics/bc-policing-jurisdiction-crime-trends.pdf

Casselman, M.T., N.J. Burnett, N.N. Bett, C.T. Middleton, E.G. Martins, D.C. Braun, D. McCubbing, and S.G. Hinch. 2016. *BRGMON-14 Effectiveness of Cayoosh Flow Dilution, Dam Operation, and Fishway Passage on Delay and Survival of Upstream Migration of Salmon in the Seton-Anderson Watershed*. Annual Report – 2015. Report prepared for St'át'imc Government Services and BC Hydro. Vancouver, BC: University of British Columbia. 66 p. + 2 Apps.

CFJC Today. 2018. RCMP Determine Recent Death in Seton Portage as a Homicide. Accessed March 2020. Available at: https://cfjctoday.com/2018/10/20/rcmp-determine-recent-death-in-seton-portage-as-a-homicide/

Chamberlain, M.W., D.S. O'Brien, A. Caverly, and A.R. Morris. 2001. *2000 Middle Bridge River Bull Trout (Slavelinus confluentus) and Kokanee (Onchorhynchus nerka) Investigation*. British Columbia Ministry of Environment, Lands and Parks, Fisheries Branch, Southern Interior Region.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2017. COSEWIC assessment and status report on the Sockeye Salmon *Oncorhynchus nerka,* 24 Designatable Units in the Fraser River Drainage Basin, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xli + 179 pp. (http://www.registrelepsararegistry. gc.ca/default.asp?lang=en&n=24F7211B-1).

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2018. COSEWIC assessment and status report on the Chinook Salmon *Oncorhynchus tshawytscha,* Designatable Units in Southern British Columbia (Part One – Designatable Units with no or low levels of artificial releases in the last 12 years), in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxxi + 283 pp. (http://www.registrelepsararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Dawson Road Maintenance. 2020. Our Service Areas. Accessed April 2020. Available at: https://www.dawsonroadmaintenance.ca/.

District of Lillooet 2021. Official Community Plan. Access March 2021. Available at http://www.lillooet.ca/OCP

Fish and Wildlife Compensation Program (FWCP). 2011. *Bridge/Seton River Watershed: Species of Interest Action Plan*. Final Draft. October 2011.

Fish and Wildlife Compensation Program (FWCP). 2020. *Bridge-Seton Watershed Action Plan*. Final Draft. November 14, 2017. Updated July 21, 2020. https://fwcp.ca/app/uploads/2017/12/Action-Plan-Coastal-Region-Bridge-River-and-Seton-River-Watersheds-Jul-2020.pdf

Fisheries and Oceans Canada (DFO). 2011. Information Document to Assist Development of a Fraser Chinook Management Plan. Draft for Discussion Purposes. March 9, 2011.

Fisheries and Oceans Canada (DFO). 2017. "New Salmon Escapement Database (NuSEDs)" [web application]. Accessed November 2017. http://open.canada.ca/en/suggested-datasets/new-salmon-escapement-database-nuseds.

Furey, P.C., R.N. Nordin, and A. Mazumder. 2004. "Water Level Drawdown Affects Physical and Biogeochemical Properties of Littoral Sediments of a Reservoir and a Natural Lake." *Lake and Reservoir Management*. 20:4. 280-295.

Geen, G.H., and F.J. Andrew. 1961. *Limnological Changes in Seton Lake Resulting from Hydroelectric Diversions*. International Pacific Salmon Fisheries Commission. Progress Report No. 8.

Golder Associates Ltd. (Golder). 2002. *Seton Dam Fish Diversion Project, 1999-2001 Executive Summary Report*. Report prepared for BC Hydro, Kamloops, BC. Golder Report No. 0128948SR: 31 p.

Griffith, R.P. 1999. *Assessment of Fish Habitat and Production in Carpenter Lake Reservoir Relative to Hydroelectric Operations.* Prepared for BC Hydro, Kamloops, BC. 2002p.

Groot, C., and R.A. Margolis. 1991. *Pacific Salmon Life Histories*. First Edition. Vancouver, BC: UBC Press. 576 p.

Hillaby, J. 2012. *Late Summer Distribution of Juvenile Coho Salmon in the Gates Creek Watershed*. Prepared for Lillooet Tribal Council. August 2012.

Hopkins, J., B. Adolph, and D. Levy. 2015. *Bridge River Project Water Use Plan Seton Sockeye Smolt Monitoring Program: Implementation Year 4*. Reference: BRGMON-13. Prepared by St'át'imc Eco-Resources. December 2015.

Indigenous and Northern Affair Canada (INAC). 2021a. First Nations Profiles. Tsal'salh. Accessed February 2021. Available at https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FNReserves.aspx?BAND_NUMBER=595&lang=eng.

Indigenous and Norther Affairs Canada (INAC). 2021b. First Nations Profiles. T'it'q'et. Accessed March 2020. Available at https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FNReserves.aspx?BAND_NUMBER=593&lang=eng

Indigenous and Norther Affairs Canada (INAC). 2021c. First Nations Profiles. Xaxli'p. Accessed February 2021. Available at https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FNReserves.aspx?BAND_NUMBER=592&lang=eng

Indigenous and Norther Affairs Canada (INAC). 2021d. First Nations Profiles, Ts'kw'aylaxw. Accessed February 2021. Available at: https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FNReserves.aspx?BAND_NUMBER=594&lang=eng

Indigenous and Norther Affairs Canada (INAC). 2020e. First Nations Profiles. Bridge River. Accessed March 2020. Available at https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FNReserves.aspx?BAND_NUMBER=590&lang=eng

Interior Health. 2018. Local Health Area Profile: Lillooet. Accessed February 2021. Available at: https://www.interiorhealth.ca/AboutUs/QuickFacts/PopulationLocalAreaProfiles/Documents/Lillooet%20LHA.pdf

Interior Health. 2021a. Lillooet Hospital and Health Centre. Accessed February 2021. Available at: https://www.interiorhealth.ca/FindUs/_layouts/FindUs/info.aspx?type=Location&loc=Lillooet%20Hospital%20%and%%20Health%20Centre&svc=Immunization%20Services&ploc=N/A

Interior Health. 2021b. Royal Inland Hospital. Accessed February 2021. Available at: https://www.interiorhealth.ca/FindUs/_layouts/FindUs/info.aspx?type=Location&loc=Royal%20Inland%20Hospital&svc=&ploc=

Kendall, N.W., G.W. Marston, and M.M. Klungle. 2017. *Declining patterns of Pacific Northwest steelhead trout (Oncorhynchus mykiss) adult abundance and smolt survival in the ocean.* Canadian Journal of Fisheries and Aquatic Sciences. 74: 1275-1290.

Komori, V. 1997. *Salmon Watershed Planning Profiles for the Bridge/Seton Habitat Management Area.* Prepared for Department of Fisheries and Oceans Fraser River Action Plan.

Levy, D.A., and E. Parkinson. 2014. *Independent review of the science and management of Thompson River steelhead.* Prepared for Thompson Steelhead Technical Subcommittee c/o Cook's Ferry Indian Band, Spences Bridge, BC. 104p.

Lil'tem' Mountain Hotel. 2021. Lil'tem' Mountain Hotel. Accessed March 2021. Available at: http://liltemmountainhotel.com/

Lillooet Municipal Government. 2021. Municipal Fire Services. Accessed March 2021. Available at: http://lillooet.ca/Municipal-Government/Municipal-Departments/Fire

Limnotek Research and Development Inc. (Limnotek). 2015. *Seton Lake Aquatic Productivity Monitoring: Progress in 2014 - 2015.* BC Hydro project number BRGMON#6. Submitted to BC Hydro. March 31, 2015.

Limnotek Research and Development Inc. (Limnotek). 2016. *Seton Lake Aquatic Productivity Monitoring: Progress in 2015 - 2016.* BC Hydro project number BRGMON#6. Submitted to BC Hydro. May 16, 2016

Limnotek Research and Development Inc. (Limnotek). 2018. *Carpenter Reservoir Productivity Model Validation and Refinement: Progress in 2015 - 2018.* BC Hydro project number BRGMON#10. Submitted to BC Hydro. October 31, 2018

Lingard, S., D. Braun, and C. Melville. 2013. *Gates Creek Salmonid Assessment Spring 2013 Part 1 of 2.* Fish and Wildlife Compensation Project No. 13.SON.01. Prepared for Lillooet Tribal Council and Fisheries and Oceans Canada. North Vancouver, BC.

Lingard, S., D. Ramos-Espinoza, N. Burnett, D. Braun, and C. Melville. 2016. *Gates Creek Salmonid Population Assessment, Spring and Summer 2016. Implementation Year 5 (2016).* Prepared for the Fish and Wildlife Compensation Program, Lillooet Tribal Council and Fisheries and Oceans Canada.

McPhail, J.D. 2007. *The Freshwater Fishes of British Columbia.* Edmonton: The University of Alberta Press.

Moreira, A.L. 2014. *The Evolutionary Origin of "Black" Kokanee (*Oncorhynchus nerka*) and their Genetic and Phenotypic Diversity in the Anderson and Seton Lakes System.* Master of Science Thesis, University of British Columbia.

Moreira, A.L., and E.B. Taylor. 2015. "The origin and genetic divergence of "black" kokanee, a novel reproductive ecotype of *Oncorhynchus nerka.*" *Canadian Journal of Fisheries and Aquatic Sciences*. 2015:72(10). 1,584-1,595. Accessed November 2017. dx.doi.org/10.1139/cjfas-2015-0145.

Morris, A.R., and A. Caverly. 2004. *2003-2004 Seton and Anderson Lakes Kokanee Assessment*. Prepared for the British Columbia Conservation Foundation and Ministry of Water, Land and Air Protection.

National Inquiry into Missing and Murdered Indigenous Women and Girls (NIMMIWG). 2019. Calls for Justice. Accessed June 2020. Available at: https://www.mmiwg-ffada.ca/final-report/

Naturally:Wood. 2021. Ts'kw'aylaxw Cultural and Community Health Centre. Accessed February 2021. Available at: https://www.naturallywood.com/project/tskwaylaxw-cultural-and-community-health-centre/

Perrin, C.J., R. Pieters, J. Harding, S. Bennett, and G. Lawrence. 2016. *Carpenter Reservoir Productivity Model Validation and Refinement Progress in 2015-2016 Bridge – Seton Water Use Plan Study Number BRGMON10*. Submitted to BC Hydro. May 30, 2016.

Pon, L.B., S.J. Cooke, and S.G. Hinch. 2006. *Passage Efficiency and Migration Behaviour of Salmonid Fishes at the Seton Dam Fishway*. Final Report for the Bridge Coastal Restoration Program.

Provincial Health Services Authority. 2019. BC Community Health Profile, Lillooet. Accessed April 2020. Available at: http://communityhealth.phsa.ca/HealthProfiles/PdfGenerator/Lillooet

Putt, A., D. Ramos-Espinoza, C. Melville, N. Burnett, C. Martin and S. Lingard. 2018. *Bridge-Seton Water Use Plan Implementation Year 5 (2016-2017): Carpenter Reservoir and Middle Bridge River Fish Habitat and Population Monitoring.* Prepared by InStream Fisheries Research Inc. for St'át'imc Eco-Resources. March 2018.

Question. 2013. Court Declares Highline Road a Highway. Accessed June 2020. Available at: https://www.whistlerquestion.com/news/pemberton/court-declares-highline-road-a-highway-1.961369

R.L. and L. Environmental Services Ltd. 1999. *Seton Dam Fish Diversion Project, 1999 Investigations and Testing*. Report prepared for BC Hydro, Kamloops, BC. R.L. and L. Report No. 9928729F: 50 p. + 5 app.

Ramos-Espinoza, D., D.C. Braun, and D. McCubbing. 2015. *Seton River Habitat and Fish Monitor 2014.* Reference: BRGMON-9. Prepared by InStream Fisheries Research Inc. January 2015.

Retasket Lodge. 2021. Retasket Lodge Amenities. Accessed March 2021. Available at: https://www.retasketlodge.com/amenities

Rieman, B.E., and J.D. McIntyre. 1993. *Demographic and Habitat Requirements for Conservation of Bull Trout*. United States Department of Agriculture: Forest Service, Intermountain Research Station. General Technical Report INT-302. September 1993.

Roberge, M., T. Slaney, and C.K. Minns. 2001. *Life History Characteristics of Freshwater Fishes Occurring in British Columbia, with Major Emphasis on Lake Habitat Requirements*. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2574: 189 pp.

Roscoe, DW. 2009. *Hydro-System Related Mortality and In-Lake Behaviour of Migrating Adult Sockeye Salmon in the Seton-Anderson Watershed, British Columbia*. Master of Science Thesis. Vancouver, BC: University of British Columbia.

Scholz, O., P. Gibeau, and A. Moody. 2016. *BRGMON 2 Carpenter Reservoir Riparian Vegetation Monitoring Year 3 Implementation year of Component 2: BRGWORKS 1 re-vegetation monitoring on the Carpenter Reservoir*. Reference: BRGMON 2 year 3 Period: 2015. Lillooet, BC: Splitrock Environmental Sekw'el'was.

Shortreed, K.S., K.F. Morton, K. Malange, and J.M.B. Hume, J.M.B. 2001. *Factors Limiting Juvenile Sockeye Production and Enhancement Potential for Selected B.C. Nursery Lakes*. Fisheries and Oceans Canada, Marine Environment and Habitat Science Division. Cultus Lake, BC.

Sneep, J. 2015. *BRGMON-8 Seton Lake Resident Fish Habitat and Population Monitoring, 2013 and 2014 Results*. Implementation Years 1 and 2. File no.: BRGMON-8. Prepared for St'át'imc Eco-Resources. March 2015.

Sneep, J. 2019. *BRGMON-8 Seton Lake Resident Fish Habitat and Population Monitoring,2017 Results*. File no.: BRGMON-8. Prepared for St'át'imc Eco-Resources. January 2019.

Squamish-Lillooet Regional District. 2008a. Regional Growth Strategy Bylaw No.1062, 2008. Updated October 23, 2019 Accessed March 2020. Available at: https://www.slrd.bc.ca/sites/default/files/pdfs/BL1062.pdf

Squamish-Lillooet Regional District. 2008b. Economic Base Analysis. District of Lillooet, Electoral Areas A and B, Northern St'át'imc . Prepared by Ecoplan International Inc. Accessed March 2020. Available at: https://www.slrd.bc.ca/sites/default/files/reports/Lillooet%20and%20Area%20-%20Economic%20Base%20Analysis%20-%20Final.pdf

Squamish-Lillooet Regional District. 2012. Economic Development Assessment, Strategy, and Action Plan. Squamish-Lillooet Regional District - District of Lillooet, Area A and Area B. Accessed March 2020. Available at: https://www.slrd.bc.ca/sites/default/files/reports/Economic%20Development%20Assessment%2C%20Strategy%20and%20Action%20Plan%20for%20the%20Northern%20SLRD_2012.pdf

Squamish-Lillooet Regional District. 2015. Squamish-Lillooet Regional District RGS Monitoring Report-2014/15. Accessed March 2020. Available at https://www.slrd.bc.ca/sites/default/files/reports/SLRD%20Monitoring%20Report%202014-15%20Final%20wapp.pdf

Squamish-Lillooet Regional District. 2019. Squamish-Lillooet Regional District Regional Growth Strategy Schedule "A" to Bylaw 1062, 2008. Updated October 23, 2019. Available at https://www.slrd.bc.ca/sites/default/files/pdfs/planning/staff-reports/181024%20AppendA-RGSReview1562_CLEAN_SecondReading_Oct17.pdf

St'át'imc Outreach Health Services. 2020. About Us. Accessed March 2020. Available at: https://statimchealth.net/

St'át'imc. 2020. St'át'imc Businesses. Accessed June 2020. Available at: https://statimc.ca/programs/statimc-businesses/

Statistics Canada. 2017. Census Profile, 2016 Census. Statistics Canada catalogue no 8-316-X2016001. Ottawa. Release November 29, 2017. Accessed March 2020. Available at https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E

Statistics Canada. 2020. The Open Database of Healthcare Facilities. Accessed February 2021. Available at: https://www.statcan.gc.ca/eng/lode/databases/odhf

Stl'atl'imx Tribal Police Service. 2021. Links, Community Websites. Accessed February 2021. Available at: www.stlatlimxpolice.ca/links.html.

Stl'atl'imx Tribal Police. 2021. Stl'atl'imx Tribal Police Services. Accessed February 2021. Available at: http://www.stlatlimxpolice.ca/

Tisdale, A.E. 2013. BRGMON – 4 Carpenter Reservoir and Middle Bridge River Fish Habitat and Population Monitoring. Progress Report – 2013. Tisdale Environmental Consulting Inc. Unpublished report by Tisdale Environmental Consulting Inc., Kamloops, BC, for BC Hydro Generation, Bridge Seton Watershed Use Plan, Shalalth, BC.

Truth and Reconciliation Commission of Canada. 2015. Honouring the Truth, Reconciling for the Future. Summary of the Final Report of the Truth and Reconciliation Commission of Canada. Accessed June 2020. Available at: http://www.trc.ca/assets/pdf/Honouring_the_Truth_Reconciling_for_the_Future_July_23_2015.pdf

Vancouver Coastal Health. 2021. Squamish General Hospital. Accessed February 2021. Available at: http://www.vch.ca/Locations-Services/result?res_id=1338

Webb, S.L., R. Bison, A. Caverly, and J. Renn. 2001. *The Reproductive Biology of Steelhead (*Oncorhynchus mykiss*) in the Bridge and Seton Rivers, as Determined by Radio Telemetry 1996/97 and 1998/99*. Prepared for the Ministry of Environment, Lands and Parks, and Fisheries Branch.

Weston, S. 2017. *BC Hydrologic Overview: BC Hydro Bridge River System La Joie, Carpenter and Seton Basins*.

Wetzel, R.G. 1983. *Limnology*. 2nd ed. CBS College Publishing.

Xwísten. 2013. Community Profile. Accessed June 2020. Available at: https://Xwísten.files.wordpress.com/2013/03/Xwísten_communityprofile_v2_low-1.pdf

Xaxli'p. 2021. Home - Xaxli'p. Accessed February 2021. Available at: http://xaxlip.ca/

BC Hydro Bridge River Projects

Bridge River Transmission Project

Appendix C-9

BRT Project Stakeholder Engagement Materials

PUBLIC

Bridge River Transmission Project: Update

June 2020

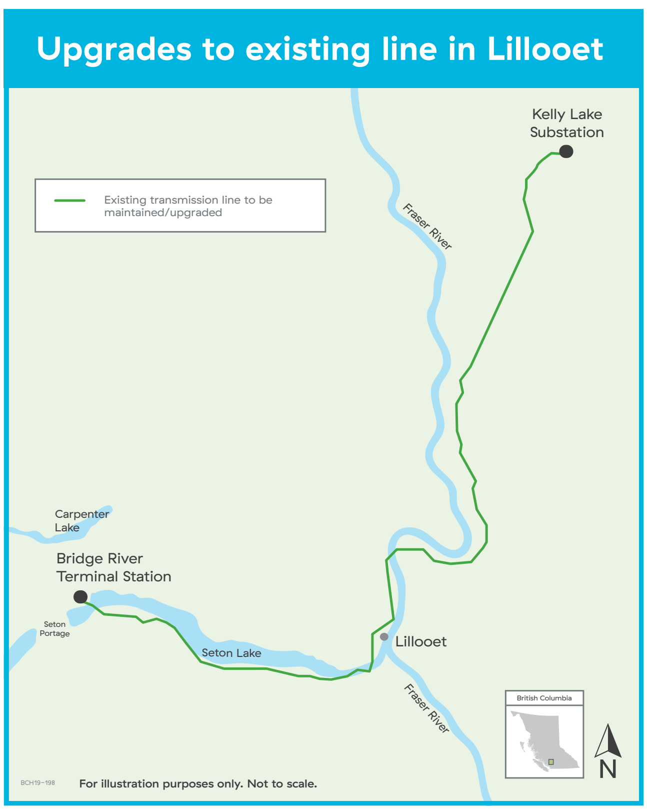
We're currently in the process of upgrading our Bridge River generating facilities located near Seton Portage to restore their capacity. The Bridge River Transmission Project will ensure that the regional transmission system continues to reliably move electricity from these generating facilities to our customers during peak periods.

We've completed our evaluation process of the three project alternatives. Key aspects of our assessment included: costs, system reliability, safety, environmental impacts, stakeholder interests, schedule, constructability and maintenance. We've identified **Alternative 1: Upgrades to an existing power line in Lillooet** as the leading alternative for further study. Over the next few months we'll complete detailed studies to confirm the preferred alternative.

Leading alternative

1. UPGRADES TO AN EXISTING POWER LINE IN THE LILLOOET AREA

We would upgrade approximately 135 structures and raise the height of an existing line in several sections between Kelly Lake Substation and Bridge River Terminal Station. Work would include upgrades to existing access roads and the creation of some new roads to access the structures. Most of the work would be within existing BC Hydro right-of-way.



Schedule

We're in the early planning stages for this project. Construction is anticipated to take place between 2023 – 2025.

A more detailed schedule will be developed as the project progresses.

Other work on the system

Maintenance work on the existing line between Kelly Lake Substation and Bridge River Terminal Station will continue to occur as needed over the coming years.

Rosedale substation will have some equipment replacement over the coming years as part of our substation sustainment program.

If you have any questions or would like to be added to our email notification list, please email projects@bchydro.com or call our Stakeholder Engagement line at 604 623 4472 or toll free at 1 866 647 3334.

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Other assessed alternatives

2. UPGRADES TO ROSEDALE SUBSTATION IN THE FRASER VALLEY

We would add new equipment and complete upgrades to the existing equipment at Rosedale substation located just east of Chilliwack. All work would take place within the existing fenced area of the substation.

3. ADJUSTMENTS TO EXISTING INDEPENDENT POWER PRODUCERS (IPPS) GENERATION

We would request IPPs interconnecting at BC Hydro's [redacted] to reduce generation during specific periods. There would be no physical changes at any location.

Alt 2: Rosedale Substation Upgrade

Alt 3: IPPs Adjustments

[redacted]

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BCH20–528

Bridge River Transmission Project: Update

February 2021

We're currently in the process of upgrading our Bridge River generating facilities located near Seton Portage to restore their capacity. The Bridge River Transmission Project (**bchrydro.com/brt**) will ensure that the regional transmission system continues to reliably move electricity from these generating facilities to our customers during peak periods.

In the fall of 2020, the BC Utilities Commission determined that this project should file for a joint Certificate of Public Convenience and Necessity (CPCN) with the Bridge River generating facility upgrade project. More information on the CPCN process is available at bcuc.com/get-involved.

In addition to participating in the CPCN process over the coming months, the project will be doing more in-depth studies and design work to confirm the leading alternative as the preferred alternative by spring 2022.

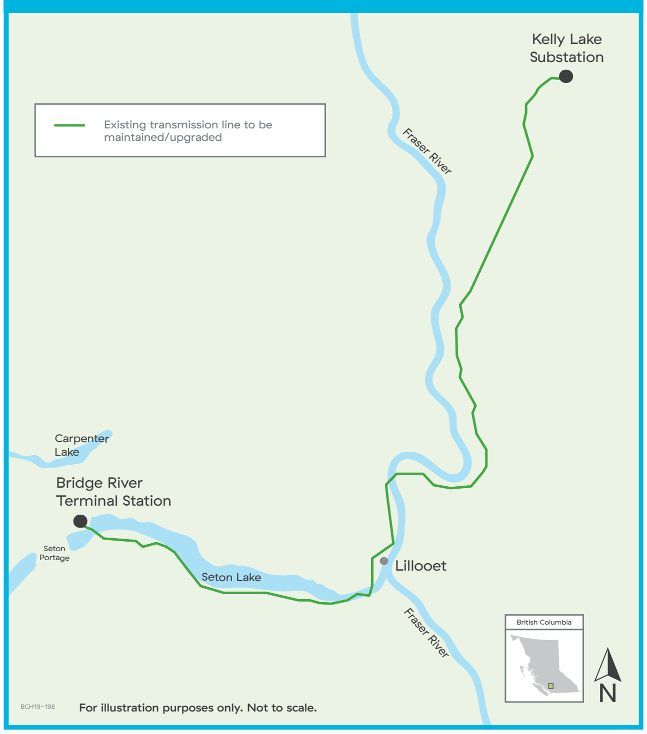
Leading alternative

UPGRADES TO AN EXISTING POWER LINE IN THE LILLOOET AREA

In June 2020, we completed our evaluation process of the project alternatives and selected **Alternative 1: Upgrades to an existing power line in Lillooet** as the leading alternative. Key aspects of our assessment included: costs, system reliability, safety, environmental impacts, stakeholder interests, schedule, constructability and maintenance.

We are planning to upgrade approximately 135 structures and raise the height of an existing line in several sections between Kelly Lake Substation and Bridge River Terminal Station. Work will include upgrades to existing access roads and the creation of some new roads to access the structures. Most of the work will be within existing BC Hydro right-of-way.

Upgrades to existing line in Lillooet



Schedule

We're in the early planning stages for this project. Construction is anticipated to be completed by fall 2025.

A more detailed schedule will be developed as the project progresses.

Other work on the system

Maintenance work on the existing line between Kelly Lake Substation and Bridge River Terminal Station will continue to occur as needed over the coming years.

If you have any questions or would like to be added to our email notification list, please email **projects@bchydro.com** or call our Stakeholder Engagement line at 604 623 4472 or toll free at 1 866 647 3334.

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