Table 12.5-8: Summary of Non-Fish Bearing Habitat Loss Due to the Project

Site ID	Fish Bearing	Reach Length (m)	Average Bankfull Width (m)	Area (m^2)
WAL3	No	578.3	2.07	1,197
WAL4	No	424.9	5.89	2,502.7
UWA1	No	2040.8	-	-
UWA1b-1	No	182.1	2.85	518.9
UWA1b-2	No	1385.9	2.80	3,880.5
UWA2	No	777.4	1.65	1,282.7
UWA3	No	869.6	2.07	1,800
			TOTAL	11,181.8

To date, efforts have been made to identify conceptual offsetting opportunities in the Fish and Fish Habitat LSA and Aquatic RSA in anticipation of the need to undertake offsetting as a mitigation to loss of habitat. Conceptual offsetting measures were identified within the Aquatic RSA. Table 12.5-9 provides a summary of the conceptual offsetting measures identified. Descriptions of each conceptual offsetting measure and a characterization of offsetting value is provided in Appendix 12-E. The effectiveness of the conceptual fish habitat offsetting plans are rated as high due to the similarity between habitats restored that will support the same species composition (e.g., Westslope Cutthroat Trout and Bull Trout).

The likelihood that most of the offsetting available will come from outside of the Fish and Fish Habitat LSA is a key topic for DFO and Indigenous consultation. DFO consultation is in progress and the decision of whether the effect on habitat loss due to the Project can be adequately compensated for will reside outside of the scope of this assessment. Offsetting a potentially resident population's home range is a policy decision and will be driven by DFO goals and is therefore outside the scope of this assessment. For the purpose of this assessment; however, it is assumed that should the Project proceed, DFO will have made a policy decision to issue an authorization under the *Fisheries Act* and that the offsetting measures ultimately selected in support of that authorization will be sufficient at offsetting the residual effects of the Project such that they are not significant. This is a reasonable conclusion since development of the Project would obviously not be able to lawfully occur in the absence of such an authorization.

12.5.3.2 Summary of Mitigation Measures for Fish and Fish Habitat

The key measures proposed to mitigate potential effects to fish and fish habitat are summarized in Table 12.5-10. This table also identifies the anticipated residual effects that will be carried forward in the characterization of residual effects, significance, and likelihood and confidence. Where no residual effect is identified in this table, the effect is rated not significant with a high level of confidence and is not carried forward for further assessment.

Mitigation measures proposed to reduce adverse effects to fish and fish habitat are generally accepted, understood, and proven to effectively reduce adverse effects on fish and fish habitat. Where mitigation measures do not or may not mitigate all effects or if there is an unknown or moderate level of confidence in their effectiveness, the effect was carried forward for further analysis of residual effects. Mitigation measures that are expected to completely mitigate potential effects with a high level of confidence based on their proven effectiveness elsewhere were classified as having no expected residual effects. If monitoring indicates that the effectiveness of mitigation measures and reclamation activities is lower than predicted, further mitigation may be required (refer to the Fish and Fish Habitat Management Plan [Chapter 33, Section 33.4.1.5] for more details).

Table 12.5-9: Summary of Conceptual Fish Habitat Offsetting Plan for Total Area Enhanced (m^2) and Productivity-Adjusted Area (m^2)

Project	Habitat Type	Area Lost (m^2)	Area Enhanced (m^2)	Area Gained (m^2)	Relative Habitat Value	Total Area (m^2)	Productivity-Adjusted Total Area (m^2)
Crown Mountain Coking Coal Project	Instream Habitat (Fish Bearing)	35,165	0	0	1.0	-35,165	-35,165
	Instream Habitat (Non-Fish Bearing)	11,182	0	0	0.5	-11,182	-5,591
	Riparian Habitat	361,300	0	0	0.5	-361,300	-180,650
Total (Crown Mountain Coking Coal Project; m^2):						-407,647	-221,406
Weigert Creek Crossing Replacements	Instream Habitat	0	5,320	0	1.0	+5,320	+5,320
	Riparian Habitat	0	26,097	0	0.5	+26,097	+13,049
Grace Creek Crossing Replacements	Instream Habitat	0	0	5,738	1.0	+5,738	+5,738
Brule Creek Fish Introduction	Instream Habitat	0	0	11,345	3.0	+11,345	+34,035
Elk River Side Channel Improvements	Instream Habitat	0	20,702	0	2.0	+20,702	+41,404
	Riparian Habitat	0	37,958	0	1.0	+37,958	+37,958
Elk River Side Channel Creation	Instream Habitat	0	0	15,005	2.0	+15,005	+30,009
	Riparian Habitat	0	0	26,023	1.0	+26,023	+26,023
Ingham Channel	Instream Habitat	0	0	1,108	1.0	+1,108	+1,108
	Riparian Habitat	0	0	65,570	0.5	+65,570	+32,785
Total Riparian Gain (m^2):							+109,814
Total Instream Gain (m^2):							+117,614
Total Net Gain (m^2):							+6,022

No other technically and economically feasible mitigation measures were considered for fish and fish habitat, and NWP is not aware of potential future technology innovations that could help further mitigate effects.

Table 12.5-10 presents a summary of the Project effects and the VCs with the potential to be impacted by the effect. Some of these effects have been fully avoided, minimized, or mitigated, while others have been partially, or not fully been avoided, minimized, or mitigated. In cases where an effect was not fully avoided, minimized, or mitigated the effect has the potential to impact one or more Project VC. The potentially impacted VCs, as well as the impacted VCs (after avoiding, minimizing, and mitigating have been applied) are discussed in more detail below, as well as summarized in Table 12.5-10.

Instream habitat loss due to mine design and development is anticipated to potentially impact Westslope Cutthroat Trout, Bull Trout, and benthic invertebrates only. This is due to the habitat loss being limited to the West Alexander Creek valley, which the baseline fish and fish habitat assessment found to be exclusively used by Westslope Cutthroat Trout. Bull Trout occur throughout Alexander Creek, but not all of West Alexander Creek. Further studies could aim to better understand the Bull Trout movement in Fish and Fish Habitat LSA. Based on data collected during the baseline assessment and population study of 2020-2021, it was found that Westslope Cutthroat Trout and Bull Trout were the only fish species occurring in West Alexander Creek. No other fish and fish habitat VCs were therefore considered further for potential impacts due to instream habitat loss due to mine design, only benthic invertebrates, Bull Trout, and Westslope Cutthroat Trout were carried forward in the assessment.

Habitat loss due to changes in water quantity has the potential to impact Westslope Cutthroat Trout, Bull Trout, and benthic invertebrates. Due to the reductions in flow being limited to West Alexander Creek, fish and fish habitat VCs occurring in West Alexander Creek and those occurring immediately downstream are anticipated to be impacted. The reduction is anticipated to be effectively mitigated below ALE7. These three VCs were therefore carried forward in the assessment, while all VCs occurring outside this spatial area were not found to be impacted by the reduction of flows in West Alexander Creek due to the Project.

Changes in water quality have the potential to impact all fish and fish habitat VCs: Westslope Cutthroat Trout, Bull Trout, Kokanee, Burbot, Mountain Whitefish, Longnose Sucker, and benthic invertebrates. Due to water quality impacts having the potential to interact at a local (Fish and Fish Habitat LSA), but also cumulatively at a regional (Aquatic RSA) level, all VCs could be potentially impacted by Project induced changes to water quality. In particular, metals leaching into the receiving environment have the potential to result in the bioaccumulation of metal pollutants in the biological food web. Based on the surface water quality assessment (Chapter 11), water quality is not anticipated to exceed the EVWQP benchmarks downstream of the Project. EV MC2, which is situated just downstream of the Fish and Fish Habitat LSA, is a compliance point for which the water quality model found no exceedances are anticipated to occur (i.e., <19 µg/L selenium). This means that changes in water quality are anticipated to be adequately mitigated for fish and fish habitat downstream of the Fish and Fish Habitat LSA. The dilution of metals as far down as ALE1 and ALE2 showed metal levels below the EVWQP benchmarks. This means Mountain Whitefish would not be anticipated to be impacted by changes in water quality due to the Project. Therefore, the only VCs carried forward in the effects assessment were Westslope Cutthroat Trout, Bull Trout, and benthic invertebrates.

Table 12.5-10: Summary of Proposed Mitigation Measures

Potential Effect	Potentially Affected VCs	Key Mitigation Measures	Rationale	Applicable Project Phase	Effectiveness	Residual Effect	Impacted VCs
Fish Mortality	• Westslope Cutthroat Trout • Bull Trout	• Avoiding killing fish by means other than fishing • Avoiding using explosives in or near water • Planning in water works, undertakings, or activities to respective timing windows to protect fish	• When appropriate application procedures for work in and about a stream are followed, the impact of projects can be effectively managed in such a way as to avoid fish death • The approval for work is often accompanied by the recommendation of an on-site Environmental Monitor to be present to do a fish salvage, monitor turbidity, and isolate fish accordingly throughout the work being conducted • Effects to fish mortality for the Project as planned are expected to be fully mitigated, are rated not significant with a high level of confidence, and are not carried forward for further assessment. Fish mortality is further discussed in Chapter 21	• Construction and Pre-Production • Operations • Reclamation and Closure	High	No	None
Change in Fishing Pressure	• Westslope Cutthroat Trout • Bull Trout	• Develop NUE areas to prohibit public access to the Project footprint • Secure access roads to restrict and enforce unauthorized access • Implement the Access Management Plan • Implement a no angling policy for NWP employees and contractors • Coordination with local conservation enforcement for Alexander and West Alexander Creeks should increases in recreational fishing be observed by NWP employees	• By implementing NUE areas and the Access Management Plan, site access to the public will be prohibited and increased fishing pressure in West Alexander and Alexander Creeks will therefore not occur as a result of the Project • Coordination with local conservation officers if increased recreational fishing is observed will allow for enhanced management of the area by Provincial regulators	• Construction and Pre-Production • Operations • Reclamation and Closure	High	No	None
Instream Habitat Loss Due to Mine Design and Development	• Westslope Cutthroat Trout • Bull Trout • Benthic Invertebrates	• Avoid conducting works, undertakings, or activities in water • Avoid placing fill or other temporary or permanent structures below the high-water mark • Avoid fording of the watercourse • Avoid disturbing or removing materials from the banks, shoreline, or waterbody bed, such as; sand, rocks, aquatic vegetation, or natural wood debris • Avoid building structures in watercourses or in areas that may result in erosion and/or scouring of the streambed or banks that are inherently unstable • Minimize the impact by obtaining and authorization under the Fisheries Act for HADD of fish habitat caused by habitat loss, and developing an offsetting plan to compensate and replace for habitat loss caused by the Project	• Habitat loss is avoided and minimized through design and planning of the mine development footprint and infrastructure • It is not possible to avoid or minimize all Project effects of fish and fish habitat • Offsetting is required and is subject to Indigenous and DFO consultation	• Construction and Pre-Production • Operations	Moderate	Yes	• Westslope Cutthroat Trout • Bull Trout • Benthic Invertebrates

Potential Effect	Potentially Affected VCs	Key Mitigation Measures	Rationale	Applicable Project Phase	Effectiveness	Residual Effect	Impacted VCs
Habitat Loss Due to Changes in Water Quantity	• Westslope Cutthroat Trout • Bull Trout • Benthic Invertebrates	• Segregation and diversion of non-contact surface runoff around mine disturbed areas and water control facilities • Controlling outflows from water management facilities to maintain streamflow conditions in the receiving watercourses to the extent possible, particularly during low flow conditions • Limiting surface water withdrawals to minimize impacts on streamflow • Implementation of progressive contouring and reclamation of the Mine Rock Storage Facility to minimize changes in land use and hydrological characteristics • Decommissioning and reclaiming water management facilities to restore natural streamflow conditions in the receiving watercourses to the extent possible • Implement the Site Water Management Plan • Maintain fish passage by avoiding changing flow or water level and obstructing or interfering with the movement and migration of fish	• Measures will help maintain streamflow conditions (flows and water levels) within the receiving watercourses • It is not possible to avoid or minimize all Project effects of fish and fish habitat • Offsetting is required and is subject to Indigenous and DFO consultation	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	Moderate	Yes	• Westslope Cutthroat Trout • Bull Trout • Benthic Invertebrates
Changes in Water Quality	• Westslope Cutthroat Trout • Bull Trout • Kokanee • Burbot • Mountain Whitefish • Longnose Sucker • Benthic Invertebrates	• Limit erosion and contain sediment through the application of standard industry practices • Conduct regular inspections to confirm control measures are effective and functioning properly • Divert clean runoff around mine disturbed areas, where possible • Capture clean surface water that cannot be diverted in sediment ponds prior to release • Limit the mine disturbance footprint through Project design and progressive reclamation • During active mining, dewatering will be carried out using drainage ditches, berms, sumps and pumps. Pit dewatering will be coordinated to meet overall water quality objectives • Once backfilled and allowed to fill with groundwater inflows, selenium and nitrate are effectively reduced in mildly suboxic saturated rock fill • Engineered layering of coal rejects and mine rock to limit Metal Leaching/Acid Rock Drainage • Saturated backfill of mine rock in the East and North Pits • Progressive reclamation of the Mine Rock Storage Facility • Installation of impermeable liners in the Interim and Main Sediment Ponds • Appropriate sizing of sediment ponds to minimize seepage losses and convey runoff during storm events • Groundwater and surface water monitoring	• Standard industry practices for dewatering are proven to be effective at reducing impacts in the receiving environment • The mine rock placement outside of the pits will blend Potentially Acid Generating (PAG) and non-PAG materials such that the resulting mixture performs as non-PAG. The reject layers will act as suboxic environments where oxygen, nitrate, and selenate will be reduced. The proposed design will be evaluated during the first few years of Operations to determine if successful • Selenium removal from contact waters has not been demonstrated directly, but selenium concentrations from saturated backfills are much lower than observed for conventional ex-pit mine rock at several operating mines • Progressive reclamation will limit exposure time of the Mine Rock Storage Facility • Impermeable geomembrane liners are proven to be effective in preventing leakage/seepage to groundwater. However, the potential for seepage of contaminated groundwater to surface water downstream of the sediment ponds remains • Appropriately sized sediment ponds are proven to be effective to settle particles • Descaling agents are proven effective in reducing calcite formation • Minimizing the Project footprint reduces the amount of surface runoff from mine disturbed areas, reducing the burden on the sediment ponds	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	Moderate	Yes	• Westslope Cutthroat Trout • Bull Trout • Benthic Invertebrates

Potential Effect	Potentially Affected VCs	Key Mitigation Measures	Rationale	Applicable Project Phase	Effectiveness	Residual Effect	Impacted VCs
			• The potential for discharge of water containing elevated concentrations of TSS, selenium, nitrate, or other parameters exists should other upstream mitigation methods (e.g., mine rock management) not operate as intended				
Change in Fish and Fish Habitat Due to Blasting	• Westslope Cutthroat Trout • Bull Trout	• Reduction of charge per delay by decking the blast holes • Increasing the delay time between rows and holes to produce discrete explosions • Use of bubble/air curtains to disrupt the shock waves • Design of blasts and delay configurations to minimize vibration	When charges are managed to remain below the 13 mm/s vibration guideline, fish and fish habitat are protected against impacts from mine pit blasts. Effects of blasting on fish and fish habitat are expected to be fully mitigated, are rated not significant with a high level of confidence, and are not carried forward for further assessment.	• Construction and Pre-Production • Operations	High	No	None
Changes in Streambed Structure	• Westslope Cutthroat Trout • Bull Trout • Mountain Whitefish • Benthic Invertebrates	• Limit erosion and contain sediment through the application of standard industry practices • Conduct regular inspections to confirm control measures are effective and functioning properly • Divert clean runoff around mine disturbed areas, where possible • Capture clean surface water that cannot be diverted in sediment ponds prior to release • Limit the mine disturbance footprint through Project design and progressive reclamation • Limit dust generation and emissions through the application of standard industry practices and emissions control measures	• Erosion and sediment control measures (e.g., silt fencing) are standard industry practice and proven to be effective • Regular inspection of erosion and sediment control measures allows for timely repairs and adjustments as required • Minimizing the Project footprint minimizes potential erosion and sedimentation effects to surface water • Emission control measures (e.g., fabric covers, dust suppression) are standard industry practice and proven to be effective • Regular inspection of emission control measures allows for timely repairs and adjustments as required • Minimizing the Project footprint, particularly exposed soils, minimizes potential wind erosion and dust generation	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	Moderate	Yes	• Westslope Cutthroat Trout • Bull Trout • Benthic Invertebrates
Functional Riparian Disturbance	• Westslope Cutthroat Trout • Bull Trout • Mountain Whitefish • Benthic Invertebrates	• Maintaining an undisturbed vegetated buffer zone between areas of on-land activity and the high-water mark of any waterbody • Using existing trails, roads, or cut lines wherever possible • Avoiding tree removal, where possible • Using methods to prevent soil compaction, such as swamp mats or pads • Carry out works, undertakings, and activities on land • Project design optimization • Implementation of Ecological Restoration Plan • Minimizing disturbance and cleared areas • Monitor reclaimed wetlands and wetland function • Minimum design standards for water management infrastructure • Energy dissipation devices	• Measures contribute to the avoidance, minimization, and restoration of riparian habitat losses associated with construction, mining, and operational management activities. By accomplishing these, the effect on fish and fish habitat will indirectly be avoided, minimized, and ecosystem services associated with habitat functioning restored • Effects of Project development on the riparian habitat extent are not expected to be fully mitigated • Offsetting is likely required and is subject to Indigenous and DFO consultation	• Construction and Pre-Production • Operations • Reclamation and Closure	Moderate	Yes	• Westslope Cutthroat Trout • Bull Trout • Benthic Invertebrates

Changes in streambed structure have the potential to impact Westslope Cutthroat Trout, Bull Trout, Mountain Whitefish, and benthic invertebrates. Geomorphological and TSS impacts are not anticipated to extend beyond the Fish and Fish Habitat LSA. As such, it is not anticipated that Mountain Whitefish, or other fish and fish habitat VCs occurring lower down in the Elk River watershed, will be affected by changes in streambed structure. The effects assessment therefore focusses on the effects occurring due to changes in streambed within the Fish and Fish Habitat LSA upstream of Highway 3. The VCs anticipated to potentially be impacted by changes in streambed structure are therefore Westslope Cutthroat Trout, Bull Trout, and benthic invertebrates.

Functional riparian disturbance has the potential to impact Westslope Cutthroat Trout, Bull Trout, Mountain Whitefish, and benthic invertebrates. While riparian disturbances often occur at and interact with the aquatic ecosystem at a landscape scale, functional riparian disturbance due to the Project is limited to the Fish and Fish Habitat LSA and therefore to fish and fish habitat VCs that occur in the Fish and Fish Habitat LSA. After avoidance and mitigation has been applied, the fish and fish habitat VCs anticipated to be affected by the Project are Westslope Cutthroat Trout, Bull Trout, and benthic invertebrates.

12.5.4 Characterization of Residual Effects

For the characterization of residual effects for the fish and fish habitat assessment, 7 VCs were identified be assessed against the potential effects that could impact the quantity and quality of habitat available to them. The VCs are: Westslope Cutthroat Trout, Bull Trout, Kokanee, Burbot, Mountain Whitefish, Longnose Sucker, and benthic invertebrates. There is a gradient of distribution present, with Burbot and Kokanee only occurring downstream of Elko, B.C., and Westslope Cutthroat Trout being the most prominent species found in the upper tributaries of the Fish and Fish Habitat LSA (Figure 12.4-1). The residual effects assessment was conducted in such a manner as to evaluate potential effects from the Project, relative to the geographic extent in which each effect is anticipated to occur, and in particular, taking into account the VCs that would be impacted by such an effect based on existing distribution patterns.

Based on the evaluation of potential Project effects on fish and fish habitat, potential residual effects that may remain after implementation of proposed mitigation measures include:

- Instream habitat loss due to mine design and development;
- Habitat loss due to changes in water quantity;
- Changes in water quality;
- Changes in streambed structure; and
- Functional riparian disturbance.

Interpretation of potential residual toxicological impacts to fish and benthic invertebrate VCs in relation to changes in water quality and sediment quality is presented in Chapter 22.

12.5.4.1 Assessment Methods

12.5.4.1.1 Instream Habitat Loss Due to Mine Design and Development

Instream habitat anticipated to be directly affected by construction of Project infrastructure was identified using Project footprint development and fish baseline assessment layers in GIS. Direct habitat loss in square metres (m^2) was calculated using the average stream reach bankfull width and the length of fish bearing stream anticipated to be removed.

Together with the fish bearing sections of West Alexander Creek that will be removed, there are also two non-fish bearing reaches and a few noticeable non-fish bearing tributaries that will be removed by the Project:

- WAL3, which is situated immediately upstream of WAL2 (fish bearing) and was frequently observed to dewater;
- WAL4 is a wetland situated upstream of WAL3. Overland flow leaving the wetland quickly goes underground throughout much of the year;
- UWA1b-1 and UWA1b-2 are two reaches on a tributary (UWA1) that enters on the eastern bank of West Alexander Creek. This tributary (both reaches) is considered non-fish bearing due a very steep gradient; and
- UWA2 is a tributary also on the east side of West Alexander Creek. UWA2 has a 10 m high waterfall fish barrier located 15 m from the confluence with WAL3.

Fish bearing sections impacted by instream habitat loss due to mine design and development are West Alexander Creek Reach 1 and Reach 2 (WAL1 and WAL2). WAL1 starts at the confluence with Alexander Creek and ends at the confluence with UWA1b, where there is a notable reduction in stream size upstream of the tributary confluence. WAL1 is 6.75 km long with an average gradient of 4.36% and average bankfull width of 6.25 m, giving it a cascade-pool morphology. The riparian vegetation is mature forest. West Alexander Creek Reach 2 extends 0.26 km upstream from the confluence with UWA1b up to a dry cascade that had a slope of >30%. The average gradient for WAL2 is 15.0% with an average bankfull width of 3.82 m, giving it a step-pool morphology.

12.5.4.1.2 Habitat Loss Due to Changes in Water Quantity

Habitat loss due to flow reductions requires a hydrological assessment to identify the areas and extent of anticipated reduction, or increases, in flows. These changes to flows were assessed by modelling the anticipated percent change in MAD at different periods on the annual hydrograph over the course of the Project duration using flow screening thresholds for fish life stages defined in Hatfield et al. (2003). Depending on when, and to what extent, these changes occur, an assessment on potential impact to fish habitat was made. The full assessment of anticipated changes in flow conditions is presented in Chapter 10.

For the assessment of changes in surface water quantity, the approach as outlined in Lewis et al. (2004) was used. Lewis et al. (2004) makes use of the calculations outlined in Hatfield et al. (2003) for determining flow thresholds by using a seasonally-adjusted threshold for alterations to natural stream flows in fish bearing streams. These thresholds are calculated as percentiles of natural mean daily flows for each calendar month. The environmental flow for the lowest flow month is set as Q_{90} (90^{th} percentile), and for the highest flow month as Q_{20} (20^{th} percentile). The environmental flow thresholds for all other months are calculated as a percentile between Q_{90} and Q_{20} using a weighted function (Hatfield et al., 2003). As a result, more water is available for diversion during high flow months than during low flow months. These percentiles vary through the year in order to provide higher protection during low flow months than during high flow months. In addition to the flow thresholds, an assessment for whether flows will be adequate to support fish during migration, overwintering, and spawning periods was also completed as needed.

12.5.4.1.3 Changes in Water Quality

Two pathways of effect to fish and fish habitat due to changes in water quality were identified; these are: increased TSS and turbidity, and increased metal concentrations.

Increased TSS and Turbidity

The potential impacts of TSS are assessed in more detail in Chapter 11. TSS do not act conservatively due to sedimentation processes and were not accounted for in the mass balance approach used to develop the water quality model. It was assumed that the proposed on-site sediment ponds designed to meet provincial and industrial standards will be sufficient for settling of particulates. Specific details on the sediment pond designs are provided in Chapter 3.

Increased Metal Concentrations

An assessment of the potential threats of changes in water quality to aquatic wildlife is provided in Chapter 22. This assessment was based on a risk assessment which used the Elk Valley Bioaccumulation Model to equate the potential risk of bioaccumulation to occur using data produced from the surface water quality model. However, this assessment approach was based on using water column volumes and were not related to µg/g (ww [wet weight] and dw). This assessment considers results presented in Chapter 11, Chapter 22, and Appendix 22-B to assess the potential for the Project to have an effect on fish and fish habitat health through bioaccumulation and metal contamination.

An assessment of the contaminants of potential concern including cobalt, cadmium, nickel, nitrate, and sulphate is provided in Appendix 12-F. This assessment includes the prediction of cadmium concentrations in fish tissue based on predicted changes to aqueous concentrations in the receiving environment. Other contaminants were found not found to be bioaccumulative and therefore excluded from the detailed assessment.

12.5.4.1.4 Changes in Streambed Structure

Changes in streambed structure was informed by Chapter 11 for increased sediment load to receiving environments. The Calcification Assessment (Appendix 11-D) was used to inform the likelihood of calcite precipitation occurring downstream of the Project. The geomorphology assessment (Appendix 12-A) was completed to provide information on the potential sensitivity of different receiving aquatic reaches to changes in geomorphological streambed structure due to the Project.

12.5.4.1.5 Functional Riparian Disturbance

Davidson et al. (2018) characterizes benchmarks of disturbance to riparian habitat within the Elk Valley Cumulative Effects Management Framework in three levels:

- Low: <10% riparian disturbance;
- Moderate: >10% but < 20% riparian disturbance; and
- High: ≥20% riparian disturbance.

A significant adverse residual effect on riparian habitats is defined as one where the Project directly results in the removal of more than 20% of riparian habitat within the Landscape and Ecosystems LSA (i.e., high magnitude) that is not reversible (i.e., permanent duration) within the timeframe of the Post-Closure phase following implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3). In circumstances where the magnitude of potential changes to riparian habitats cannot be accurately quantified (i.e., not directly attributable to assessed VCs), then the quantification of potential change of an intermediate VC (e.g., alteration of surface water quantity) was considered. A detailed assessment on riparian habitat is presented in Chapter 13.

12.5.4.2 Assessment of Potential Residual Effects

12.5.4.2.1 Instream Habitat Loss Due to Mine Design and Development

The Project is anticipated to have a residual adverse effect on fish and fish habitat, specifically on the West Alexander Creek tributary within the Fish and Fish Habitat LSA due to the construction of the proposed Mine Rock Storage Facility. In this light, HADD was assessed to quantify the anticipated impact of the Project on fish habitat in order to apply appropriate offsetting requirements, if possible.

Due to the mine design, two fish bearing reaches on West Alexander Creek (WAL1 and WAL2) will be removed by the Project. WAL 1u/s and WAL2 will be completely removed, while only parts of WAL1d/s is anticipated to be removed, with direct habitat loss ending at the downstream outlet of the Main Sediment Pond's spillway. Figure 12.5-3 presents West Alexander Creek at end of Operations or maximum build-out. The Main Sediment Pond is situated below the Mine Rock Storage Facility within the West Alexander Creek valley.

Fish population composition through species and characteristics are overall unlikely to be changed as a result of the potential impacts to habitat in the Project footprint. Change will occur in the suspected resident Westslope Cutthroat Trout population in West Alexander Creek due to the direct removal of fish habitat. However, habitat in downstream and adjacent waterbodies are similar and will be able to support the species in the current community. Offsetting measures will also take place in areas of similar habitat that will support local fish populations (Appendix 12-E).

Apart from fish habitat use being lost, the overall functional input of this habitat to the aquatic food web downstream is lost. Table 12.5-11 provides a summary of the habitat anticipated to be removed by the Project. The loss of fish habitat in West Alexander Creek has the potential to cause an imbalance in the aquatic food web due to the reduction of invertebrate drift. Invertebrate drift refers to the in-channel, downstream transport of terrestrial and aquatic invertebrates, and is an important food source for insectivorous fish species, including Westslope Cutthroat Trout (Shepard et al., 1984; Wipfli and Gregovich 2002; Naman et al. 2016). Up to 80% of the invertebrate drift community has been documented to be reduced by fish consumption (Naman et al., 2016). Several abiotic and biotic factors including flow rates, species, life cycle stage, and light have been demonstrated to impact invertebrate drift distances; and has been widely documented to be short range from centimetres up to several metres (Elliot, 1971; Waters 1972; Hemsworth and Brooker, 1979; Brittain and Eikeland, 1988). Longer range distances over several hundred metres have been documented; however, have been labelled as extreme (Brittain and Eikeland, 1988; Naman et al., 2016). Although the loss of fish habitat will affect the biomass of invertebrates available, the reduction of short range drift is anticipated to have a minimal effect on consumers and will be limited to the upstream sections of Alexander Creek. As drift-feeding fish further downstream of West Alexander will likely continue to rely on more local sources of invertebrates, the potential impact on the aquatic food web and productivity is predicted to be minor.

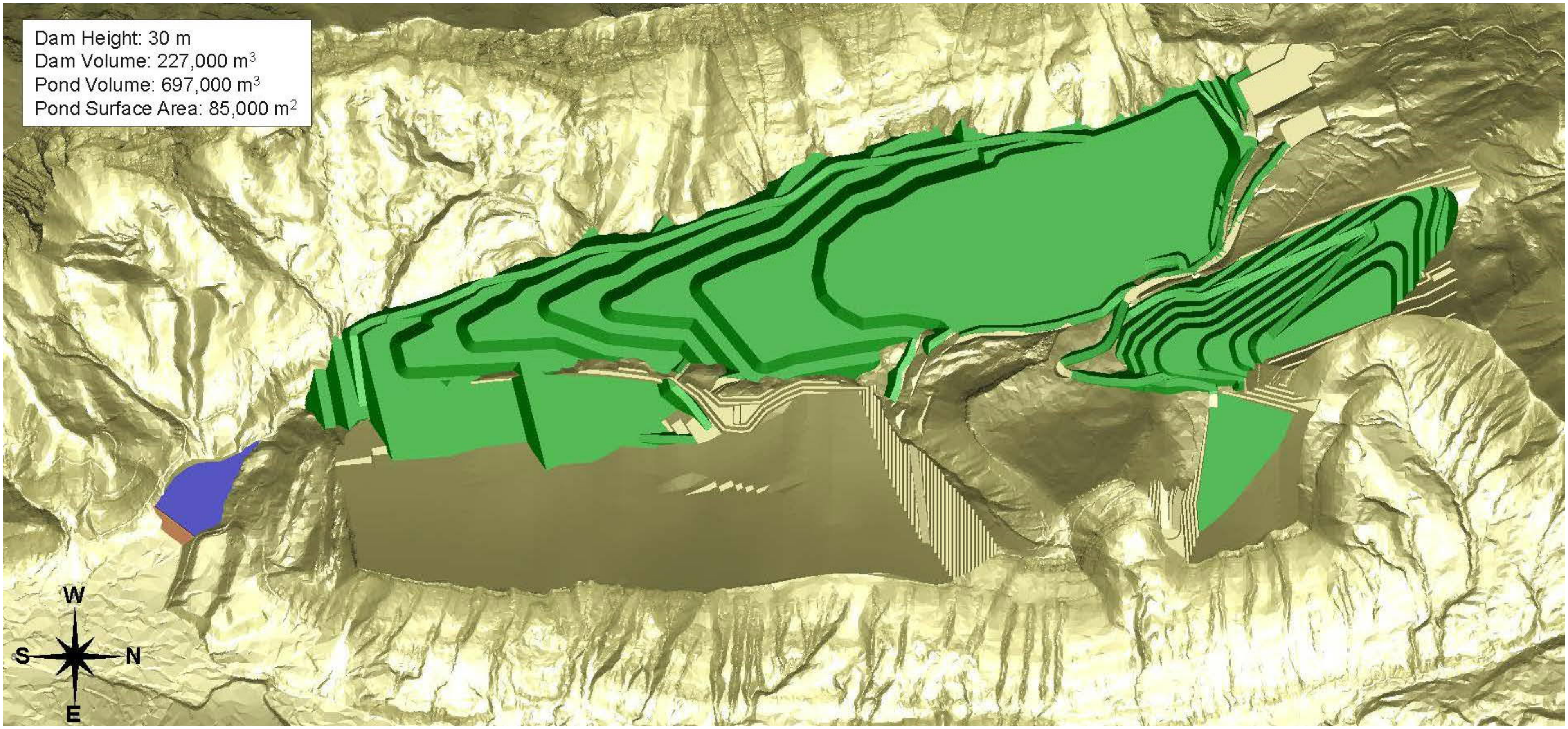

Figure 12.5-3: Project Footprint in West Alexander Creek at End of Operations showing the Main Sediment Pond (blue) and Mine Rock Storage Facility (green) in the West Alexander Creek Valley

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Table 12.5-11: Summary of Instream Habitat Loss Due to Mine Design and Development in West Alexander Creek

Site ID	Fish Bearing	Reach Length (m)	Average Bankfull Width (m)	Area (m^2)
WAL1 u/s and WAL1 d/s up to downstream end of the Spillway	Yes	5,001.94	6.25	31,262.1
WAL2	Yes	174.23	3.82	665.6
			Total Fish Bearing	31,927.7
WAL3	No	578.3	2.07	1,197
WAL4	No	424.9	5.89	2,502.7
UWA1	No	2040.8	-	-
UWA1b-1	No	182.1	2.85	518.9
UWA1b-2	No	1385.9	2.8	3,880.5
UWA2	No	777.4	1.65	1,282.7
UWA3	No	869.6	2.07	1,800
			Total Non-Fish Bearing	11,181.8

Subject to DFO's approval, NWP will apply for and obtain an authorization under Section 35(2) of the *Fisheries Act* in order to authorize this HADD of fish habitat as a result of instream habitat loss due to mine design and development, with appropriate offsetting for the residual effects of this loss to such an extent that no residual effects will remain following the implementation of the offsetting measures. This approach is consistent with the DFO "Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat Under the *Fisheries Act*" (DFO, 2019b).

Figure 12.5-2 presents the geographic extent of habitat loss anticipated to occur due to the Project. The habitat anticipated to be lost is considered high value WCT habitat as it provides suitable habitat for all life stages (i.e., spawning, rearing, and overwintering).

12.5.4.2.2 Habitat Loss Due to Changes in Water Quantity

To assess potential residual habitat loss due to changes in water quantity, MAD (in m^3/s [cubic metres/second]) by month were assessed at select flow nodes anticipated to be impacted by the Project. The nodes assessed included:

- AC-1 – Alexander Creek upstream of Highway 3;
- AC-3 – Alexander Creek downstream of West Alexander Creek;
- AC-4 – Alexander Creek upstream of West Alexander Creek;
- AC-5 – West Alexander upstream of Alexander Creek confluence; and
- AC-6 – West Alexander Creek downstream of Main Sediment Pond outlet.

Flow conditions are presented under both historical climate conditions (Figure 12.5-4) and under climate change conditions (Figure 12.5-5). None of the flow nodes were found to exceed the 20% MAD threshold during low flow periods. This means that the Project is not anticipated to result in reduced flows below 20% MAD at any time during Construction and Pre-Production, Operations, Reclamation and Closure, or Post-Closure, which would result in significant residual effects on fish and fish habitat. However, during low flow months (December to March), the reduction in flows predicted at AC-6 and AC-5 are anticipated to have a potential effect on fish habitat suitability and availability, due its close proximity to the 20% MAD threshold. Depending on the time of year and the amount of flow that remains, certain habitat uses for life history stages could be reduced or completely lost. For instance, if the flow that remains during low flow periods (winter) is below 20% MAD, the habitat becomes unsuitable for overwintering fish use. The baseline average flow at AC-6, just downstream of the Main Sediment Pond, is 0.04 m3/s during low flow conditions. During low flow conditions in January and February, a predicted flow reduction of 34.4% (Operations), 37.4% (Reclamation and Closure), and 36.5% (Post-Closure) is predicted, leaving 0.06 m3/s of flow at a 20% MAD of 0.04 m3/s. AC-5, which is situated downstream of AC-6 and upstream of the confluence of West Alexander Creek with Alexander Creek, and will experience similar reductions during winter low flow periods. As described in Chapter 10, a comparison of the projected mean monthly flow data for the baseline and mine development (with climate change) scenarios identified the following conclusions at the Alexander Creek and West Alexander Creek assessment nodes:

- At all locations assessed, there is a distinct change in the shape of the hydrograph resulting from a shift in the timing of the peak of the freshet from late spring (May-June) to mid-spring (April-May), together with changes to the magnitude of mean monthly flows;
- The increase in the magnitude of mean monthly flows during the freshet is most notable at the Alexander Creek nodes (AC-1 and AC-3) for the Operations and Reclamation and Closure phases. At the West Alexander Creek downstream of the Main Sediment Pond (AC-6) node, there is a reduction in the magnitude of the mean monthly flows during the freshet period for all phases with the exception of Reclamation and Closure; and
- The impacts of climate change could have a substantial influence on the timing and magnitude of streamflow within West Alexander Creek, increasing annual peak flows at AC-5 and AC-6 from around 0.4 to 0.6 m^3/s. Details on the methodology used for climate change modelling is presented in Chapter 10. Climate change could have an effect on fish and fish habitat due to substantially increased peak annual freshet flows having the ability to alter fish habitat geomorphologically due to increased velocity associated with these flow peaks. Substantially increased flows could also alter large woody debris deposition and distribution, substrate size due to increased carrying capacity, and the ability for smaller fish to not be able to withstand the high flows.

The hydrological model predicts increases in flow to potentially occur during the Project. Increased flows/increased flooding volumes can have positive and negative effects on fish and fish habitat. Examples of positive effects include stimulating invertebrate production and triggering spawning for certain species, such as WCT and Bull Trout in the Fish and Fish Habitat LSA. Potential negative effects include erosion, contamination of downstream waters, increased sediment introduction, which can have negative impacts on spawning areas, and on fry and juvenile fish, which can be overtaken by high flows. Maintaining complexity in streams using responsible management practices is important to increase the ability of fish and habitats to respond positively to flood events (Walker et al., 2016). Since the 20% MAD threshold for maintaining fish habitat during low flow periods was not exceeded at any of the flow nodes, residual

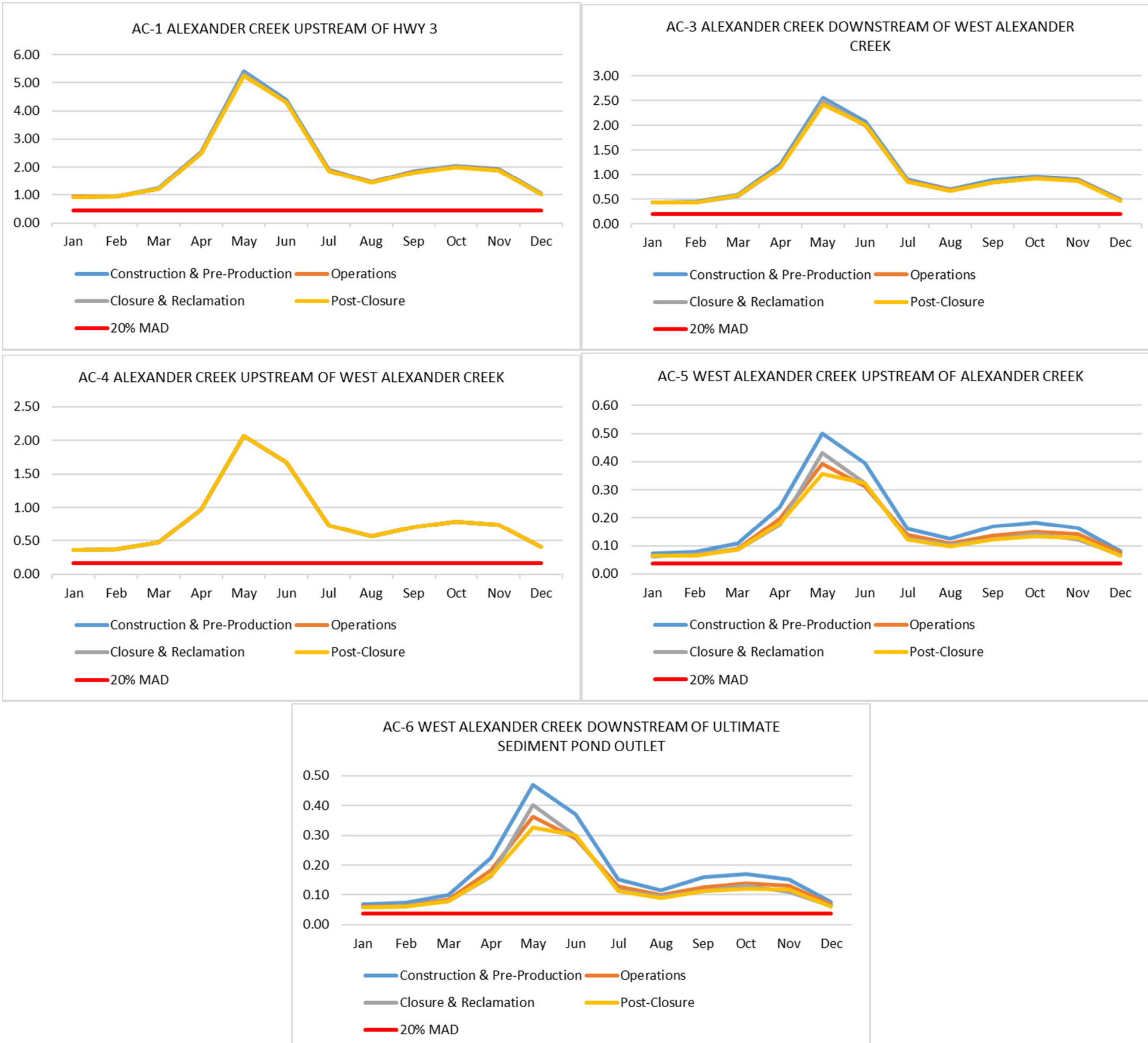


Figure 12.5-4: Predicted Mean Annual Discharge for Mine Development Phases under Historical Climate Conditions

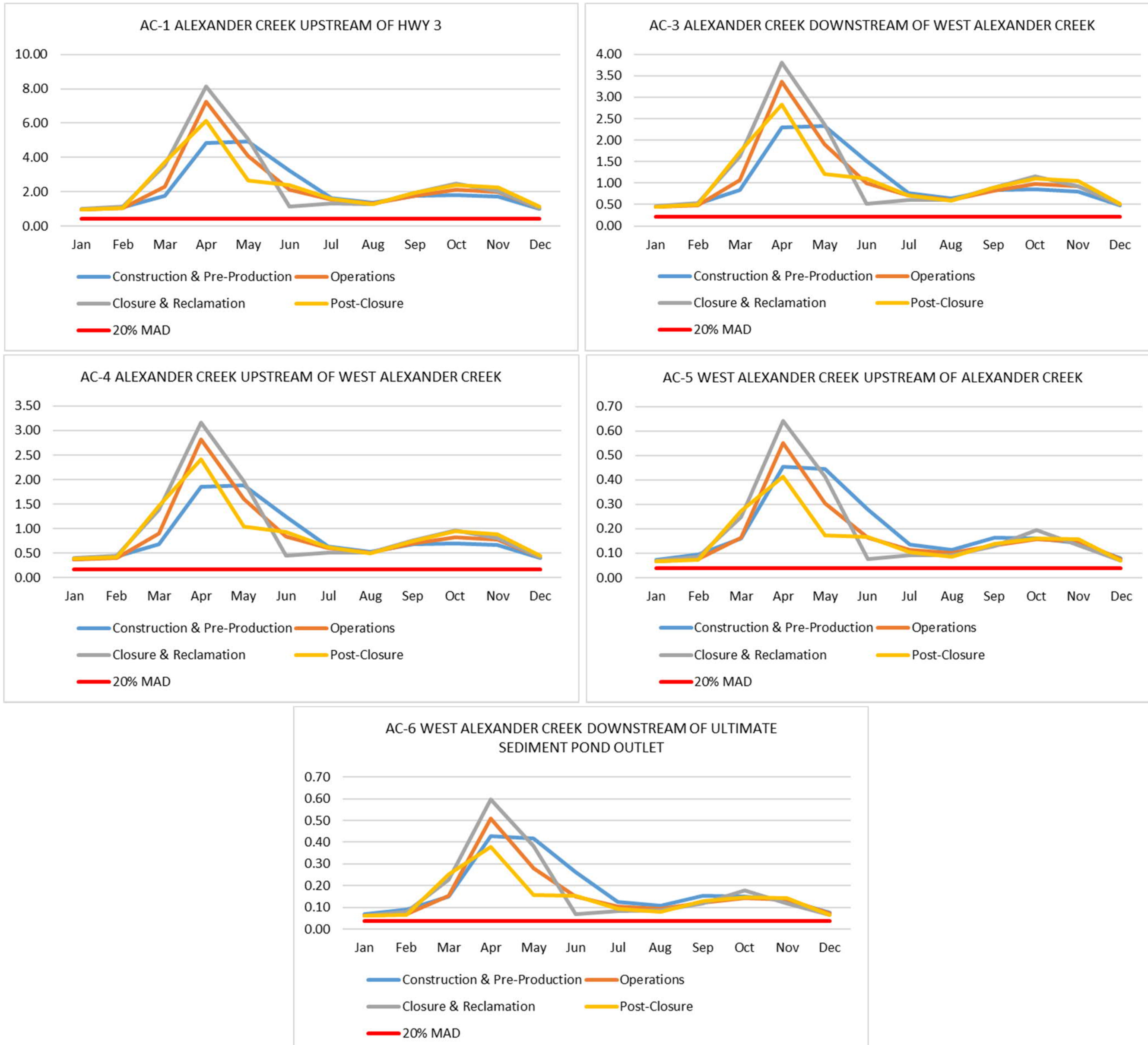


Figure 12.5-5: Predicted Mean Annual Discharge for Mine Development Phases under Climate Change Conditions

habitat loss due to changes in water quantity were not found to be present. However, AC-5 and AC-6 were very close to exceeding this threshold and due to the size of West Alexander Creek and the high value fish habitat present in this section of the Fish and Fish Habitat LSA, instream flow thresholds were calculated to confirm that remaining flows would be adequate in maintaining fish and fish habitat during different months of the year (Hatfield et al., 2003). The results for these calculations are presented in Table 12.5-12 and Table 12.5-13.

Results from the hydrological model (Chapter 10) predicts that the flows that remain in West Alexander Creek below the Main Sediment Pond will not meet the monthly thresholds required to maintain fish and fish habitat during low flow periods. During spawning months for Westslope Cutthroat Trout (April and May), flows will meet the thresholds and therefore not result in an effect to fish and fish habitat due to the Project. However, due to reduced flows exceeding the thresholds during already naturally low flow periods on the hydrograph (November to March) and during summer low flows (July to September), overwintering and rearing potential of habitat below the Main Sediment Pond will be lost. This loss in habitat function will require offsetting to compensate for the loss in fish habitat use.

Table 12.5-12: Summary of Instream Habitat Loss Due to Changes in Water Quantity on WAL1d/s

Site ID	Fish Bearing	Reach Length (m)	Average Bankfull Width (m)	Area (m^2)
WAL1 d/s of the Spillway up to confluence with Alexander Creek	Yes	549.65	5.89	3,237.44

12.5.4.2.3 Changes in Water Quality

TSS is not anticipated to increase to the extent that it would substantially affect fish and fish habitat below the Main Sediment Pond. The controlled releases from the Main Sediment Pond aims to prevent excessive sediment input in receiving environments.

Selenium concentrations in West Alexander Creek are predicted, by the water quality model presented in Chapter 11, to increase above the B.C. WQG of 0.002 mg/L from Year 6 until Year 34, with guideline exceedances occurring year-round. Maximum concentrations reach 0.014 mg/L in Year 17 in the 95^{th} percentile scenario, and 0.0070 mg/L in Year 17 in the 50^{th} percentile scenario. Selenium concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet. Concentrations below the guideline occur between freshet and late summer/early fall every year in the 50^{th} percentile results, but primarily remain elevated above guideline value year-round in the 95^{th} percentile scenario. West Alexander Creek will require habitat offsetting and the exceedances predicted would therefore not be considered as the habitat will be removed by direct habitat loss and reductions in flow volume.

In Alexander Creek, no selenium exceedances are predicted to occur at AC-3, AC-2, or AC-1 in the 50^{th} percentile scenario, with a maximum concentration of 0.002 mg/L at AC-3 in Year 17. In the 95^{th} percentile scenario, at AC-3, B.C. WQG exceedances occur every year between Year 6 and Year 34, reaching a maximum of 0.0038 mg/L in Year 17. At AC-2, selenium exceedances occur every year between Year 7 and Year 34, with the exception of Year 12, reaching a maximum of 0.0028 mg/L in Year 17. At AC-1, selenium exceedances occur in Year 7 and Year 8 and from Year 13 to 34, reaching a maximum of 0.0026 mg/L in Year 17.

Table 12.5-13: Hydrologic Characteristics for AC-6 (West Alexander Creek Downstream of the Main Sediment Pond Outlet), Showing the Key Hydrologic Statistics, Median Monthly Flows at Baseline, %MAD at Baseline by Month, Predicted Change in Flow under Historical Climate and Climate Change Conditions During Different Phases of the Project, and Flow Thresholds as per Hatfield et al. (2003).

Month	Mean baseline flow (m^3/s)	% MAD	Median (m^3/s)	Fish bearing threshold percentile	Fish bearing threshold Flow (m^3/s)	Changes in Mean Flows: Mine Development (Historical Climate)								Changes in Mean Flows: Mine Development (with Climate Change)							
						Construction and Pre-Production		Operations		Reclamation and Closure		Post-Closure		Construction and Pre-Production		Operations		Reclamation and Closure		Post-Closure	
						% change	Flow (m^3/s)	% change	Flow (m^3/s)	% change	Flow (m^3/s)	% change	Flow (m^3/s)	% change	Flow (m^3/s)	% change	Flow (m^3/s)	% change	Flow (m^3/s)	% change	Flow (m^3/s)
Jan	0.09	42.85%	0.08	90%	0.08	-27.10%	0.07	-34.40%	0.06	-37.40%	0.06	-36.50%	0.06	-25.80%	0.07	-32.80%	0.06	-31.40%	0.06	-33.10%	0.06
Feb	0.09	42.85%	0.08	90%	0.08	-21.80%	0.07	-32.40%	0.06	-32.20%	0.06	-36.20%	0.06	-3.20%	0.09	-25.20%	0.07	-14.00%	0.08	-27.50%	0.07
Dec	0.1	47.62%	0.09	88%	0.09	-25.80%	0.08	-32.10%	0.07	-39.70%	0.06	-42.10%	0.06	-27.10%	0.07	-30.10%	0.07	-37.30%	0.06	-37.10%	0.06
Mar	0.12	57.14%	0.09	88%	0.1	-17.10%	0.1	-31.30%	0.08	-35.50%	0.08	-34.10%	0.08	23.70%	0.15	25.60%	0.15	87.30%	0.23	107.90%	0.25
Aug	0.14	66.67%	0.12	82%	0.11	-19.10%	0.12	-29.90%	0.1	-34.20%	0.09	-38.20%	0.09	-26.00%	0.11	-35.70%	0.09	-40.50%	0.09	-45.70%	0.08
Sep	0.18	85.71%	0.14	78%	0.14	-11.10%	0.16	-30.00%	0.13	-37.00%	0.11	-37.20%	0.11	-14.80%	0.15	-31.70%	0.12	-33.40%	0.12	-28.60%	0.13
Jul	0.19	90.48%	0.15	76%	0.14	-18.60%	0.15	-31.40%	0.13	-38.00%	0.11	-39.80%	0.11	-32.00%	0.13	-42.60%	0.11	-54.90%	0.08	-49.00%	0.09
Nov	0.19	90.48%	0.14	78%	0.14	-19.00%	0.15	-30.00%	0.13	-40.90%	0.11	-37.50%	0.12	-29.00%	0.13	-26.60%	0.14	-35.90%	0.12	-23.70%	0.14
Oct	0.2	95.24%	0.16	74%	0.14	-14.20%	0.17	-30.20%	0.14	-34.40%	0.13	-38.90%	0.12	-24.40%	0.15	-27.10%	0.14	-9.40%	0.18	-25.90%	0.15
Apr	0.25	119.05%	0.20	66%	0.16	-8.80%	0.23	-26.20%	0.18	-34.60%	0.16	-32.90%	0.17	73.20%	0.43	106.40%	0.51	141.50%	0.6	53.00%	0.38
Jun	0.43	204.76%	0.31	44%	0.18	-12.80%	0.37	-32.00%	0.29	-29.80%	0.3	-29.50%	0.3	-38.60%	0.26	-64.70%	0.15	-83.50%	0.07	-64.10%	0.15
May	0.52	247.62%	0.43	20%	0.1	-10.20%	0.47	-30.60%	0.36	-23.30%	0.4	-37.70%	0.33	-20.00%	0.42	-46.30%	0.28	-26.60%	0.38	-69.70%	0.16
MAD	0.21	100%	0.17			-17.10%	0.18	-30.90%	0.14	-34.80%	0.14	-36.70%	0.13	-12.00%	0.18	-19.20%	0.16	-11.50%	0.17	-20.30%	0.14

Shaded cells represent the months anticipated to exceed the fish bearing threshold for flows that need to remain in the stream to maintain fish and fish habitat

Based on results provided in Chapter 11, Chapter 22, and Appendix 22-B, the possibility for bioaccumulation exists but is found to be not significant as it relates to aquatic wildlife.

Based on the risk assessment of selenium to aquatic wildlife, the following conclusions were made:

- Risk estimates were in exceedance of target thresholds calculated for benthic invertebrates associated with direct sediment contact, as well as aquatic invertebrates associated with direct contact with surface water;
- Risk estimates found to be in exceedance of target thresholds were limited to the lower reach of West Alexander Creek before the confluence of Alexander Creek;
- Maximum calculated HQs are 1.9 and 3.2 for surface water and sediment exposure, respectively. The calculated HQs are suggestive of a low potential magnitude of effect on aquatic wildlife from changes in water quality; and
- Predicted concentrations of selenium in fish eggs at model nodes along West Alexander Creek and Alexander Creek show a very slight increase as a result of the Project; however, predicted concentrations are below the identified tissue-based toxicity reference value of 15.1 mg/kg dw protective of local fish populations. Potential effects to fish reproduction in West Alexander Creek and Alexander Creek are therefore considered to be negligible.

As detailed in the assessment of fish health effects associated with bioaccumulative substances (Appendix 12-F), the likelihood of deleterious effects as a result of cadmium bioaccumulation is considered to be low. Predicted whole-body fish tissue concentrations located outside the Project exclusion zone suggest an acceptable risk based on the current assessment. Other contaminants of potential concern as identified in the surface water quality assessment (Chapter 11) were excluded from modelling as they were considered not to be bioaccumulative substances.

12.5.4.2.4 Changes in Streambed Structure

Stream channel sensitivity (or resilience) to change is complex and not easy to predict. The ability to forecast change is difficult due to the inherent variability in the ability for landforms to respond or resist change. The likelihood that changes in a system will produce a response are a function of the channel's propensity for change, and the system's ability to absorb that change (Appendix 12-A). The geomorphology assessment found that the Project is likely to increase water yield and runoff rates. It also has the potential to increase sediment input to the stream channel due to surface erosion and increase sediment transport rates to downstream reaches. The Project also has the potential to reduce downgradient stream flow due to sequestering in ponds and, at the same time, increase the downgradient flow due to sediment pond discharge. Upon decommissioning of the Main Sediment Pond during Post-Closure, the flows to downgradient watercourses are anticipated to be restored.

The primary component of the Project with the potential to substantially affect stream channel geomorphology is the Main Sediment Pond, which will result in decreased flow and alter the character of sediment loading from West Alexander Creek. A decrease in flow may also decrease the stream's ability to mobilize and transport sediment. The reduction in flow may therefore result in channel aggradation.
Characteristics of an aggraded channel with a gravel riffle-pool morphology characteristic, as presented in the geomorphology assessment (Appendix 12-A), are summarized in Table 12.5-14.

Table 12.5-14: Characteristics of an Aggraded Channel (with a Gravel Riffle-Pool Morphology)

Channel Attribute	Aggraded Channel Characteristics
Morphology	• Extensive riffles and runs • Small, shallow pools (due to infilling) • Multiple channels on a braided bed surface • Lacking habitat diversity due to uniform riffle and run character
Substrate	• Mainly gravel and finer textures (although this will vary depending on baseline substrate character and the nature of sediment sources) • Increases substrate embeddedness due to reduced sediment transport potential
Bank Erosion	• Bank erosion, where vulnerable • Increased width/depth ratio where banks are erodible • Reduction in undercut/overhanging banks
Large Woody Debris	• LWD reoriented parallel to bank, as opposed to across/spanning the channel • Smaller sized LWD

ALE7 was classified as highly sensitive to morphological change by the geomorphology assessment (Appendix 12-A). ALE7 lacks competence, lacks confinement, and is very braided. Substrates and bank materials within sensitive reaches tend to be finer and more easily eroded (sand, gravel, and small cobble). ALE7 has a high risk of geomorphological changes to occur due to the Project. The high risk is linked to potential changes in streambed structure associated with aggradation.

WAL1 d/s was classified as being a moderately resilient channel, together with ALE1, ALE4, and ALE5. The results indicate that, although Reach 1 of West Alexander Creek (WAL1) is morphologically more resilient, it lies in direct proximity to the Project and its entire contributing catchment is affected. Reach WAL1 will experience the greatest level of change associated with stream flow and with sediment load. Changes are anticipated but not because of the channel sensitivity. Rather, with decreased flow and increased fine sediment load, effects are more likely to include decreased stream width, depth, and increased substrate embeddedness (refer to Appendix 12-A for further details).

Due to a steeper channel gradient, coarser substrate, and moderate confinement, the morphology of Reach WAL1 of West Alexander Creek is considered slightly more resilient. Due to the anticipated Project effects on flow and sediment load within the West Alexander Creek sub-basin catchment, the effects are more likely to affect channel geometry and substrate character.

Both ALE7 and WAL1 d/s are likely to undergo geomorphological changes in channel morphology as a result of the Project. Changes anticipated to occur are likely that pools will become shallower, large woody debris will be distributed differently, embeddedness will increase, and a reduction in overhanging banks will be present, all of which could alter the way in which fish access and use these habitats, as well as impacting their feeding success due to altered benthic invertebrate habitat suitability. Spawning potential would likely be reduced, as gravel and pebble substrate, needed for WCT to spawn, will be decreased in ALE7 and WAL1 d/s.

12.5.4.2.5 Functional Riparian Disturbance

Changes to or a loss of riparian habitat will impact fish and fish habitat because it plays an important role in the maintenance of many important habitat features required by Westslope Cutthroat Trout, Bull Trout, and Mountain Whitefish in the Alexander Creek drainage system. The potential for riparian disturbance to have a residual adverse effect on species like Burbot and Kokanee, which reside lower down in the Elk River system (Aquatic RSA scale), is not anticipated to occur, as the disturbance is confined to the Fish and Fish Habitat LSA and not anticipated to be at a scale that would have measurable impacts outside the Alexander Creek catchment. Riparian vegetation is important as it provides short- and long-term recruitment of large woody debris for the creation of optimal salmonid habitat such as pools and for providing cover (DFO and MOE, 1992). Riparian habitat also provides shade, which cools streams significantly more than streams without well-established riparian vegetation (Scruton et al., 1998; Maloney et al., 1999). Riparian habitats increase bank stability and maintain channel morphology (Robison and Beschta, 1990; DFO and MOE, 1992; Bragg et al., 1998 and 2000) and act as a substrate for many terrestrial insects, which in turn are an important food source. Riparian habitat also provides a valuable food source through its contribution of organic matter, in the form of leaf litter, that supports the aquatic food chain (Minshall, 1967; DFO and MOE, 1992; Wipfil, 1997). In addition, riparian habitats intercept runoff and act as a filter for sediment and pollutants (DFO and MOE, 1992).

Riparian ecosystems found in the Landscapes and Ecosystems LSA are primarily dominated by either a tree overstory or tall shrub and low tree overstory located in active channels, annually flooded low-bench floodplain, less frequently flooded mid-bench floodplain, and moist closed canopy conifer forest (Chapter 13). Changes in composition and structure of riparian habitat can occur through multiple mechanisms, acting independently and/or cumulatively to reduce the vigour, and therefore the competitive ability of desirable vegetation. Where sufficient resources exist, other species may establish and compete with the riparian vegetation, or reduced vigour may result in greater areas of exposed soil, increasing the risk of erosion and bank instability. Through implementation of the provided environmental management plans and additional mitigation measures, changes in the composition and structure of riparian habitat can be effectively mitigated for those mechanisms attributed to erosion and sedimentation/deposition of dust, release of deleterious substances, and the introduction and/or spread of non-native and invasive species.

Given the removal of habitat in West Alexander Creek due to mine design, which involves infilling of the valley with mine rock, the riparian habitat associated with the instream habitat will be removed as well. This riparian habitat is closely linked to the instream fish and fish habitat and will need to be included in the offsetting requirements of the Project. The total riparian area anticipated to be removed is 36.13 ha.

A reduction in riparian habitat is anticipated to occur in the lower section of WAL1d/s between the downstream end of the spillway and the confluence of West Alexander and Alexander Creeks. This reduction will be due to reduced flows below the Main Sediment Pond. The extent to which the riparian habitat will be affected by reduced flows in this section is difficult to determine and will depend on the type of vegetation affected. Where alteration of surface water quantity does not result in reduction or complete loss of riparian habitats, the composition of such communities may be altered with the incursion of adjacent upland species. Species adapted to the wetter, sub-irrigated conditions of riparian habitats may have a reduced competitive ability as water levels draw down in the lower reach of West Alexander Creek and middle reaches of Alexander Creek. Areas of riparian habitat along these reaches are likely to experience altered vigour of constituent species, resulting in a change in composition and/or structure of the vegetation community. Although still functioning as a riparian habitat ecosystem, alteration of water levels could, for example, increase the understorey growth of shrubby species, or eliminate hypoxic conditions that restricted growth of sub-canopy tree species.

Where changes in water flows are anticipated to return to baseline conditions, vegetation composition and structure of riparian habitats may similarly return; however, the rate of return will depend on the type of vegetation affected. Given their faster rate of growth, herbaceous and shrubby species are anticipated to restore within 5 to 10 years following restoration of water levels. Restoration of tree species and associated coarse woody debris may take up to 140 years to restore, depending on the degree of change from baseline conditions. Restoration of a disclimax forest subjected to regular disturbance may take less time to restore when compared to a mature or old growth forest dominated by large diameter cottonwoods (*Populus spp.*). Additionally, the loss of nutrient and mineral (leaf litter) input from the reduction or removal of riparian habitats could have substantial impacts on the food web downstream of the impacted areas.

Calculation Method 1 (Table 12.5-15) aligns with the results presented in Chapter 13 for mapped riparian habitat ecosystems along fish bearing reaches of West Alexander Creek. Due to the limitations of the Terrestrial Ecosystem Mapping (TEM), additional riparian habitat may exist outside of the streamside protection and enhancement areas that cannot be accurately identified/mapped at this time. Given these limitations, a moderate level of confidence to the assessment of riparian habitat exists, which should incorporate confirmatory mapping and assessment in accordance with the *Riparian Areas Protection Regulation* (RAPR) and associated policies, guidelines, and directives prior to construction. However, it is recommended to use a 31.5 m buffer zone (Method 2) from West Alexander Creek instead of Method 1 (TEM) as the functional riparian zone. This produces a different area than that presented in Chapter 13; however, this accounts for the functional aspects of the adjacent upland vegetation including leaf litter, cover, shade, and erosion protection. While this may be a generic buffer to apply, it is more appropriately representative of the functional riparian habitat in relation to fish and fish habitat.

Table 12.5-15: Summary of Estimated Riparian Habitat Loss in West Alexander Creek Due to the Project

Site ID	Area (ha)
Method 1 (TEM Polygons)	13.56
Method 2 (31.5 m buffer)	36.13

12.5.4.3 Characterization of Residual Effects, Significance, Likelihood, and Confidence

12.5.4.3.1 Instream Habitat Loss Due to Mine Design and Development

The residual effect to instream habitat loss due to mine design and development is characterized as follows:

- Duration: *Permanent*, the potential for this habitat to remain lost to the use of fish and benthic invertebrates will persist beyond the 34-year temporal boundary for the Project.
- Magnitude: *High*, the change in habitat availability to fish and benthic invertebrate communities is considerably different from baseline and results in zero habitat remaining intact at sites

anticipated to be impacted by infrastructure development and activities associated with the Project. A direct habitat loss of 31,928 m^2 is expected as a result of the Project development.

- Geographic Extent: *Discrete*, the loss of instream habitat due to mine design is localized to areas on West Alexander Creek within the Project footprint.
- Frequency: *Once*, the loss of instream habitat to fish and benthic invertebrate communities will occur once, albeit that the losses will occur at different areas during different Project phases.
- Reversibility: *Irreversible*, effects on fish and fish habitat arising from instream habitat loss will be permanent.
- Context: *Low to neutral*, fish and fish habitat sensitivity and resilience to instream loss of habitat in the receiving environment may be able to adapt to the effect; however, the potential resident population is less likely to be as resilient and able to adapt to removal of their entire home range within the Fish and Fish Habitat LSA.

Determination of Significance

The significance of the loss of instream habitat due to mine design is rated as significant. The Project will result in direct habitat loss due to mine design, removing 31,928 m^2 of high value Westslope Cutthroat Trout habitat, as well as habitat used by Bull Trout in WAL1. The Westslope Cutthroat Trout occupying this section of the Fish and Fish Habitat LSA are suspected to be a resident population using this habitat for all life stages. How the removal of this home range will impact the potential population and how they use habitat in the rest of the Fish and Fish Habitat LSA is unknown. Any direct habitat losses (as classified under HADD) will need to be compensated for in an offsetting strategy. Offsetting measures will need to ensure the Project's effect on fish and fish habitat in West Alexander Creek, due to HADD, results in no-net loss of available habitat to both fish and benthic invertebrate communities. Thus, resulting in no net loss of instream habitat due to the Project renders the significance of the effect of direct habitat loss due to mine design and development as not significant since offsetting will result in no residual effect. Currently, there is no guideline available on whether a suspected resident population's habitat is appropriate to be included in offsetting, and further engagement with DFO and Indigenous communities will be required to develop a suitable offsetting strategy that would result in a not significant determination. Offsetting is a policy decision which will be guided by the goals of DFO and falls outside the scope of this assessment.

Likelihood and Confidence

The effect of direct habitat loss due to mine design and development has a high likelihood to occur.

Confidence considers the reliability of data and analytical methods used in the assessment of effects. The confidence in the characterization of the residual effect to fish and fish habitat as a result of instream habitat loss due to mine design and development is considered to be high, based on the extent of offsetting required and the importance of Westslope Cutthroat Trout to the region.

12.5.4.3.2 Habitat Loss Due to Changes in Water Quantity

None of the flow assessment nodes were found to exceed the 20% threshold for maintaining fish and fish habitat during low flow periods. This means that at no time during Construction and Pre-Production, Operations, Reclamation and Closure, or Post-Closure is the Project anticipated to reduce flows below the point where fish will no longer be able to use the habitat for different stages of their life history (i.e., spawning, overwintering, and rearing). However, AC-6 and AC-5 came very close to this threshold and are anticipated to experience the greatest impact due to changes in flow due to being located immediately downstream of the Main Sediment Pond. B.C. Instream Flow Guidelines thresholds were developed for AC-6, immediately below the Main Sediment Pond, and results showed that AC-6 did exceed the B.C. IFG thresholds.

The residual effect to fish and fish habitat due to changes in water quantity is characterized as follows:

- Duration: *Permanent*, the potential for adverse effects to fish and fish habitat due to changes in surface water quantity will result in habitat loss for fish and benthic invertebrates that spans more than 34 years.
- Magnitude: *Moderate to High*, the potential for adverse effects to fish and fish habitat due to changes in surface water quantity is high in West Alexander Creek, with some potentially moderate to high effects occurring later on in the Reclamation and Closure and Post-Closure phases in Alexander Creek downstream of the confluence with West Alexander Creek.
- Geographic Extent: *Local*, potential effects to fish and fish habitat due to changes in surface water quantity are restricted to the Fish and Fish Habitat LSA and are non-detectable in the Aquatic RSA (Elk River and Lake Koocanusa).
- Frequency: *Continuous*, the potential for adverse effects to fish and fish habitat from changes in surface water quantity occurs continuously as Project activities are ongoing (including mining activities, drainage modifications, and operation of the Main Sediment Pond).
- Reversibility: *Irreversible*, changes in fish and fish habitat from changes in surface water quantity are anticipated to be irreversible until after the Post-Closure phase. In West Alexander Creek downstream of the Main Sediment Pond and upstream of the confluence with Alexander Creek, the effects are considered irreversible due to habitat losses associated with reduced flows.
- Context: *Neutral*, fish and fish habitat are anticipated to have some resilience to the reduction in surface water quantity expected to occur at AC-6, downstream of the Main Sediment Pond's spillway.

Determination of Significance

The residual effect of the loss of instream habitat due to changes in water quantity is rated as significant. The Project will result in habitat loss due to reductions in flow below the Main Sediment Pond, removing 3,237 m^2 of high value Westslope Cutthroat Trout habitat.

The B.C. IFG thresholds were developed for each month of the calendar year and are aimed at protecting different fish life history stages during different parts of the hydrograph throughout the year. It was found that at AC-6, immediately downstream of the Main Sediment Pond, overwintering and rearing would be adversely affected while spawning would not be affected by changes in water quantity. Given that the high value Westslope Cutthroat Trout habitat is being used by a suspected resident population in this section of West Alexander Creek, these effects are considered significant.

The potential reduction in water quantity in West Alexander Creek would also result in a change in the natural flow regime, which may cause fluvial/geomorphologic changes (i.e., erosion potential, bedload movement) and sediment transport capacity to downstream reaches of Alexander Creek. ALE7 was classified as having a high sensitivity to geomorphological changes due to the Project, and continued monitoring and mitigation will be required so that no significant effect results in Alexander Creek due to changes in water quantity.

It is also notable that the results of the effect assessment on surface water quantity, captured in Chapter 10, indicate that the potential impacts of future climate change will have a substantially greater influence on surface water quantity (i.e., magnitude and timing of streamflow) along the downstream watercourses in the Aquatic LSA and RS, which are therefore included in the Fish and Fish Habitat Management Plan (Chapter 33, Section 33.4.1.5) for continued monitoring and assessment. The climate change-related impacts are projected to escalate over time and are most pronounced during the Post-Closure phase. While climate change scenarios were not found to have a significant impact on fish and fish habitat, continued monitoring will be imperative to confirm flows are adequately managed to protect fish and fish habitat under changing climate conditions over the course of the Project, particularly during Post-Closure.

Changes in water quantity are anticipated to have a significant residual effect on fish and fish habitat in West Alexander Creek, but to not have a significant effect on fish and fish habitat in Alexander Creek. The reduction in flows during low flow periods will alter the fish use and habitat suitability for Westslope Cutthroat Trout in the section below the Main Sediment Pond. Rearing and overwintering may no longer be possible, while spawning during high flow periods/freshet will most likely remain intact.

Likelihood and Confidence

The effect of direct habitat loss due to changes in water quantity has a high likelihood to occur.

The surface water quantity assessment (Chapter 10) does include potential sources of uncertainty:

- The water balance model development process involved several assumptions and limitations regarding the proposed timeline for the mine site development, water management plan implementation, mine rock seepage, groundwater interactions, and climate related variables (i.e., precipitation, snowpack/melt, evaporation, etc.);
- Limited information was available regarding the current and future operation of the Teck's Elkview Operations (including water management practices), which influences streamflow in Grave Creek;
- The surface water quantity estimates for the climate change scenarios are based on projected temperature and precipitation conditions, which involve potential uncertainties;
- Uncertainty is considered to be higher in the future over the longer-term, as there are aspects with respect to the mine development operations and water management plan that are less defined and subject to change; and
- The modelling process for the Aquatic RSA involved integration with the Elk Valley Water Quality Prediction Model, which applied average flow rates for the Elk River watershed hydrology.

Contributing to the uncertainty of the fish and fish habitat assessment is the uncertainty that remains regarding the suitability of offsetting to be applied to a suspected resident population habitat that requires offsetting due to habitat loss caused by changes in water quantity. The level of confidence with which the assessment of effects on fish and fish habitat due to changes in water quantity is therefore described as moderate.

12.5.4.3.3 Changes in Water Quality

The residual effect to fish and fish habitat due to changes in water quality is characterized as follows:

- Duration: *Long-term*, the potential effects to fish and fish habitat associated with changes in water quality are anticipated to occur during all Project phases, and potentially beyond the Project life.
- Magnitude: *Low*, TSS is not anticipated to have an effect on the receiving environment with the Interim and Main Sediment Ponds trapping the majority of anticipated sediment input from the Project. Metals are not anticipated to be likely to bioaccumulate in the Fish and Fish Habitat LSA (based on the risk assessment in Chapter 22, Appendix 22-B, and Appendix 12-F). . Predicted concentrations of selenium in fish eggs at model nodes along West Alexander Creek and Alexander Creek show a very slight increase as a result of the Project; however, predicted concentrations are below the identified tissue-based toxicity reference value of 15.1 mg/kg dw protective of local fish populations. Potential effects to fish reproduction in West Alexander Creek and Alexander Creek are therefore considered to be negligible.
- Geographic Extent: *Local*, the most measurable effects to fish and fish habitat from changes in water quality will be just below the sediment ponds and in Alexander Creek upstream of Highway 3. It is unlikely that the effect of water quality on fish health will extend into the RSA, as described in Chapter 11 and Chapter 22.
- Frequency: *Continuous*, the potential effects to fish and fish habitat associated with changes in water quality are anticipated to occur continuously during all Project phases, and potentially beyond the Project life.
- Reversibility: *Reversible to Irreversible*, the increased sediment releases that may occur during the decommissioning of the Main Sediment Pond would result in increased TSS that could be reversible in the medium to long term. Bioaccumulation occurring during the Project life is considered irreversible. While there is a low risk for bioaccumulation to occur in the Fish and Fish Habitat LSA, it is understood that if the exceedances predicted by the water quality model are to occur downstream of the sediment ponds and upstream of Highway 3, and these do lead to bioaccumulation, the effect would be considered irreversible.

Context: *Neutral*, changes to surface water quality as a result of sediment pond discharge are anticipated to be neutral due to the resilience of fish to short exposures of increased TSS. Benthic invertebrates would be less resilient, and resiliency is anticipated to depend on the duration and level of increases experienced, particularly during sediment pond decommissioning. Fish health is not anticipated to be affected by bioaccumulation as predicted concentrations are below the identified egg/ovary tissue-based toxicity reference value of 15.1 mg/kg dw protective of fish populations (Chapter 22; Appendix 22-B).

Determination of Significance

The residual effect on fish and fish habitat as a result of TSS is not significant. The sediment load will be managed by the sediment ponds and controlled releases are anticipated to allow for adequate sediment management. The residual effect on fish and fish habitat as a result of increased metal concentrations is not significant based on results presented in Chapter 11 and Chapter 22.

Likelihood and Confidence

Effects that are determined to be not significant do not require a characterization of likelihood.

The confidence for TSS assessment is moderate, as reflected in limitations and assumptions of the water quality model. The assessment of potential effect of the Project on fish and fish habitat due to changes in water quality as it relates to changes in metal concentrations is completed with moderate confidence. Some of the limitations contributing to a moderate confidence in the assessment are as follows:

1. The use of ambient water concentrations to assess the potential risk for bioaccumulation; and
2. Assumptions and limitations associated with the water quality model (refer to Chapter 11).

12.5.4.3.4 Changes in Streambed Structure

The residual effect to fish and fish habitat due to changes in streambed structure is characterized as follows:

- Duration: *Long-term*, changes in streambed structure will occur during all Project phases.
- Magnitude: *Moderate*, the effects of changes in streambed structure to fish and fish habitat will be definable, measurable, and detectable.
- Geographic Extent: *Local*, the most measurable effects to fish and fish habitat from changes in streambed structure will be downstream of the Main Sediment Pond.
- Frequency: *Continuous*, the potential effects to fish and fish habitat associated with changes in streambed structure are anticipated to occur during all Project phases, and if altered substantially, would extend beyond the Project life
- Reversibility: *Reversible* to *Irreversible*, when flow regime returns to pre-Project conditions, the geomorphological processes will likely return to maintaining fish and fish habitat in a way similar to baseline. However, the effects from calcite concreting in the streambed would be considered irreversible.
- Context: *Neutral*, fish and fish habitat would have the potential to adapt to some of the effects associated with changes to streambed structure depending on the severity of change.

Determination of Significance

The effects on fish and fish habitat from changes in streambed structure are considered to be not significant. While some sensitivity to changes in geomorphology exist in ALE7, changes in streambed structure associated with sediment and calcite are not anticipated to occur at an extent that they substantially change the habitat functionality and considerably affect fish and fish habitat. Continued monitoring and management of sediment and erosion below the Main Sediment Pond will enable adaptive management for geomorphology downstream of the confluence of West Alexander and Alexander Creeks.

Likelihood and Confidence

Effects that are determined to be not significant do not require a characterization of likelihood.

The confidence for the assessment of effects through changes in streambed structure is moderate, as reflected in limitations and assumptions of the water quality model and geomorphology assessment.

12.5.4.3.5 Functional Riparian Disturbance

Although the loss of riparian habitat due to changes in surface water quantity may extend beyond the Landscapes and Ecosystems LSA, the majority of the area affected is considered to be negligible relative to the total area of riparian habitat in the Landscapes and Ecosystems LSA. However, from a fish and fish habitat perspective (Fish and Fish Habitat LSA), the effect ranges from negligible to substantial, depending on the area and mechanism driving the effect.

The residual effect to fish and fish habitat due to functional riparian disturbance is characterized as follows:

- Duration: *Long-term to Permanent,* for those areas of riparian habitat that can be restored, reclamation is anticipated to occur throughout the Reclamation and Closure and potentially beyond the Post-Closure phases. For sections on West Alexander Creek above the Main Sediment Pond, the duration will be permanent, and downstream sections of Alexander Creek will experience reduced water levels through to the end of, and likely beyond, the Post-Closure phase, which will be long-term in duration.
- Magnitude: *Low to High*, The loss of riparian habitat is small relative to the total area in the Landscapes and Ecosystems LSA (i.e., 7%) and is less than the "low" benchmark established under the EV-CEMF (Davidson et al., 2018). However, compared to the riparian habitat in the Fish and Fish Habitat LSA, the permanent removal of riparian habitat in West Alexander Creek is considered to be of high magnitude, particularly with regards to reduced input of leaf litter, minerals, and sediment control, in downstream environments. The abundance of riparian habitat along middle and lower Alexander Creek is not likely to detectably change as the difference in flow rate from existing conditions is exceptionally low and within a reasonably assumed range of natural variation, resulting in a low magnitude effect. Areas of substantially greater change in water flow rates of the retained lower West Alexander Creek below the Main Sediment Pond are likely to noticeably reduce the extent of typical high-water levels that define the riparian area (i.e., range of natural variation). Recruitment of adjacent upland vegetation in these areas is anticipated, but recovery rate will depend on the type of vegetation affected and could consequently take up to 104 years to recover.
- Geographic Extent: *Discrete to Regional*, direct loss of riparian habitat will occur within the Project footprint, as well as indirectly due to reduced water flow rates that could marginally exceed the boundary of the Landscapes and Ecosystems LSA.
- Frequency: *Once to Continuous*, although general construction and subsequent mine expansion activities will be conducted throughout the Construction and Pre-Production and Operations Phases, removal of the riparian habitat at any location within the Project footprint can only happen once. However, loss of riparian habitat is anticipated to occur incrementally, and alongside key milestones of Project construction in the respective catchment areas and seasonal precipitation cycles. Consequently, the residual effect is expected to occur regularly, or continuously throughout the Construction and Pre-Production and Operations phases of development.
- Reversibility *Reversible Long-Term to Irreversible*, the effects of vegetation removal on riparian areas that are buried by the Mine Rock Storage Facility cannot be reversed, nor where reduced flow rates are anticipated to extend beyond the Post-Closure phase. West Alexander Creek is anticipated to therefore experience an irreversible effect due to loss of riparian habitat. Where infrastructure is completely decommissioned (powerline and explosives storage area) and watercourse reclamation is successful, there is potential for effects to be reversible within the Post-Closure phase. Alexander Creek would likely experience reversible effects over the long-term.

- Context: *Low to Neutral*, riparian habitats in the Landscapes and Ecosystems LSA are likely adapted to natural periods of disturbance. Pending successful restoration of contours and drainage profiles, riparian habitat is likely to restore using reasonably simple revegetation techniques (e.g., willow staking). However, in West Alexander Creek, the majority of riparian habitat will be permanently removed and will have low resilience below the Main Sediment Pond and possibly extending into ALE7 due to moderate to high risk associated with geomorphological changes and flow reductions. Other parts of the Fish and Fish Habitat LSA and the Aquatic RSA are expected to have a neutral context.

Determination of Significance

The residual effect of functional riparian disturbance in the Fish and Fish Habitat LSA is rated as not significant. The Project will result in direct riparian habitat loss due to mine design and reduced flows in West Alexander Creek, removing an estimated 36.13 ha and in an area of high value Westslope Cutthroat Trout habitat. However, the loss is anticipated to be compensated for through an offsetting requirement.

At the Fish and Fish Habitat LSA scale, the impact on fish and fish habitat due to changes in riparian habitat are considered to be not significant. WAL2, WAL1u/s, and the majority of WAL1d/s will be permanently removed. With a reduction of riparian input from West Alexander Creek into Alexander Creek, there is an additional anticipated (non-significant) residual effect on Alexander Creek fish and fish habitat. This effect relates to reduced flows in WAL1d/s below the spillway, direct habitat removal due to mine design, and high risk associated with changes in geomorphology in ALE7.

At the Aquatic RSA scale, collectively with removals due to logging, clearing, grubbing, and soil salvage activities, cumulative loss of riparian habitat is considered to be not significant. The areas that cannot be successfully restored during the Reclamation and Closure phase are likely to be less than the EV-CEMF benchmarks used to define moderate to high risk of impact to riparian habitats (i.e., likely to be less than or equal to 10% loss). Consequently, the residual effect associated with the adverse change in abundance (or area) of riparian habitat in the Aquatic RSA is considered to be not significant.

Likelihood and Confidence

Effects that are determined to be not significant do not require a characterization of likelihood.

The potential for riparian habitat loss in West Alexander Creek is high and moderate for mid and lower sections of Alexander Creek. Given that the exact areas of riparian habitat to be reclaimed have yet to be determined, and that some species may not respond in complete alignment with the assumptions of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3), there is only moderate confidence in the characterized extent and degree of success in the restoration of riparian habitats in Alexander Creek. As a result, the significance prediction is ascribed a moderate level of confidence for the larger part of the Fish and Fish Habitat LSA; follow-up and monitoring may improve this level of confidence.

12.5.4.4 Summary of Residual Effects Assessment

A summary of the residual effects assessment is presented in Table 12.5-16.

Table 12.5-16: Summary of Residual Effects on Fish and Fish Habitat

Residual Effect	Impacted FFH VC	Project Phases	Mitigation Measures	Comments	Summary of Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Instream Habitat Loss Due to Mine Design and Development	Westslope Cutthroat Trout	• Construction and Pre-Production • Operations	• Cannot be fully minimized or mitigated • Requires an offsetting/compensation plan to ensure no net loss occurs • Feasibility of offsetting requires consultation with Indigenous stakeholders and DFO	Potential resident population of Westslope Cutthroat Trout in West Alexander Creek. Considered high value habitat.	Duration: Permanent Magnitude: High Geographic Extent: Discrete Frequency: Once Reversibility: Irreversible Context: Low to neutral	Significant	High
	Bull Trout	• Construction and Pre-Production • Operations	• Cannot be fully minimized or mitigated • Requires an offsetting/compensation plan to ensure no net loss occurs. The amount of habitat used by Bull Trout and the low density of Bull Trout present in these sections of West Alexander Creek would suggest that offsetting is feasible and would be able to fully offset the residual losses caused by the Project	While the lower portions of the West Alexander Creek do have Bull Trout present, given the range of habitat, low density of Bull Trout present, and habitat use suspected to be limited to seasonal rearing, the effect of instream habitat loss due to mine design and development is found to be not significant.	Duration: Permanent Magnitude: Low Geographic Extent: Discrete Frequency: Once Reversibility: Irreversible Context: Low to neutral	Not Significant	High
	Benthic Invertebrates	• Construction and Pre-Production • Operations	• Cannot be fully minimized or mitigated • Requires an offsetting/compensation plan to ensure no net loss occurs • The amount of habitat lost in West Alexander Creek is potentially very high (fish bearing and non-fish bearing), and the functional contributions made by benthic invertebrates to the food web downstream of West Alexander would require further consideration during offsetting measure development and finalization • Uncertainty remains on the amount of habitat required for offsetting and it relates to non-fish bearing reaches in the West Alexander Creek watershed, but the losses are anticipated to be fully offset through the development and finalization of an offsetting plan with Indigenous stakeholder and DFO consultation	While a loss in productivity and resources as it relates to nutrient input and food web functionality is anticipated to occur, the loss in benthic community is considered not significant.	Duration: Permanent Magnitude: High Geographic Extent: Discrete Frequency: Once Reversibility: Irreversible Context: Low to neutral	Not Significant	High
Habitat Loss Due to Changes in Water Quantity	Westslope Cutthroat Trout	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Segregation and diversion of non-contact surface runoff around mine disturbed areas and water control facilities • Controlling outflows from water management facilities to maintain streamflow conditions in the receiving watercourses to the extent possible, particularly during low flow conditions • Limiting surface water withdrawals to minimize impacts on streamflow • Implementation of progressive contouring and reclamation of dump site areas to minimize changes in land use and hydrological characteristics • Decommissioning and reclaiming water management facilities to restore natural streamflow conditions in the receiving watercourses to the extent possible. • Implement the Site Water Management Plan • Maintain fish passage by avoiding changing flow or water level and obstructing or interfering with the movement and migration of fish • Cannot be fully minimized or mitigated • Requires an offsetting/compensation plan to ensure no net loss occurs • Feasibility of offsetting requires consultation with Indigenous stakeholders and DFO	Potential resident population of Westslope Cutthroat Trout in West Alexander Creek. Considered high value habitat.	Duration: Permanent Magnitude: Moderate to High Geographic Extent: Local Frequency: Continuous Reversibility: Irreversible Context: Neutral	Significant	Moderate

Residual Effect	Impacted FFH VC	Project Phases	Mitigation Measures	Comments	Summary of Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
	Bull Trout	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Segregation and diversion of non-contact surface runoff around mine disturbed areas and water control facilities • Controlling outflows from water management facilities to maintain streamflow conditions in the receiving watercourses to the extent possible, particularly during low flow conditions • Limiting surface water withdrawals to minimize impacts on streamflow • Implementation of progressive contouring and reclamation of dump site areas to minimize changes in land use and hydrological characteristics • Decommissioning and reclaiming water management facilities to restore natural streamflow conditions in the receiving watercourses to the extent possible • Implement the Site Water Management Plan • Maintain fish passage by avoiding changing flow or water level and obstructing or interfering with the movement and migration of fish • Cannot be fully minimized or mitigated • Requires an offsetting/compensation plan to ensure no net loss occurs. The amount of habitat used by Bull Trout and the low density of Bull Trout present in these sections of West Alexander Creek suggests that offsetting is feasible and would be able to fully offset the residual losses caused by the Project	While the lower portions of the West Alexander Creek do have Bull Trout present, given the range of habitat, low density of Bull Trout present, and habitat use suspected to be limited to seasonal rearing, the effect of instream habitat loss due to mine design and development is found to be not significant.	Duration: Permanent Magnitude: Moderate Geographic Extent: Local Frequency: Continuous Reversibility: Irreversible Context: Neutral	Not Significant	Moderate
	Benthic Invertebrates	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Segregation and diversion of non-contact surface runoff around mine disturbed areas and water control facilities • Controlling outflows from water management facilities to maintain streamflow conditions in the receiving watercourses to the extent possible, particularly during low flow conditions • Limiting surface water withdrawals to minimize impacts on streamflow • Implementation of progressive contouring and reclamation of dump site areas to minimize changes in land use and hydrological characteristics • Decommissioning and reclaiming water management facilities to restore natural streamflow conditions in the receiving watercourses to the extent possible • Implement the Site Water Management Plan • Maintain fish passage by avoiding changing flow or water level and obstructing or interfering with the movement and migration of fish • Cannot be fully minimized or mitigated • Requires an offsetting/compensation plan to ensure no net loss occurs • The losses are anticipated to be fully offset through the development and finalization of an offsetting plan with Indigenous stakeholder and DFO consultation	While a loss in productivity and resources as it relates to nutrient input and food web functionality is anticipated to occur, the loss in benthic community is considered not significant.	Duration: Permanent Magnitude: Moderate to High Geographic Extent: Local Frequency: Continuous Reversibility: Irreversible Context: Neutral	Not Significant	Moderate

Residual Effect	Impacted FFH VC	Project Phases	Mitigation Measures	Comments	Summary of Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Changes in Water Quality	Westslope Cutthroat Trout	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Diverting clean, non-contact water away from the sediment ponds; where possible • Appropriate sizing of sediment ponds to minimize seepage losses and convey runoff during storm events • Limiting the mine disturbance footprint through Project design and progressive reclamation • Continued monitoring • Working with other proponents, the provincial government, and the KNC to establish a regional monitoring program and long-term water quality targets for Michel Creek • Collaborating with other proponents to ensure these targets are met through a combination of Project-specific and regional mitigation measures	-	Duration: Long-term Magnitude: Low Geographic Extent: Local Frequency: Continuous Reversibility: Reversible to Irreversible Context: Neutral	Not Significant	Moderate
Changes in Water Quality	Bull Trout	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Diverting clean, non-contact water away from the sediment ponds; where possible • Appropriate sizing of sediment ponds to minimize seepage losses and convey runoff during storm events • Limiting the mine disturbance footprint through Project design and progressive reclamation • Continued monitoring • Working with other proponents, the provincial government, and the KNC to establish a regional monitoring program and long-term water quality targets for Michel Creek • Collaborating with other proponents to ensure these targets are met through a combination of Project-specific and regional mitigation measures	-	Duration: Long-term Magnitude: Low Geographic Extent: Local Frequency: Continuous Reversibility: Reversible to Irreversible Context: Neutral	Not Significant	Moderate
Changes in Water Quality	Benthic Invertebrates	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Diverting clean, non-contact water away from the sediment ponds; where possible • Appropriate sizing of sediment ponds to minimize seepage losses and convey runoff during storm events • Limiting the mine disturbance footprint through Project design and progressive reclamation • Continued monitoring • Working with other proponents, the provincial government, and the KNC to establish a regional monitoring program and long-term water quality targets for Michel Creek • Collaborating with other proponents to ensure these targets are met through a combination of Project-specific and regional mitigation measures	-	Duration: Long-term Magnitude: Low Geographic Extent: Local Frequency: Continuous Reversibility: Reversible to Irreversible Context: Neutral	Not Significant	Moderate
Changes in Streambed Structure	Westslope Cutthroat Trout	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Treating water prior to discharge as required to minimize calcite formation • Working with other proponents, the provincial government, and the KNC to establish a regional monitoring program and long-term water quality targets for Michel Creek • Appropriate sizing of sediment ponds to minimize seepage losses and convey runoff during storm events • Continued monitoring	-	Duration: Long-term Magnitude: Moderate Geographic Extent: Local Frequency: Continuous Reversibility: Reversible to Irreversible Context: Neutral	Not Significant	Moderate
Changes in Streambed Structure	Bull Trout	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Treating water prior to discharge as required to minimize calcite formation • Working with other proponents, the provincial government, and the KNC to establish a regional monitoring program and long-term water quality targets for Michel Creek • Appropriate sizing of sediment ponds to minimize seepage losses and convey runoff during storm events • Continued monitoring	-	Duration: Long-term Magnitude: Moderate Geographic Extent: Local Frequency: Continuous Reversibility: Reversible to Irreversible Context: Neutral	Not Significant	Moderate
Changes in Streambed Structure	Benthic Invertebrates	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Treating water prior to discharge as required to minimize calcite formation • Working with other proponents, the provincial government, and the KNC to establish a regional monitoring program and long-term water quality targets for Michel Creek • Appropriate sizing of sediment ponds to minimize seepage losses and convey runoff during storm events • Continued monitoring	-	Duration: Long-term Magnitude: Moderate Geographic Extent: Local Frequency: Continuous Reversibility: Reversible to Irreversible Context: Neutral	Not Significant	Moderate

Residual Effect	Impacted FFH VC	Project Phases	Mitigation Measures	Comments	Summary of Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Functional Riparian Disturbance	Westslope Cutthroat Trout	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Delay construction areas of mine components until ready to mine • Project design optimization • Minimum design standards for water management infrastructure • Energy dissipation devices • Requires an offsetting/compensation plan to ensure no net loss occurs. The amount of habitat loss in sections of West Alexander Creek is high; however, this loss could be fully offset for	Potential resident population of Westslope Cutthroat Trout in West Alexander Creek. Considered high value habitat.	Duration: Long-term to permanent Magnitude: Low to High Geographic Extent: Discrete to Regional Frequency: Once to Continuous Reversibility: Reversible Long-term to Irreversible Context: Low to neutral	Not Significant	Moderate
	Bull Trout	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Delay construction areas of mine components until ready to mine • Project design optimization • Minimum design standards for water management infrastructure • Energy dissipation devices	While the lower portions of the West Alexander Creek do have Bull Trout present, given the range of habitat, low density of Bull Trout present, and habitat use suspected to be limited to seasonal rearing, the effect of functional riparian disturbance is found to be not significant.	Duration: Long-term to permanent Magnitude: Low to High Geographic Extent: Discrete to Regional Frequency: Once to Continuous Reversibility: Reversible Long-term to Irreversible Context: Low to neutral	Not Significant	Moderate
	Benthic Invertebrates	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure		While a loss in productivity and resources as it relates to nutrient input and food web functionality is anticipated to occur, the loss in benthic community is considered not significant.	Duration: Long-term to permanent Magnitude: Low to High Geographic Extent: Discrete to Regional Frequency: Once to Continuous Reversibility: Reversible Long-term to Irreversible Context: Low to neutral	Not Significant	Moderate

12.6 Cumulative Effects Assessment

Cumulative environmental effects are the result of Project residual environmental effects interacting with the effects of other past, present, and reasonably foreseeable future projects or activities to produce a combined/overlapping effect. The objective of the cumulative effects assessment is to consider overlapping effects for all residual adverse effects, not only those predicted to be significant (EAO, 2013). Specifically, the approach requires that:

- The Project results in a residual adverse environmental effect on the fish and fish habitat VC;
- A residual Project effect interacts cumulatively with effects from other projects or activities (i.e., the effects of the Project overlap spatially and temporally with those of other projects or activities that have been or will be carried out);
- The other projects or activities have been or will be carried out and are not hypothetical; and
- The cumulative effect is likely to occur.

Further information regarding the cumulative effects assessment methodology is provided in Chapter 5, Section 5.3.5.

12.6.1 Overview of Residual Effects

A cumulative effects assessment is required for the fish and fish habitat VCs because there is a possibility that the following potential Project residual effects may remain after implementation of proposed mitigation measures:

- Instream habitat loss due to mine design and development;
- Habitat loss due to changes in water quantity;
- Changes in water quality;
- Changes in streambed structure; and
- Functional riparian disturbance.

Instream habitat loss due to mine design and development and changes in streambed structure were identified within the Project footprint in West Alexander Creek that have the potential to affect local Westslope Cutthroat Trout populations. There is a suspected resident sub-population of Westslope Cutthroat Trout in West Alexander Creek; however, there are no permanent barriers in West Alexander or Alexander Creeks and fish have the potential to move freely throughout the watershed, including downstream to the Elk River. As such, effects to the regional Westslope Cutthroat Trout population resulting from direct habitat loss and changes to streambed structure have the potential to interact with other reasonably foreseeable future projects and activities in the Aquatic RSA. Effects resulting from past and present projects and activities in the Aquatic RSA are reflected in the description of baseline conditions.

Habitat losses in tributaries of the Elk River are expected to occur as other coal mining projects are developed. These losses could include both direct habitat loss due to mine design and development, and indirect losses due to changes in flows. Habitat losses from other reasonably foreseeable future projects are anticipated to be compensated following DFO's strategy for offsetting instream habitat losses that result from HADD. As such, while there may be a measurable change in fish habitat availability locally in some tributaries that will be in addition to the habitat losses expected from the Project in West Alexander

Creek, a net loss of fish habitat in the Aquatic RSA is not expected, provided that compensation habitat is developed as required by regulatory habitat loss restrictions under the *Fisheries Act*. A net loss of habitat is not expected in the Aquatic RSA due to reasonably foreseeable future projects and activities, therefore no effect to the persistence of Westslope Cutthroat Trout is expected. Given that there is no anticipated spatial and temporal overlap between the residual effect to changes in streambed structure and those of other past, present, and reasonably foreseeable future projects or activities, it follows that cumulative effects are not likely to occur. As a result, the residual effects of instream habitat loss due to mine design and development and changes in streambed structure are not carried further in the cumulative effects assessment.

Therefore, the cumulative effects assessment focuses only on the following residual effects of the Project:

- Change in surface water quality from the Main Sediment Pond discharge, which has the potential to spatially or temporally overlap with currently operating or proposed projects or activities;
- Habitat loss due to changes in water quantity, as changes in flow regime, size, and timing of flooding, and water depth have the potential to impact the fish and fish habitat VCs in the Fish and Fish Habitat LSA and Aquatic RSA downstream of the Project; and
- Functional riparian disturbance in the Aquatic RSA.

In addition, the following effects of other projects and activities occurring or which may occur in the Aquatic RSA will be evaluated as overlapping with the effects of the Project:

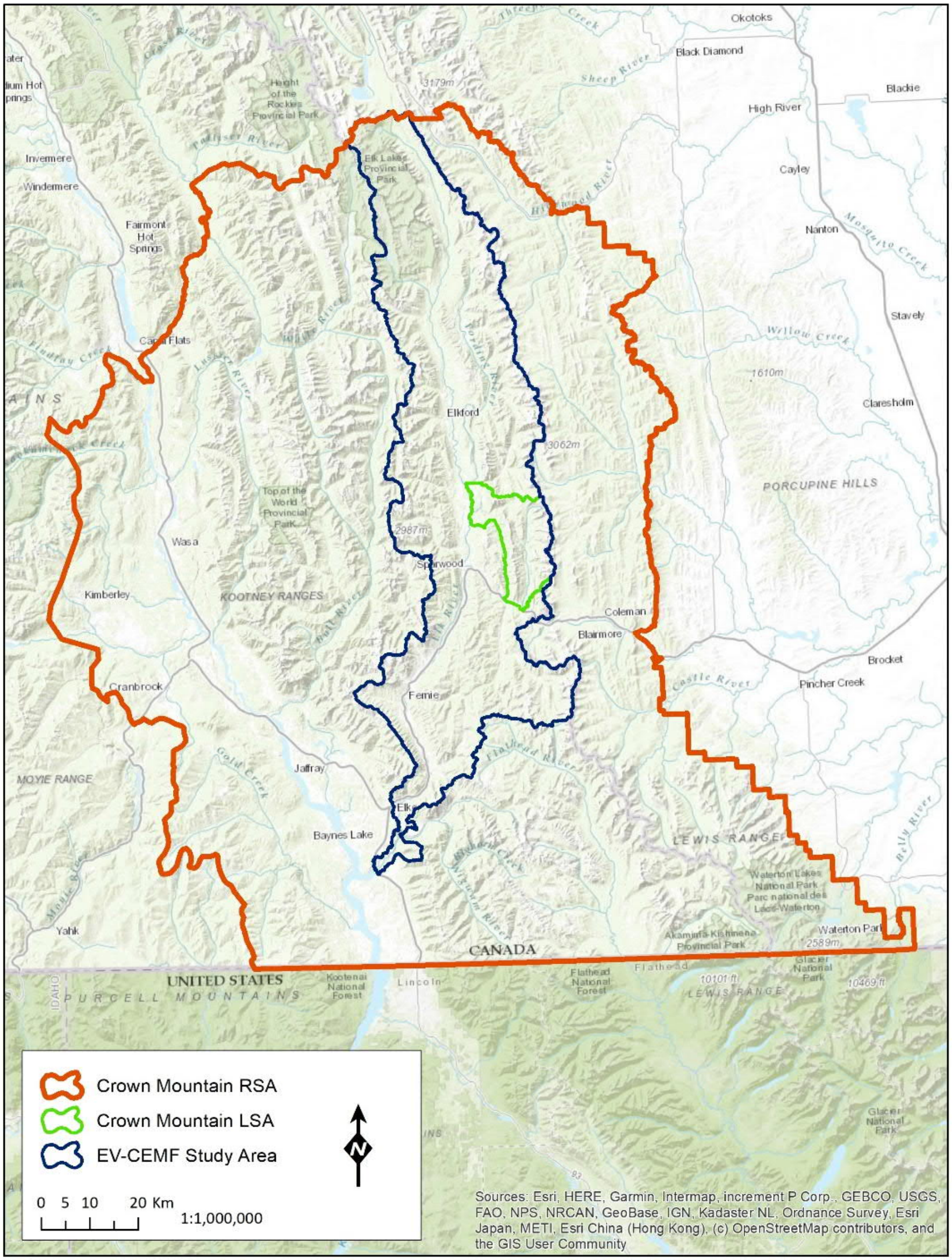
- Riparian disturbance, as driven by landscape-scale disturbances, associated with forestry harvesting;
- Road development associated with the construction and operation of the Project, and after the Project has been decommissioned;
- Increased urban and recreational development in the Aquatic RSA; and
- Increased natural disturbance due to fire and insect outbreaks.

Changes in water quality and quantity were cumulatively assessed in Chapter 10 and Chapter 11 and are therefore not included in the fish and fish habitat VC cumulative effects assessment model as it relates to the Aquatic Hazard assessment (EV-CEMF), to avoid duplication of assessing the same effect twice. However, the results of these assessments are discussed in the context of fish VCs to consider the potential effects these assessment results could have at the cumulative scale. Due to the fact that water quality has the potential to interact cumulatively with other projects and potentially impact fish and fish habitat VCs occurring in the Aquatic RSA (and not in the Fish and Fish Habitat LSA), it was important to assess the potential cumulative effect that changes in water quality could have on fish and fish habitat. This assessment is summarized in Table 12.6-2 and Section 12.6.7.3.

12.6.2 Assessment Boundaries

12.6.2.1 Spatial Boundaries

The assessment of cumulative surface water quality effects was conducted at a regional scale and was confined to the Aquatic RSA described in Section 12.2.3.1. The Crown Mountain RSA used in the cumulative effects assessment for all other effects is shown in Figure 12.6-1.



Crown Mountain RSA
Crown Mountain LSA
EV-CEMF Study Area
0 5 10 20 Km
1:1,000,000
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
Okotoks
Black Diamond
Blackie
High River
Cayley
Nanton
Stavely
Claresholm
PORCUPINE HILLS
Invermere
Windermere
Fairmont Hot Springs
Elkford
Sparwood
Coleman
Blairmore
Fernie
Brocket
Pincher Creek
Wasa
Kimberley
KOOTNEY RANGES
Cranbrook
Jaffray
Baynes Lake
MOYIE RANGE
Yahk
LEWIS RANGE
CANADA
UNITED STATES
PURCELL MOUNTAINS
Waterton Park

12.6.2.2 Temporal Boundaries

The temporal boundaries for the cumulative effects assessment are the same as those for Project effects, as defined in Section 12.2.3.2.

12.6.2.2.1 Use of Temporal Cases

The Project cumulative effects assessment used ALCES Online to evaluate VC response to three scenarios focused on future disturbance within the context of cumulative effects. The assessment focused on the Crown Mountain RSA (as defined for the ALCES Online simulations) area over a 50-year temporal scale (Figure 12.6-1). Scenarios were run at 100 m spatial resolution and simulated at an annual time scale with outputs that correspond to:

- Base Case - current condition (represented by year 2021);
- Project Case – Project maximum buildout (represented by year 2038); and
- Future Case – Post-Closure (represented by year 2055).

12.6.2.3 Administrative Boundaries

No additional administrative boundaries were considered in the cumulative effects assessment beyond those described in Section 12.2.3.3. While administrative and ecological boundaries may not be aligned adequately, assessing the potential project impacts across international borders (Lake Koocanusa) was not practical since policy and management framework implementations are specifically designed to inform the B.C. portion of the aquatic landscape. With cumulative effects anticipated to be not significant at the administrative border and Aquatic RSA scale, the assumption is that if the Project is not anticipated to impact the lower portions of the Aquatic RSA, it is unlikely to have a significant residual effect beyond this boundary (i.e., down into Lake Koocanusa).

12.6.2.4 Technical Boundaries

The technical boundaries for the cumulative effects assessment are associated to constraints imposed on the assessment due to limitations in the ability to predict the effects of the Project (EAO, 2013). For each scenario, assumptions were used to develop the simulations. These are described in more detail in Section 12.6.4.

12.6.3 Identifying Past, Present, and Reasonably Foreseeable Projects and/or Activities

Descriptions of the past, present, and reasonably foreseeable projects and/or activities for consideration in the cumulative effects assessment are provided in Chapter 5, Section 5.3.5.3.

As noted in Chapter 5, Section 5.3.5.3, the following projects were considered as past, present, or reasonably foreseeable future projects and/or activities in the cumulative effects assessment but were not included:

- Coal Mountain Phase 2 as the environmental assessment was placed on hold by Teck Coal Limited in 2016;
- Mount Brussilof (Baymag Mine) by Baymag due to no temporal overlap;
- Barnes Lake Phosphate Exploration Project by Fertoz International Inc. given that the project is in exploration phase and no project has been proposed; and

- Cabin Ridge Coal by Warburton Group is in exploration and no project has been proposed.

Table 12.6-1 presents a summary of the cumulative effects identified with the potential to interact with the fish and fish habitat VCs.

Table 12.6-1: Fish and Fish Habitat Interactions Matrix for Potential Cumulative Effects

Past, Present, or Reasonably Foreseeable Future Projects or Activities	Ranking of Potential Cumulative Effect	Justification / Rationale
Past or Present Projects and/or Activities that Have Been Carried Out		
Natural Resource Extraction – Mining (past)	I	The effects to fish and fish habitat from past mining projects are reflected in baseline conditions and are therefore implicitly considered in the assessment of cumulative effects.
Coal Mountain Operations	III	Current/ongoing mining operations have a potential for contributing to adverse cumulative effects on fish and fish habitat within the Aquatic RSA through the discharge of effluent containing potential contaminants of concern and mine-site runoff to the Elk River and its tributaries. The Coal Mountain and Elkview Operations discharge into tributaries of the Elk River that are also directly influenced by the Project; consequently, the ranking of potential cumulative effects is higher compared to other existing coal mining projects that would overlap with the Project residual effects in the Elk River only.
Elkview Operations	III	
Line Creek Operations	II	
Fording River Operations	II	
Greenhills Operations	II	
Kootenay West Mine	I	The Elkhorn Quarry West Project does not spatially overlap with the Elk River watershed or Lake Koocanusa.
Elkhorn Quarry West (Windermere Mining Operations)	I	The Kootenay West Mine Project does not spatially overlap with the Elk River watershed or Lake Koocanusa.
Energy - Elko Dam	I	Elko Dam is not anticipated to directly influence fish and fish habitat downstream of the Project; although it controls flows, it is not anticipated to have a discernable influence on the volume or dilution capacity of the Elk River.
Koocanusa Reservoir	I	The Koocanusa Reservoir is not anticipated to directly influence fish and fish habitat downstream of the Project; although it controls flows, it is not anticipated to have a discernable influence on the volume or dilution capacity of the Elk River or Koocanusa Reservoir.
Marten Phosphate Project	I	The Marten Phosphate Project is not expected to substantially contribute to adverse cumulative effects on fish and fish habitat within the Aquatic RSA because the footprint is small and current underground extraction is limited to bulk sample removal.
Energy - Pipelines	I	Past and present pipeline projects/activities are not expected to substantially contribute to adverse cumulative effects on fish and fish habitat within the Aquatic RSA.

Past, Present, or Reasonably Foreseeable Future Projects or Activities	Ranking of Potential Cumulative Effect	Justification / Rationale
Energy - Electrical Transmission	I	Past and present electrical transmission projects/activities are not expected to substantially contribute to adverse cumulative effects on fish and fish habitat within the Aquatic RSA because there is minimal interaction of transmission lines with watercourses.
Transportation	I	Past and present transportation projects/activities are not expected to substantially contribute to adverse cumulative effects on fish and fish habitat within the Aquatic RSA because there are environmental best practices for highway maintenance activities, instream works, and rail operations that are anticipated to minimize the potential for environmental effects.
Parks and Protected Areas	I	Past and present projects/activities related to parks and protected areas are not expected to substantially contribute to adverse cumulative effects on fish and fish habitat within the Aquatic RSA because land use within these areas is not anticipated to interact with fish and fish habitat.
Agriculture	I	Past and present agriculture projects/activities are not expected to substantially contribute to adverse cumulative effects on fish and fish habitat within the Aquatic RSA because agricultural land use is anticipated to have a minimal interaction with fish habitat.
Natural Processes or Events	I	Past and present natural processes or events are reflected in baseline conditions and are therefore implicitly considered in the assessment of cumulative effects.
Reasonably Foreseeable Future Projects and/or Activities That Will Be Carried Out		
Michel Coal Project	III	The proposed Michel Coal Project will discharge into Michel Creek upstream of the confluence with Alexander Creek and therefore will interact directly with fish and fish habitat downstream of the Project.
Grassy Mountain Coal Project	I	The proposed Grassy Mountain Coal Project is located in the Crowsnest River watershed, which flows west to east the in Alberta and does not spatially overlap with the Elk River watershed or Lake Koocanusa.
Tent Mountain Mine	I	The proposed Tent Mountain Mine is located in the Crowsnest River watershed, which flows west to east in Alberta and does not spatially overlap with the Elk River watershed or Lake Koocanusa.
Fording River Extension Project	II	The proposed Fording River Extension Project will discharge into the Fording River, which flows into the Elk River upstream of the Project; it has the potential to interact with fish and fish habitat in the Elk River and Lake Koocanusa.
Bingay Main Project	II	The proposed Bingay Main Project will discharge into tributaries of the Elk River; it has the potential to interact with fish and fish habitat in the Elk River and Lake Koocanusa. However, there are overlaps in landscape scale disturbance driven cumulative effects in the Aquatic RSA.

Past, Present, or Reasonably Foreseeable Future Projects or Activities	Ranking of Potential Cumulative Effect	Justification / Rationale
Elan Hard Coking Coal Project	I	The proposed Elan Hard Coking Coal Project is located in the Crowsnest River watershed, which flows west to east in Alberta and does not spatially overlap with the Elk River watershed or Lake Koocanusa.
Forestry harvest	II	Past, present, and future forestry activities have the potential to affect fish and fish habitat, as forestry operations may result in increased fire outbreaks, riparian disturbance and increased runoff and sedimentation to the Elk River and its tributaries. Information pertaining to water quality effects resulting from forestry activities in the Aquatic RSA is not available (Chapter 11, Section 11.6); however, forestry and harvesting is carried forward into the cumulative effects assessment for fish and fish habitat VCs.
Climate Change	II	Climate change has the potential to impact fish and fish habitat through alterations to air temperature and precipitation affecting stream flows and, in turn, the mobility and dilution of contaminants. It also has the potential to increase flows to such an extent that it alters or completely removes instream habitat used by fish and fish habitat VCs. Stream connectivity can also be affected by climate change.
Road development	II	Future road development and increased road density and stream crossings have the potential to contribute to the adverse cumulative effects on fish and fish habitat in the Aquatic RSA.
Urban and recreational development	II	Past, present, and future urban and recreational activities have the potential to substantially contribute to adverse cumulative effects on fish and fish habitat within the Aquatic RSA.
Natural Disturbance; Fire and insect outbreaks	II	Future natural disturbances or events such as fire and insect outbreaks have the potential to have an adverse cumulative effect on fish and fish habitat in the Aquatic RSA.

Notes:
I – Residual Project effects do not act cumulatively with those of other past, present, or reasonably foreseeable future projects and/or activities. Not carried forward in the assessment.
II – Residual Project effects act cumulatively with those of other past, present, or reasonably foreseeable future projects and/or activities, but are unlikely to result in significant cumulative effects; or residual Project effects act cumulatively with existing significant cumulative effects but the Project will not measurably contribute to these cumulative effects on the VC. Carried forward in the assessment.
III – Residual Project effects act cumulatively with those of other past, present, or reasonably foreseeable future projects and/or activities, and may result in significant cumulative effects; or residual Project effects act cumulatively with existing significant cumulative effects and the Project may measurably contribute to adverse changes in the state of the VC. Carried forward in the assessment.

12.6.4 Identification of Cumulative Effects

A review of past, present, and reasonably foreseeable future projects or activities was conducted to identify potential cumulative interactions for fish and fish habitat within the Aquatic RSA.

The projects and activities with a potential to adversely contribute to cumulative effects on fish and fish habitat are summarized in Table 12.6-2.

Table 12.6-2: List of Projects and Activities with Potential to Adversely Contribute to Cumulative Effects on Fish and Fish Habitat

Project/Activity	Project Life	Proponent	Watershed or Sub-Watershed
Coal Mountain Operations	Currently operating	Teck Coal Limited	Michel Creek
Elkview Operations	Currently operating	Teck Coal Limited	Grave/Alexander Creeks
Line Creek Operations	Currently operating	Teck Coal Limited	Line Creek
Fording River Operations	Currently operating	Teck Coal Limited	Fording River
Greenhills Operations	Currently operating	Teck Coal Limited	Elk/Fording Rivers
Michel Coal Project	Proposed	North Coal	Michel Creek
Fording River Extension Project	Proposed	Teck Coal Limited	Fording River
Bingay Main Project	Proposed	Centermount Coal Ltd.	Elk River
Climate Change	Ongoing	N/A	Regional

12.6.4.1 Assessment Methods

Future disturbance was simulated under the following scenarios: 1) The direct effects of the proposed Project development at maximum build-out and Post-Closure, 2) Project maximum build-out with cumulative effects, and 3) Project maximum build-out with cumulative effects and natural disturbance. This section outlines how the scenarios were developed and describes the assumptions that were used in the assessment.

The scenario analysis was completed using ALCES Online (https://online.alces.ca/), a computer simulation model designed for comprehensive assessment of the cumulative effects of multiple land uses and natural disturbances to ecosystems. ALCES Online simulates landscape dynamics by exposing a cell-based representation of the current condition landscape to user-defined trajectories that differ with respect to the rate and spatial pattern of future development and natural disturbance. The simulation engine incorporates numerous drivers such as forestry, mining, settlements, oil and gas exploration, agriculture, transportation networks, fire, insect outbreaks, climate change, and reclamation. Indicator relationships are applied to track the consequences of simulated changes in landscape composition and forest age to values such as wildlife. Indicator outcomes are mapped at the resolution of individual cells or sub-regional scales such as watersheds. The tool is web-based to enable collaboration, utilize the processing capacity of powerful servers, and facilitate dissemination of results (Carlson, 2020).

ALCES Online has been applied to inform cumulative effects assessment and land-use planning in multiple jurisdictions (e.g., B.C., Alberta, Northwest Territories, Yukon, Saskatchewan, Manitoba, Ontario, Australia, Paraguay, India) and planning contexts. Examples include regional land-use planning (e.g., Carlson et al. 2014), conservation planning (e.g., Carlson et al. 2019), forest management (e.g., Leston et al., 2020), community-based land-use planning by Indigenous communities, and urban planning (e.g., Carlson et al., 2015). The tool was applied to inform the Elk Valley Cumulative Effects Assessment (Elk Valley Cumulative Effects Working Group, 2018) through the simulation of forestry, mining, settlements, fire, and climate change in the Elk Valley over the next five decades. The implications of the scenarios were assessed by mapping the future impacts to five VCs at the scale of the EV-CEMF study (Figure 12.6-1): Old growth/mature forests, riparian habitat, aquatic hazard, grizzly bear, and bighorn sheep. Although the simulations were developed at the scale of the Crown Mountain Terrestrial RSA, VC response was only evaluated within the EV-CEMF study area, as the EV-CEMF VC models are spatially linked to that region. The Project's cumulative effects assessment builds upon knowledge from the EV-CEMF process to evaluate impacts within the context of multiple drivers that are shaping the region.

ALCES Online's spatial simulation engine was used to simulate natural processes and landscape changes over time. Simulations forecasted values to project future landscape change for the three scenarios described previously. Scenarios are built by defining a series of actions, each of which causes one or more transitions to landscape composition, forest age, and/or forest origin. Landscape composition, age, and origin are established as part of the current condition modeling. See Appendix A of Appendix 13-E for data sources used to establish current condition of the study area. Each action represents a process that alters the study area. Examples include settlement expansion, forest harvest, road construction, fire, and mine reclamation. The tool simulates the cumulative effect of a set of actions. (ALCES Online User Guide, 2017). The EV-CEMF VCs were assessed under each scenario by mapping the future impacts to old growth/mature forests, aquatic habitat, grizzly bear, and bighorn sheep.

12.6.4.2 Scenarios Descriptions and Assumptions

12.6.4.2.1 Scenario 1 - Project Case (only looks at Crown Mountain Development)

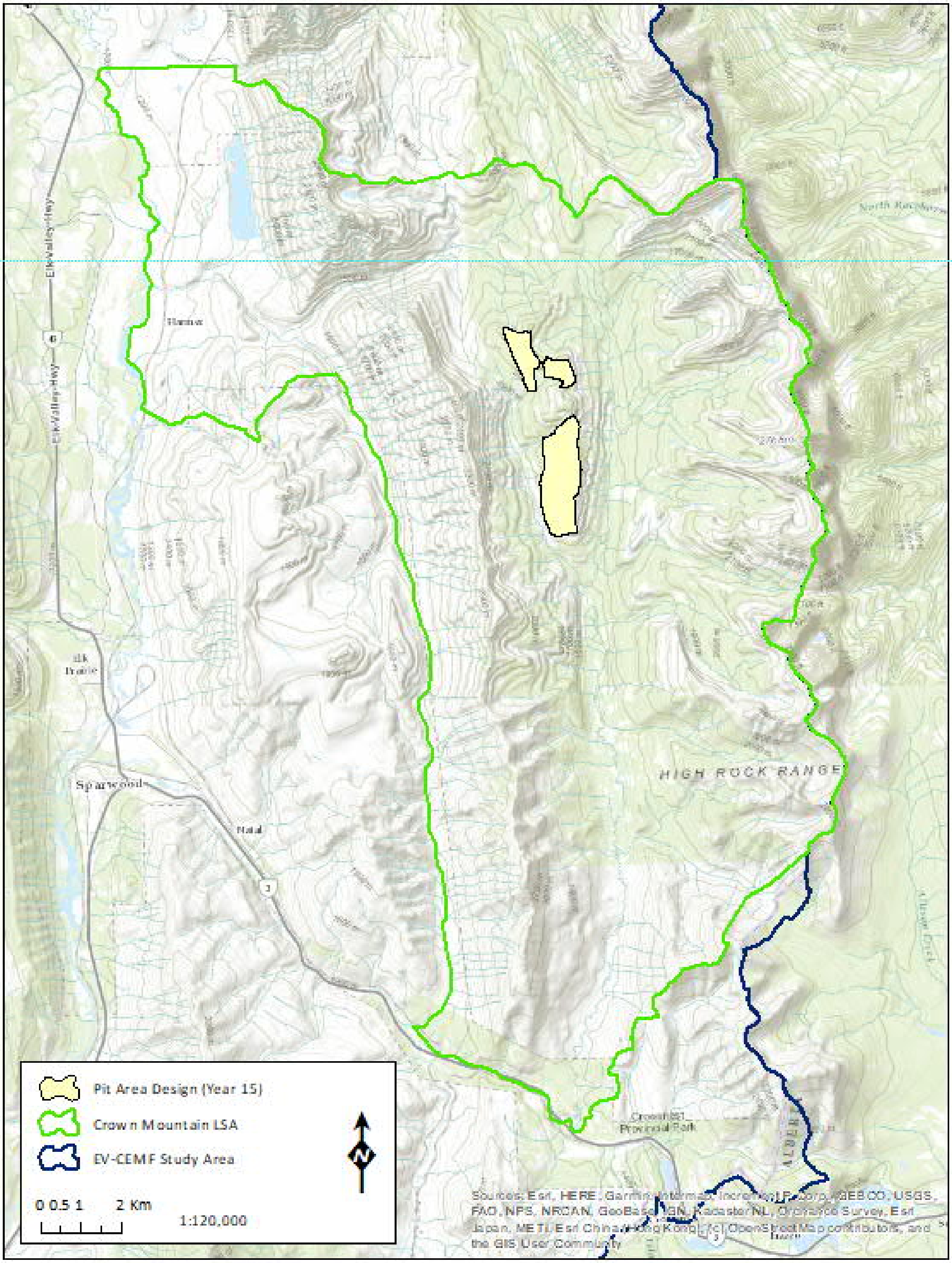
Data showing the proposed Project development and sequence of development over the life of the mine are used as inputs for this scenario (Table 12.6-3).

Table 12.6-3: Data Used for Scenario 1 Development

Description	Dataset	Format
Proposed Project Footprint	YR15_Final_Design_Pit_Area_CLOSE	Shapefile
Project Reclamation Footprint	YR15_Final_Reclaimed_Area_CLOSE	Shapefile

Assumptions for Scenario 1

a. The area (m^2) converted to mine footprint (mine area allocation) is based on the proposed development sequence. The proposed mine footprint layer (Table 12.6-3) was used to allocate equal mine growth of 199,145 m^2 annually over 15 years, filling out the mine footprint shown in Figure 12.6-2; and
b. Mine reclamation was simulated using the spatial reclamation data. Refer to Figure 12.6-3 for the area allocated to Reclamation. Table 12.6-4 outlines the landcover types that were assigned to reclamation areas. The entire reclamation footprint (4,884,655 m^2) was converted in Year 40 of the simulation (i.e, 2055).



Pit Area Design (Year 15)
Crown Mountain LSA
EV-CEMF Study Area
0 0.5 1 2 Km
1:120,000
HIGH ROCK RANGE
Sparwood
Natal
Elk Prairie
Hosmer
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

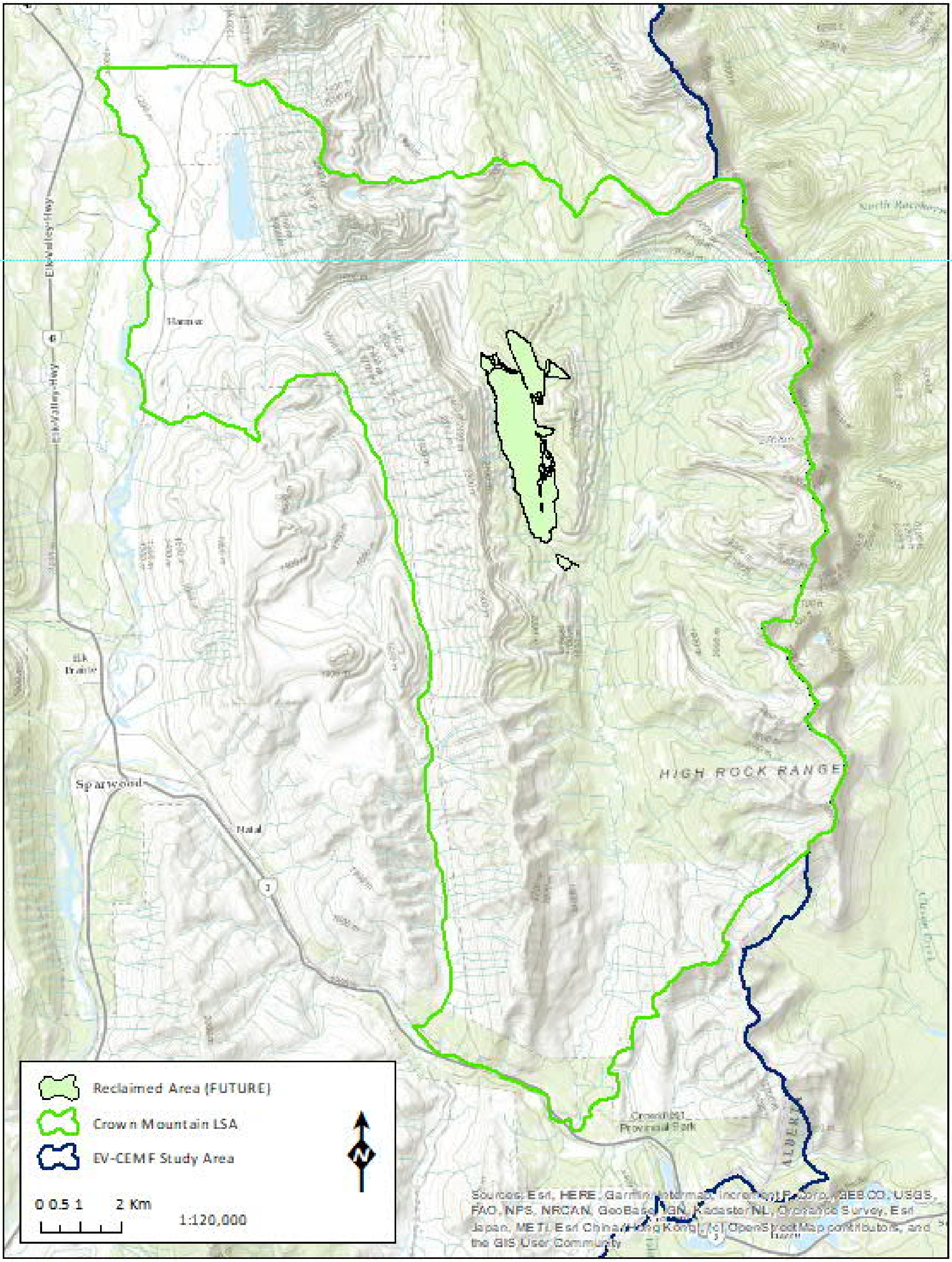


Figure 12.6-3: Crown Mountain Reclaimed Area (Future)

Table 12.6-4: Landcover Types within Identified Reclamation Polygons and Associated Allocated Areas in m^2

Landcover Type	Allocated Area (m^2)
Coniferous Dense	4,374,870
Exposed Land	47,758
Shrub Tall	60,036
Grassland	6,160
Herb	395,831

The VC response to Scenario 1 was assessed at Base Case Year 2021 (current), Project Case Year 2038 (maximum Project extent), and Future Case Year 2055 (Post-Closure).

12.6.4.2.2 Scenario 2 – Project Case and Additional Cumulative Effects

The scenario and allocations described in Scenario 1 were carried forward to form the core of the cumulative effects Scenario 2 development. Additional disturbance footprints were added to Scenario 1 to represent the cumulative foreseeable development within the study area (Table 12.6-5).

Table 12.6-5: List of Projects and Activities with Potential to Adversely Contribute to Cumulative Effects on Fish and Fish Habitat

Description	Dataset	Format
Proposed Mine Footprints	Future_MineProjects	Shapefile
Proposed Mine Footprints	CumulativeEffects_Energy_PGN	Shapefile
Mine Reclamation Footprints	CumulativeEffects_MajorMineReclamation_PGN	Shapefile
Cutblocks	CumulativeEffects_Cutblocks_PGN	Shapefile
Proposed Project Footprint	YR15_Final_Design_Pit_Area_CLOSE	Shapefile
Project Reclamation Footprint	YR15_Final_Reclaimed_Area_CLOSE	Shapefile

The following sections describe the methods and assumptions used to simulate these disturbances. All additional disturbance was simulated to occur on the landscape within the 50-year simulation timeframe.

a. Mine Footprints

Mine area allocation for proposed developments (Figure 12.6-4) were scheduled to occur on the landscape following the timeline and allocations in Table 12.6-6.

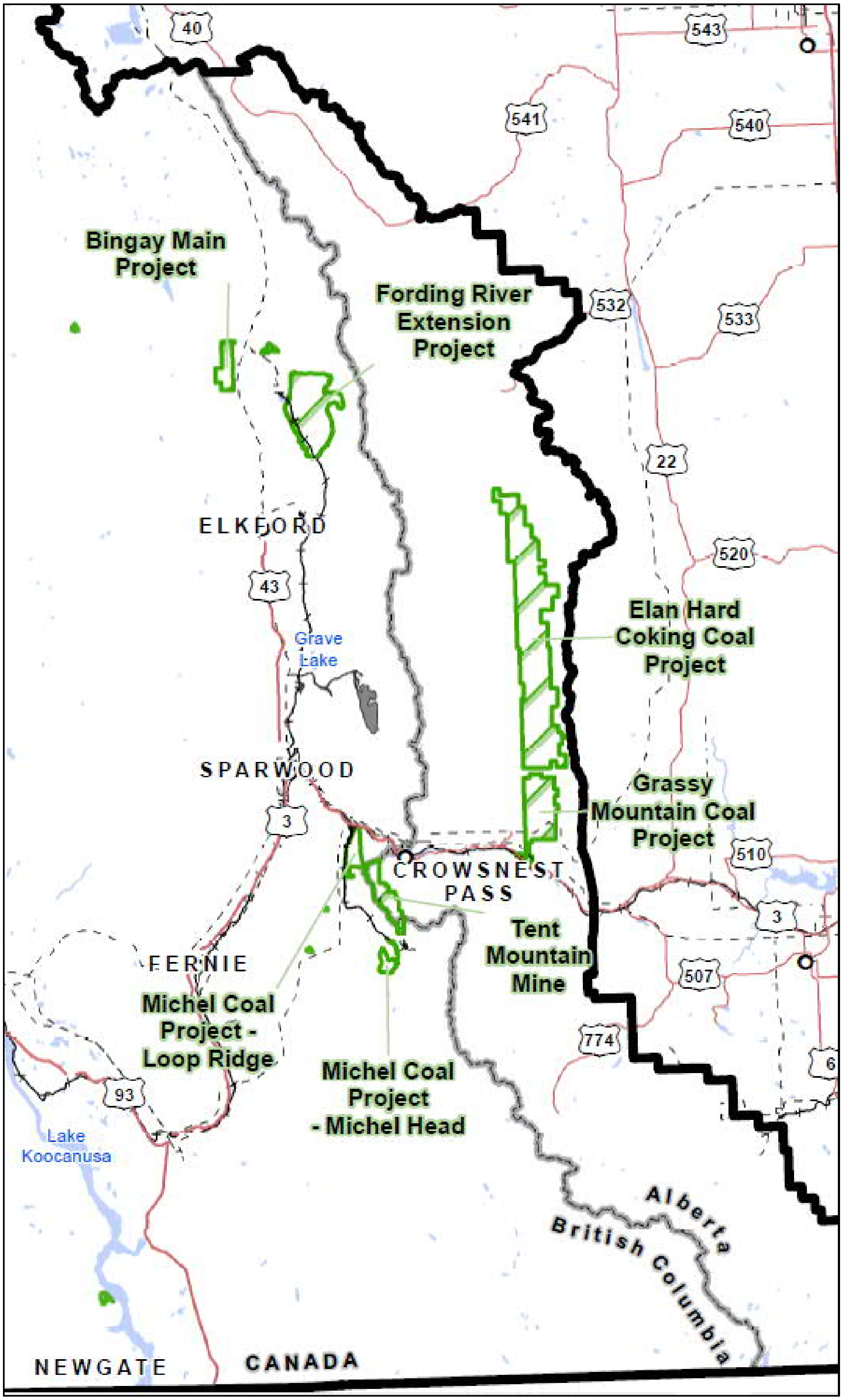


Figure 12.6-4: Future Mine Developments

Table 12.6-6: Spatial Allocations for Mine Development in Scenario 2

Mine	Total Footprint Area (m^2)	Annual Allocation (m^2) from 2021-2038
Fording River Extension Project	53,278,300	3,134,0178
Grassy Mountain Coal Project	36,991,000	2,175,941
Bingay Main Project	11,416,900	671,582
Elan Hard Coking Coal Project	151,060,000	8,885,882
Fording River Operations	1,216,090	71,535
Michel Coal Project - Head	4,603,300	270,782
Michel Coal Project - Loop Ridge	9,662,100	568,359
Tent Mountain Mine	17,114,178	684,567

b. Forest Harvest

Future forest harvest data were not available for a majority of the study area, with the exception of data provided in the Cumulative Effects_Cutblocks_PGN shapefile. The future cutblocks from this shapefile were incorporated into the simulation by directing harvest to blocks identified by a harvest date of 2020 onwards (to 2050 – the latest harvest date in the dataset). In total, 5,053 ha of forest harvest activities are planned to occur in the study area (Figure 12.6-5).

To account for additional forest harvest activities in the remainder of the study area, forest harvest was simulated using the following assumptions:

- Simulated cutblocks were confined to the timber harvest land base (THLB) within the Invermere and Cranbrook Timber Supply Areas (TSAs), and the Spray Lakes Forest Management Unit (FMU) in Alberta (forested areas only);
- Spatial arrangement of cutblocks were randomly distributed within those areas described above; and
- Cutblock size distribution (Table 12.6-7) was based on the historic size of cutblocks in the Elk Valley.

Table 12.6-7: Cutblock Size Classes

Cutblock Size Class (m^2)	Proportion of Cutblocks
100,000	0.5
500,000	0.5

In B.C., the total area of simulated cutblocks was based on the Elk Valley Cumulative Effects Management Framework (EV-CEMF, 2018) Reference Scenario. The cutblock area from the EV-CEMF was scaled up and multiplied by a proportion to account for the larger Crown Mountain RSA (Table 12.6-8).

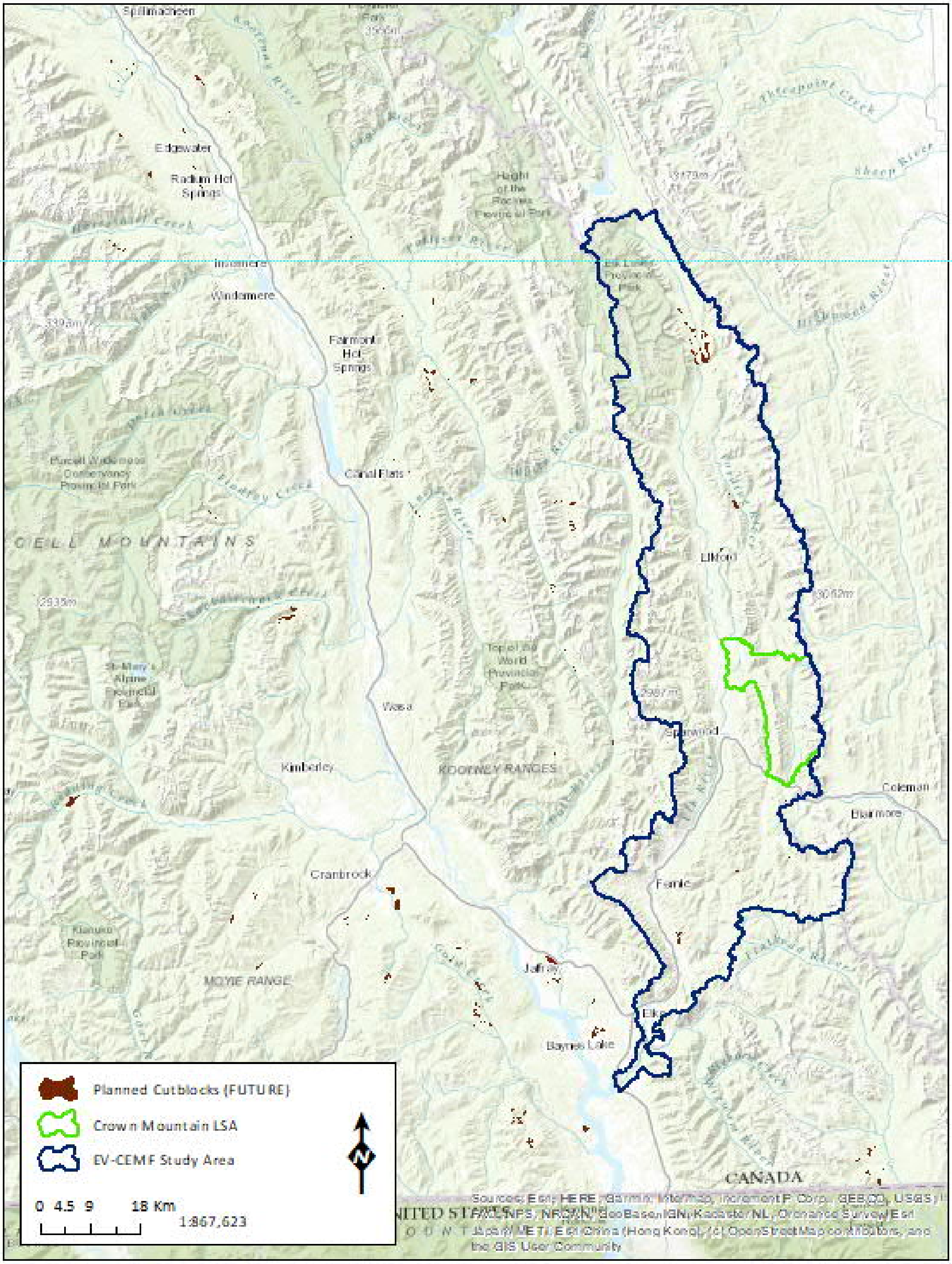

Planned Cutblocks (FUTURE)
Crown Mountain LSA
EV-CEMF Study Area
0 4.5 9 18 Km
1:867,623
Edgewater
Radium Hot Springs
Invermere
Windermere
Fairmont Hot Springs
Canal Flats
Kimberley
Cranbrook
Wasa
Jaffray
Baynes Lake
Elkford
Sparwood
Fernie
Coleman
Blairmore
CANADA
KOOTENAY RANGES
MOYIE RANGE
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Table 12.6-8: Cutblock Annual Allocation

	Area (m^2)	Proportion of Study Area	Annual Allocation (m^2)
Cranbrook THLB in RSA	3,171,028,049	0.64	7,668,622
Invermere THLB in RSA	1,797,618,387	0.36	2,193,451
Total	4,968,646,436	1.0	9,862,073

Information was drawn from the Spray Lakes Sawmills Detailed Forest Management Plan 2001 to 2026 to simulate cutblocks in Alberta. The total annual forest harvest (m^2) from the Timber Supply Analysis (Run 4) was multiplied by the proportion of the FMU within the Crown Mountain RSA (Table 12.6-9).

Table 12.6-9: Cutblock Allocation in the Alberta portion of the Crown Mountain RSA

Total area of Spray Lakes FMU (m^2)	2,847,606,208
FMU area in Crown Mountain RSA (m^2)	430,872,437
Proportion of FMU in Crown Mountain RSA	0.15
Annual area harvested under “Run 4” scenario (m^2)	374,876
Study area annual harvest (m^2)	56,723
Size classes (m^2)	10,000 (50%) 25,000 (50%)

c. Roads

Road development on the landscape was simulated to access future forest cutblocks by applying a least-cost path between the existing road network and simulated cutblocks. The road development simulations were set up so that road pathways follow the lowest elevation routes, and avoid water features.

d. Built-Up Areas and Recreation

The expansion of the towns (Fernie, Sparwood, Elkford) and ski hills within the study area follows the assumptions used in the EV-CEMF Reference Scenario for Urban expansion, and EV-CEMF Maximum Scenario for ski hill growth. A mask was used to direct future growth to those areas identified for urban expansion and recreation growth by Official Community Plans for each community.

e. Mine Reclamation

Mine reclamation was simulated using spatial reclamation data. A shapefile was provided that delineated the reclamation footprint of the Project, as well as expected reclamation at other mines in the region. Refer to Figure 12.6-6 for the area allocated to Reclamation. Table 12.6-10 outlines the landcover types that were assigned to reclamation at the Project and other mines in the region. All reclamation (161,260,144 m^2 at other mine sites and 4,884,655 m^2 at the Project) was converted in Year 40 of the simulation (2055).

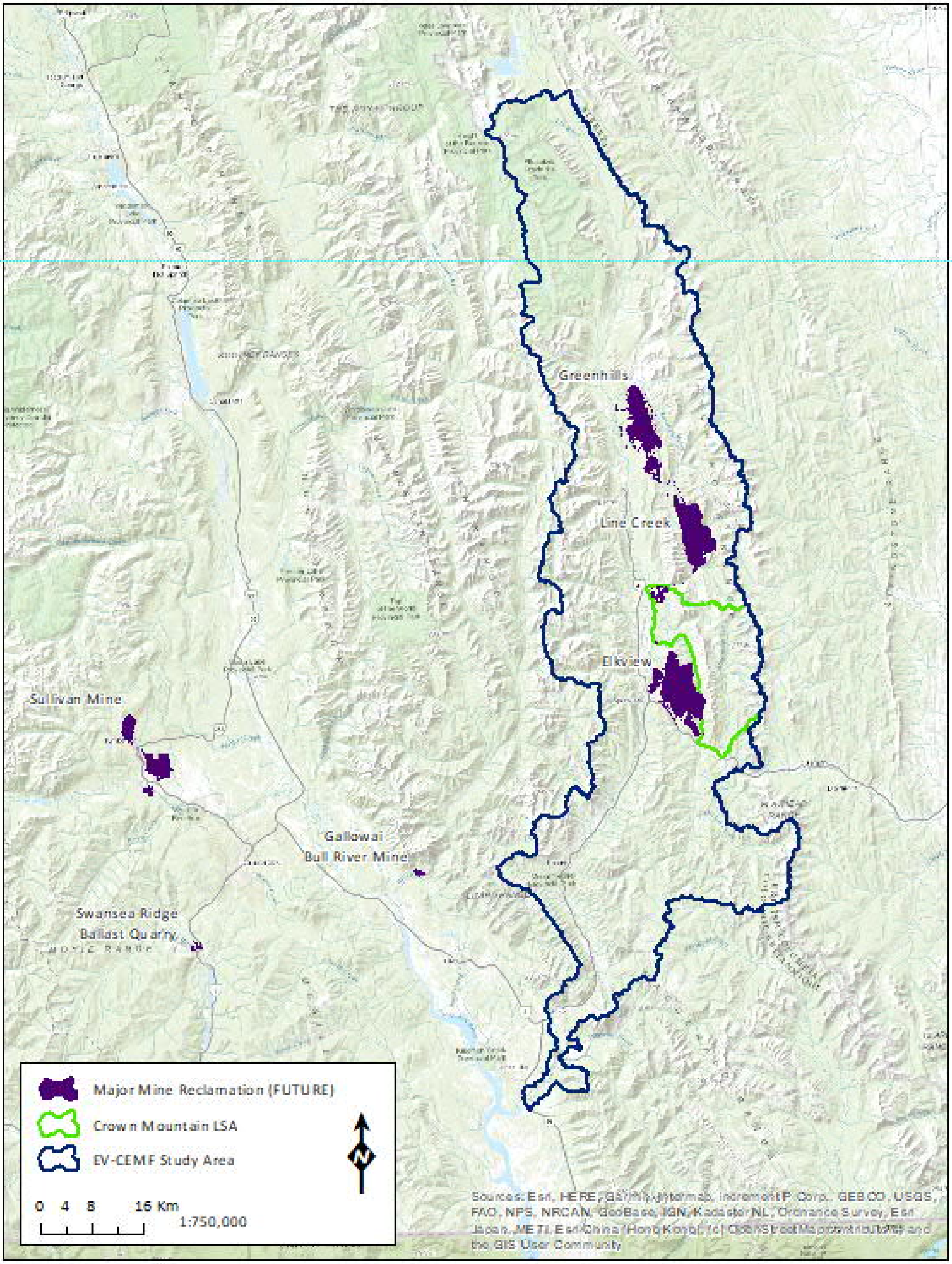


Figure 12.6-6: Future Mine Reclamation

Table 12.6-10: Schedule of Reclamation Activities for each Mine and Associated Area (m^2)

		Mine Site					
		Sullivan Mine	Greenhills Operations	Line Creek Operations	Elkview Operations	Gallowai Bull River	Crown Mountain Coking Coal Project
Landcover Type	Exposed Land	4,543,938	9,666,929	10,776,045	35,159,350	557,435	47,758
	Water	207,865	189,171	55,812	206,874	-	
	Shrub	858,037	680,480	2,014,625	387,877	95,260	60,036
	Herb	1,108,875	3,365,953	1,121,545	1,582,248	314,657	395,831
	Grassland	547,944	1,419,701	547,388	3,250,044	1,136	6,160
	Cropland	-	25,946	612,562	71,704	-	
	Forest	10,790,415	24,766,776	28,318,469	14,209,889	76,211	4,374,870
	Rock	3,291,522	-	302,524	-	118,291	
	Wetland	16,646	-	-	-	-	

12.6.4.2.3 Scenario 3 – Project Case with Additional Cumulative Effects and Natural Disturbance

This scenario builds off Scenario 2 by adding fire and insect outbreak natural disturbances (Table 12.6-11).

Table 12.6-11: Data Used for Scenario 3 Development

Description	Dataset	Format
Proposed Mine Footprints	Future_MineProjects	Shapefile
Mine Reclamation Footprints	CumulativeEffects_MajorMineReclamation_PGN	Shapefile
Cutblocks	CumulativeEffects_Cutblocks_PGN	Shapefile
Proposed Project Footprint	YR15_Final_Design_Pit_Area_CLOSE	Shapefile
Project Reclamation Footprint	YR15_Final_Reclaimed_Area_CLOSE	Shapefile
Fire	No dataset used; random allocation distributed	N/A
Insect Outbreak	Forest Health Factor (FHF)	Shapefile
Insect Outbreak	Insect Hazard Class Ratings	Shapefile

All aspects of Scenario 2 remain unchanged, with the following additions:

a. Fire

Fire was simulated using the assumptions from a scenario analysis that was recently completed in the North Thompson region of B.C. (Carlson, 2020, pers. comm.). Spatial variation in relative burn probability is influenced by vegetation zones, forest type, and age. Relative burn probability is calculated by multiplying normalized Biogeoclimatic Ecosystem Classification (BEC) burn rates (Table 12.6-12) by fire selection ratios by forest cover and age class (Table 12.6-13). Fire selection ratios are available for forest types (deciduous and coniferous); shrubland is assumed to have the same relative burn probability as young deciduous forest, the forest category exhibiting the lowest fire selection ratio (Wilson, 2015; Bernier, 2016).

The general equation for simulated fire is as follows[6]:

> ((Coniferous Dense + Coniferous Open + Coniferous Sparse) *IF (Forest age>89, THEN 2.9, ELSE IF(Forest Age > 29, THEN 2, ELSE 0.8)))*((Shrub Low + Shrub Tall + Broadleaf Dense + Broadleaf Open)*IF(Forest Age >89, THEN 0.63, ELSE IF (Forest Age >29, THEN 0.4, ELSE 0.15)))*Regional Modifier (BEC Zones with relative probabilities as outlined in Table 12.6-12)

Table 12.6-12: Relative Burn Probabilities of BEC Zones (from Wilson, 2015)

BEC category	BEC Zones	Relative Burn Probability
Alpine Tundra (AT)	IMA, CMA, BAFA	0
Bunchgrass (BG)	BG	0
High Elevation Spruce (NHE Spruce)	SWB, BWBS, ESSF	1.06
Low elevation spruce (CMLE Spruce)	SBPS, SBS, MS	1.31
Douglas fir (IDF)	IDF, CWF	0.74
Interior cedar and hemlock (ICH)	ICH	1.15

Table 12.6-13: Relative Burn Probabilities for Forest Type and Forest Age Categories (From Bernier, 2016)

	Young (<30 years)	Mature (30-89 years)	Old (>89 years)
Conifer	0.8	2	2.9
Deciduous	0.15	0.4	0.63

Area allocated to fire was based on the EV-CEMF Reference Scenario (EV-CEMF, 2018) with a multiplier applied to account for the larger Crown Mountain RSA. Table 12.6-14 shows the simulated total area burned for each decade.

Table 12.6-14: Simulated Area (m^2) Affected by Fire

Decade	Annual Burned Area (m^2)
2020	62,935,526
2030	7,081,782
2040	3,571,720
2050	22,554,518
2060	171,161

[6] Model equations used in ALCES don't conform to standard mathematical equation structure.

b. Insect Outbreaks

Insect outbreak assumptions are based primarily on two data sets: The Forest Health Factor (FHF) which is comprised of polygons created from aerial observations of current forest infestations conducted by FLNRORD (filename: AOS_2020_Polygons.shp; 2020), and the Beetle Susceptibility data which provides hazard classes of forests for each insect (filename: pest_infestation_poly.gdb; B.C. Catalogue 2019). FHF data were filtered to include only IBS (spruce beetle), IBD (Douglas fir beetle), and IBM (Mountain pine beetle) polygons within the Kootenay Boundary Region in order to determine size classes of insect outbreak.

For the B.C. portion of the Crown Mountain RSA, the Beetle Susceptibility dataset was used to spatially constrain simulated insect outbreaks to those areas identified at risk for beetle infestations. For Alberta, eligible areas for insect infestation were constrained to coniferous land cover. The proportion of each hazard class assigned to the insect outbreak were calculated by multiplying the infestation rating by the susceptible area taken from the FHF aerial surveys (2019) for each beetle species, and are outlined in Table 12.6-15, Table 12.6-16, and Table 12.6-17. Annual infestation allocations for B.C. were applied to Alberta for mountain pine and spruce beetles using a multiplier related to the area of the Alberta portion within the study area.

- Percent of coniferous forest impacted by insect outbreaks for each Hazard Class (Susceptibility Rating):
  - High (H) – 100%;
  - Moderate (M) – 66%;
  - Low (L)– 33%; and
  - Very Low (V) – 5%;

The areas were divided by ten years to determine the annual infestation area; these numbers are based on the assumption that there is a ten-year insect infestation cycle (pers. comm. Marnie Dulthie-Holt, 2019).

Table 12.6-15: Annual Area (m2) of Douglas Fir Beetle (IBD) Infestations for Each Hazard Class

Hazard (Susceptibility Rating)	Infestation Rate	Susceptible Area (m^2)	Infestation Area (m^2)	Annual Area (m^2)
H	1	122,039,600	122,039,600	12,203,960
M	0.66	193,299,800	127,577,868	12,757,787
L	0.33	2,012,053,000	663,977,490	66,397,749
V	0.05	1,487,678,000	74,383,900	7,438,390

Table 12.6-16: Annual Area (m^2) of Spruce Bark Beetle (IBS) Infestations for Each Hazard Class

Hazard (Susceptibility Rating)	Infestation Rate	Susceptible Area (m^2)	Infestation Area (m^2)	Annual Area (m^2)
H	1	59,425,020	59,425,020	5,942,502
M	0.66	300,284,930	198,188,050	19,818,805
L	0.33	3,983,573,430	1,314,579,230	131,457,923
V	0.05	748,238,200	37,411,910	3,741,191

Table 12.6-17: Annual Area (m^2) of Mountain Pine Beetle (IBM) Infestations for Each Hazard Class

Hazard (Susceptibility Rating)	Infestation Rate	Susceptible Area (m^2)	Infestation Area (m^2)	Annual Area (m^2)
H	1	820,555,318	820,555,318	82,055,532
M	0.66	921,131,076	607,946,510	60,794,651
L	0.33	3,254,398,871	1,073,951,630	107,395,163
V	0.05	2,655,922,949	132,796,150	13,279,615

- Categories of observed infestations from the Beetle Susceptibility data relate to the FHF hazard class ratings; i.e., Patch sizes from the FHF with "S" infestation (severe) apply to the High Hazard areas defined by the Bark Beetle Susceptibility Rating dataset. In order to compare between the two datasets, the “VL” (very low) and “T” (trace) infestation classes of the FHF data were combined into one category of “VL”; and
- The 2019 FHF survey data were used to allocate size class and total area (m^2) of bark beetle impacts for the simulations. Size classes were assigned for each insect Hazard Class (Table 12.6-18).

Table 12.6-18: Size Class Allocations for Insect Outbreaks

Insect	Severity	Size Class Rounded (m^2)	Proportion
IBD	L	480,000	1
IBD	M	160,000	1
IBD	S	120,000	1
IBD	V	200,000	1
IBM	L	140,000	1
IBM	M	270,000	1
IBM	S	170,000	1
IBM	V	230,000	0.5
IBM	V	380,000	0.5
IBS	L	500,000	1
IBS	M	1,140,000	1
IBS	S	550,000	1
IBS	V	550,000	1

12.6.5 Mitigation for Cumulative Effects

The mitigation strategy developed for Project effects is also applicable to the cumulative effects for fish and fish habitat. As described in Section 12.5.3, the mitigation measures include a combination of Project design features, procedures, and practices aimed at reducing or eliminating Project-related effects to fish and fish habitat. Existing and proposed mitigation measures for current coal mining operations and reasonably foreseeable projects in the Elk Valley are also described in Table 12.6-2.

Implementation of the operational practices and procedures that are prescribed in the Site Water Management Plan (Chapter 33, Section 33.4.1.8), including selenium, nitrate, and calcite management, the Erosion and Sediment Control Plan (Section 33.4.1.4), Noise and Vibration Management Plan (Chapter 33, Section 33.4.1.7), Vegetation and Ecosystems Management and Monitoring Plan (Section 33.4.1.11), and the Aquatic Effects Management Program described in Chapter 33, Section 33.4.1.5 will be the primary means by which the Project will address adverse effects to fish and fish habitat.

12.6.6 Characterization of Residual Cumulative Effects

12.6.6.1 Elk Valley CEMF

12.6.6.1.1 Scenario 1

Project development is presented in Figure 12.6-7. The Aquatic Hazard for Scenario 1 is presented in Figure 12.6-8. Aquatic Hazard increases upon peak mining at 2038 and decreases with mine reclamation at 2055. Compared to an aging forest alone, Aquatic Hazard score would have been 0.58 without mining. Mining acts to increase Hazard in this Aquatic Watersheds (AW) by 0.04 points (Table 12.6-19).

Table 12.6-19: Aquatic Hazard Anticipated by Scenario 1

AW	Development	Base Case	Project Case (2038)	Future Case (2055)
Alexander Creek – Mid	Crown Mountain	0.57	0.62	0.51

12.6.6.1.2 Scenario 2

Most AWs demonstrate increased Aquatic Hazard upon peak mining at 2038 and decreased hazard at 2055 after mine reclamation (Table 12.6-20; Figure 12.6-9; Figure 12.6-10). Conversely, the Lake Mountain & Clode AW, as well as the Kilmarnock AW, show decreased Aquatic Hazard upon peak mining. This is because the expanding mine footprint removes roads near streams and on steep slopes. Cutblock area and riparian disturbance (Figure 12.6-11) both increases, but the effect of reducing road densities drives the overall Aquatic Hazard down for these AWs. Michel Creek Mid 2 demonstrates non-change in Aquatic Hazard at 2038. This is because increases in equivalent clear-cut area (ECA) and riparian disturbance are counteracted by decreases in road densities (Figure 12.6-12). Road density is closely linked to increased recreational pressure on popular angling species.

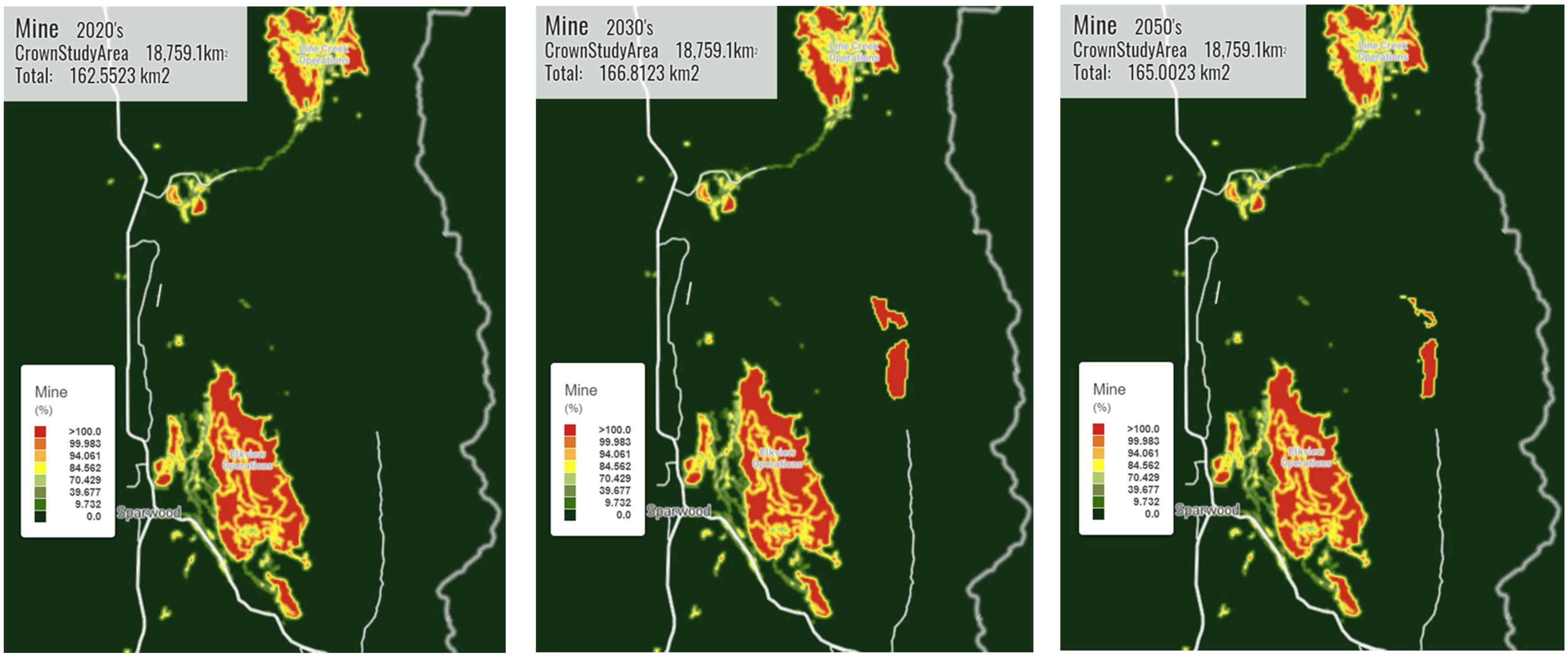
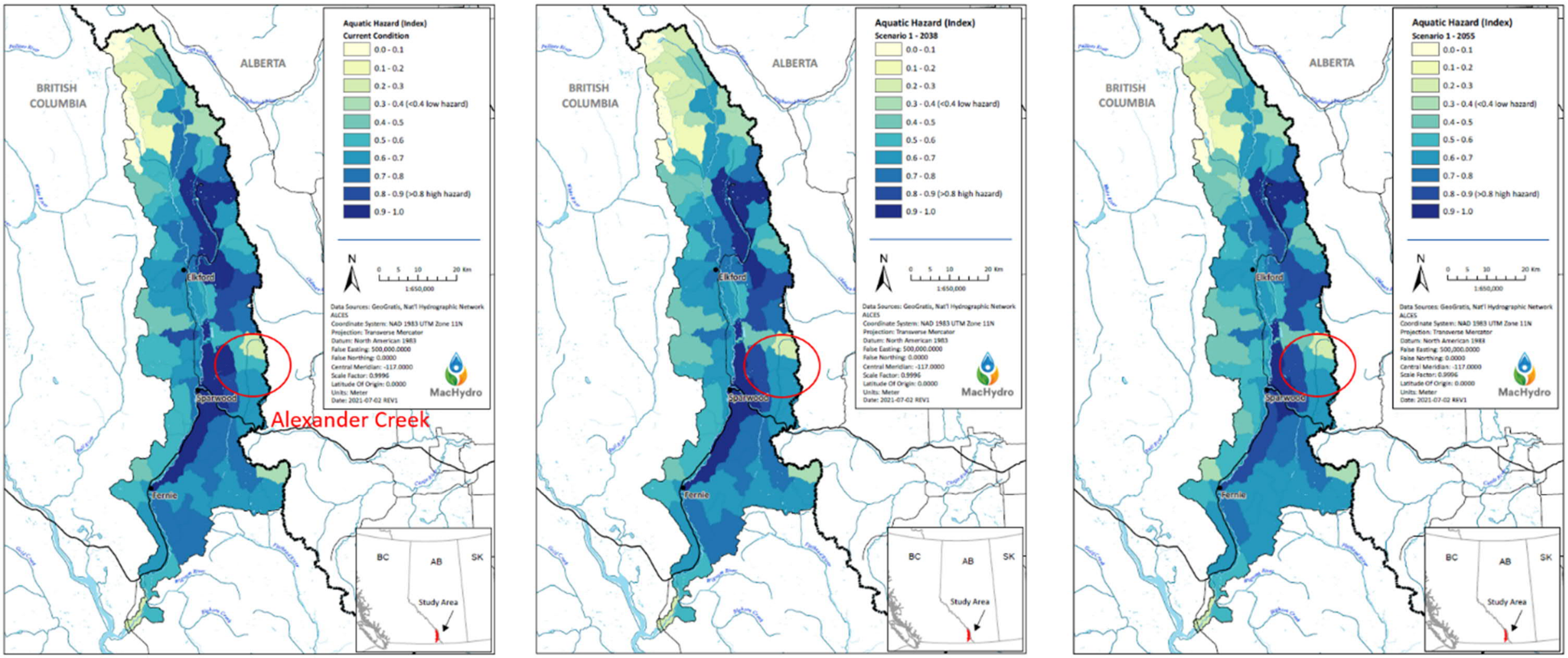


Figure 12.6 7: Scenario 1 – Mine Development in the 2020s, 2030s, and 2050s


BRITISH COLUMBIA
ALBERTA
Elkford
Sparwood
Fernie
Alexander Creek
Aquatic Hazard (Index)
Current Condition
0.0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4 (<0.4 low hazard)
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9 (>0.8 high hazard)
0.9 - 1.0
N
0 5 10 20 Km
1:650,000
Data Sources: GeoGratis, Nat'l Hydrographic Network ALCES
Coordinate System: NAD 1983 UTM Zone 11N
Projection: Transverse Mercator
Datum: North American 1983
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -117.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
Date: 2021-07-02 REV1
MacHydro
BC
AB
SK
Study Area
Aquatic Hazard (Index)
Scenario 1 - 2038
Aquatic Hazard (Index)
Scenario 1 - 2055

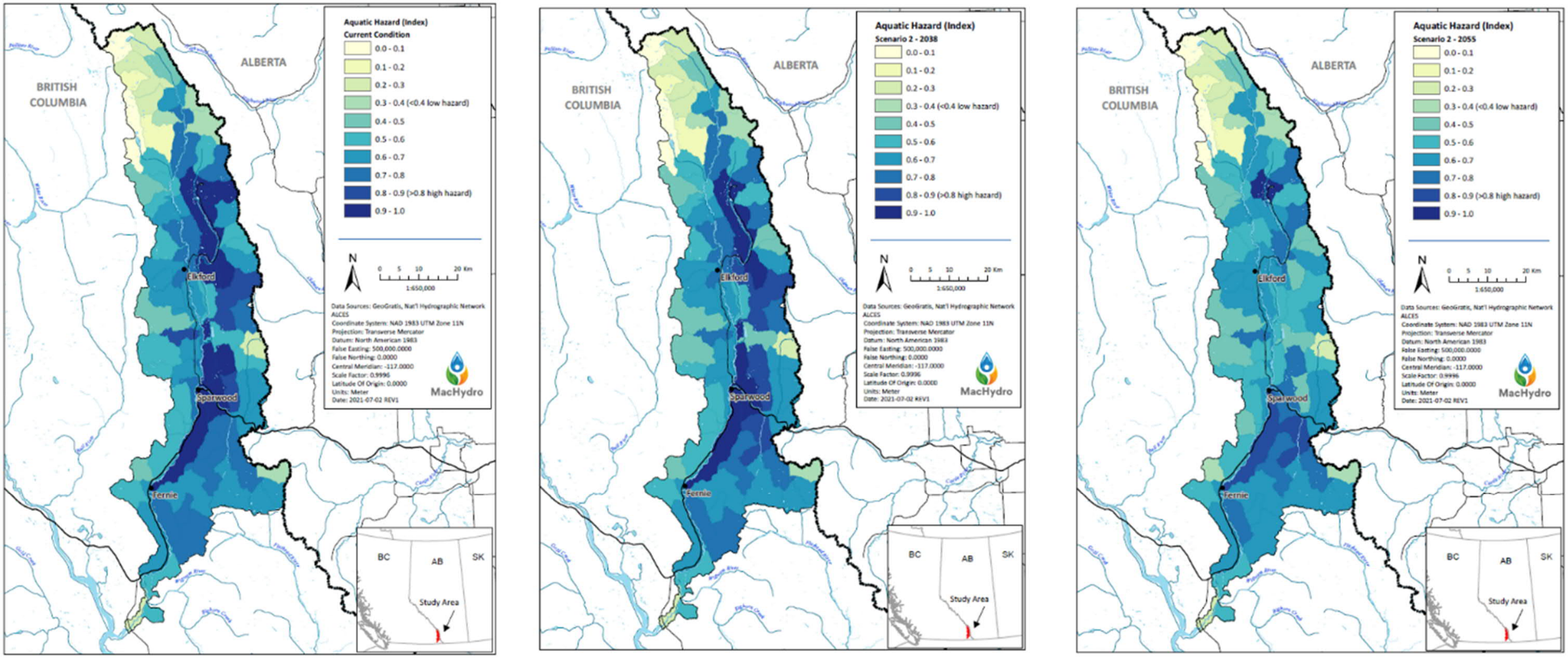
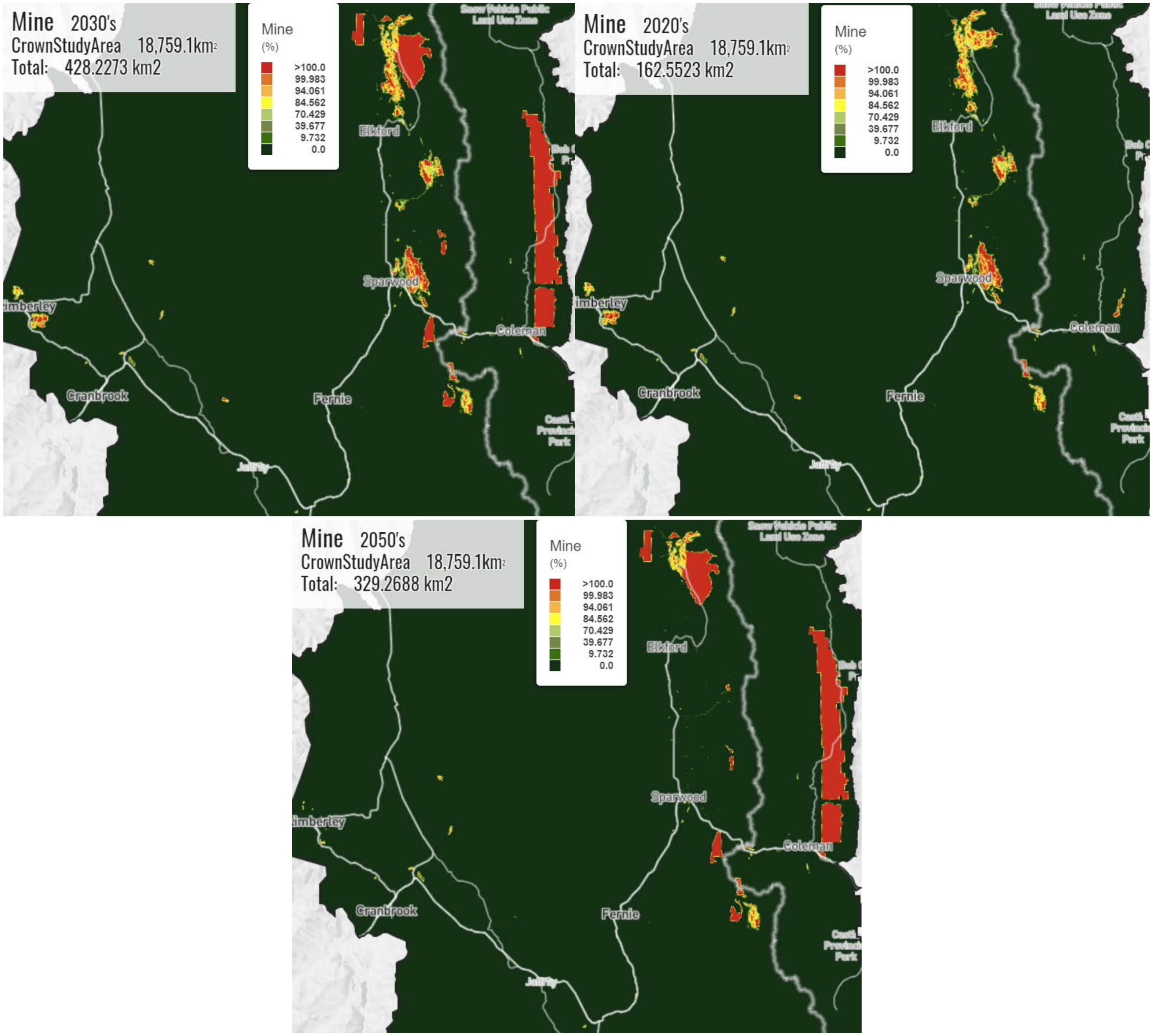


Figure 12.6-9: Aquatic Hazard Scenario 2


Mine 2030's
CrownStudyArea 18,759.1km2
Total: 428.2273 km2
Mine
(%)
>100.0
99.983
94.061
84.562
70.429
39.677
9.732
0.0
Snow Vehicle Public Land Use Zone
Elkford
Sparwood
Coleman
Cranbrook
Fernie
Jaffray
Mine 2020's
CrownStudyArea 18,759.1km2
Total: 162.5523 km2
Mine
(%)
>100.0
99.983
94.061
84.562
70.429
39.677
9.732
0.0
Elkford
Sparwood
Coleman
Cranbrook
Fernie
Jaffray
Mine 2050's
CrownStudyArea 18,759.1km2
Total: 329.2688 km2
Mine
(%)
>100.0
99.983
94.061
84.562
70.429
39.677
9.732
0.0
Elkford
Sparwood
Coleman
Cranbrook
Fernie
Jaffray

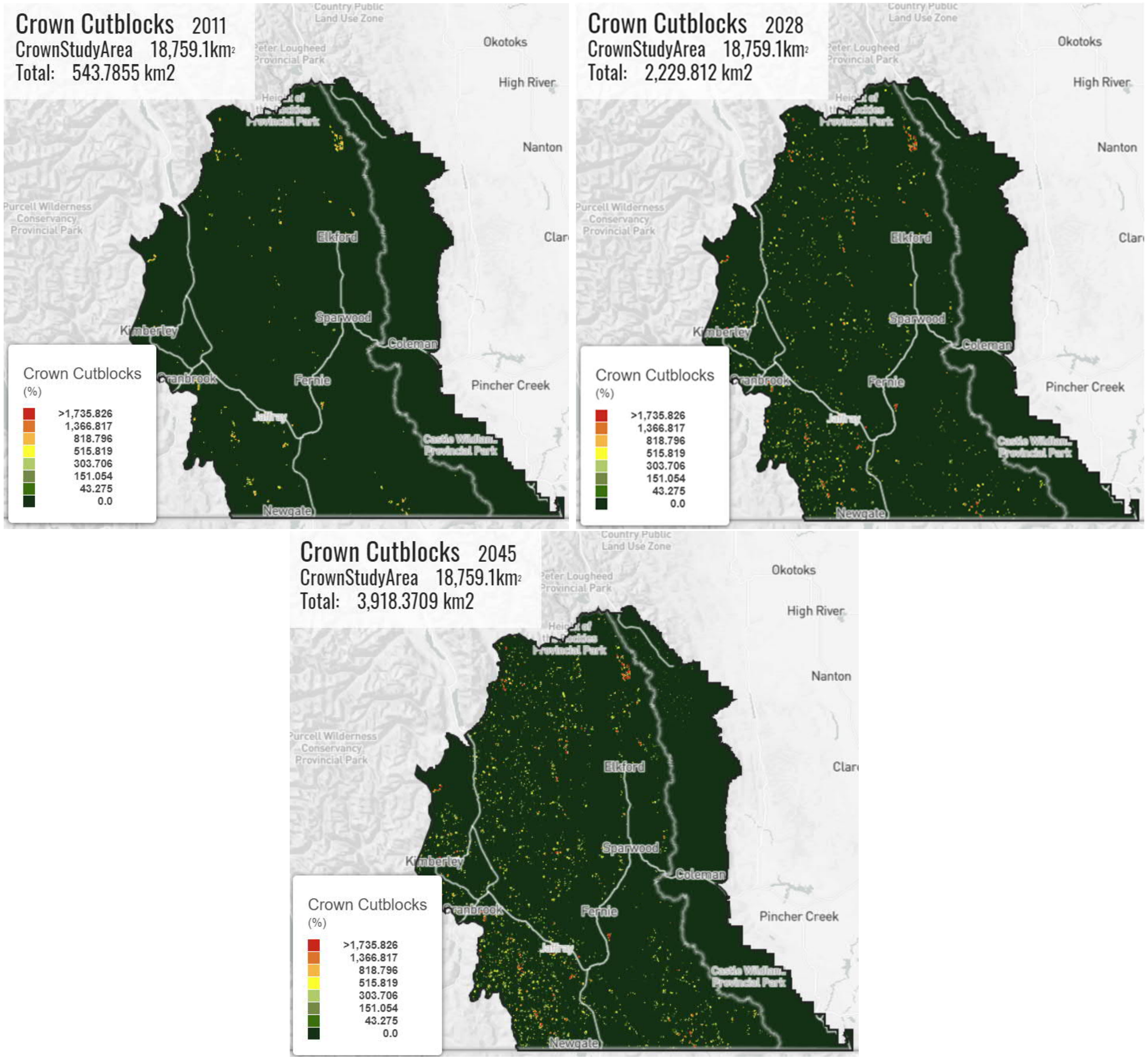
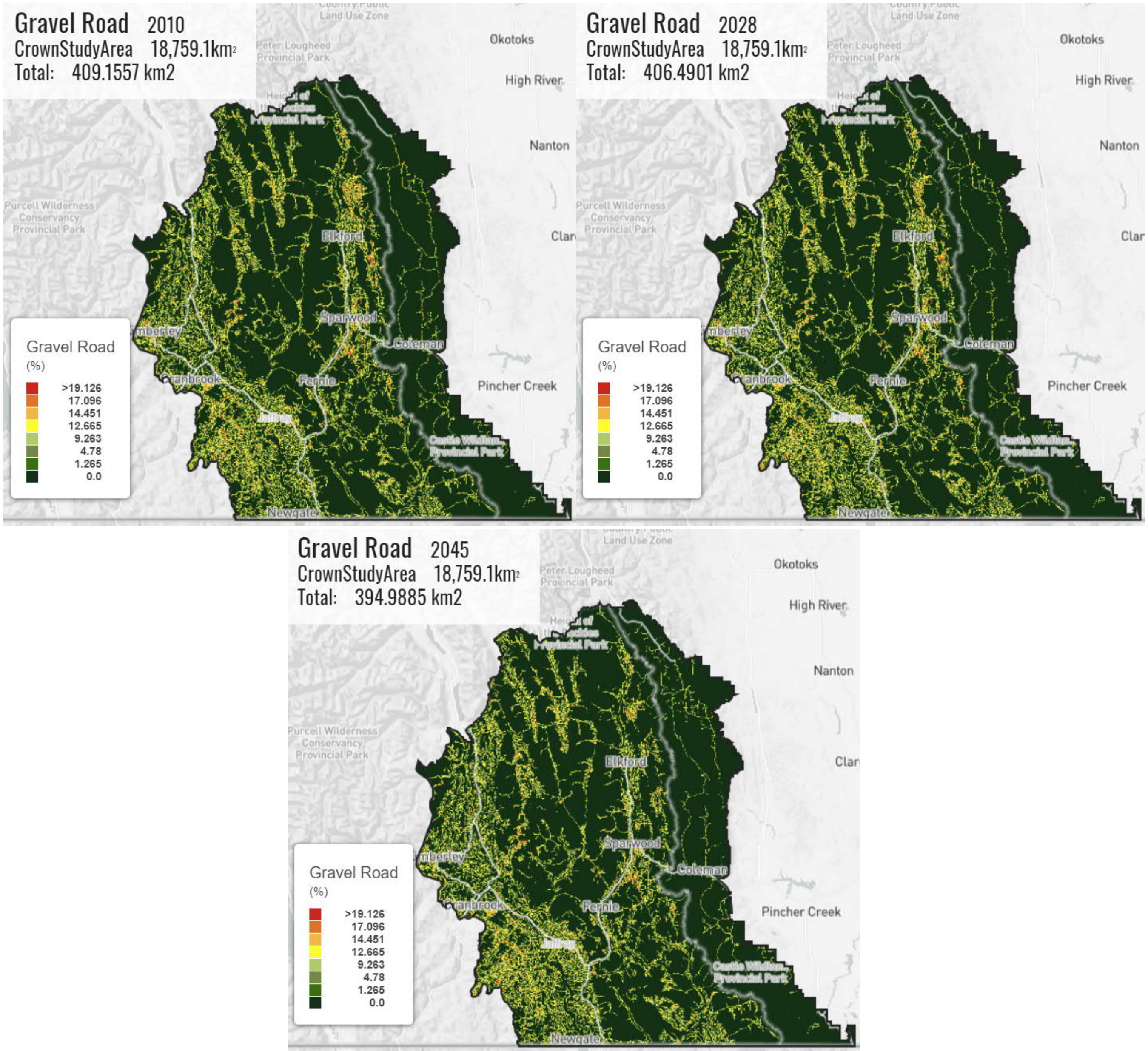


Figure 12.6-11: Scenario 2 Simulated Cutblocks at 2011, 2028, and 2045



Gravel Road 2010
CrownStudyArea 18,759.1km2
Total: 409.1557 km2
Gravel Road
(%)
>19.126
17.096
14.451
12.665
9.263
4.78
1.265
0.0
Gravel Road 2028
CrownStudyArea 18,759.1km2
Total: 406.4901 km2
Gravel Road
(%)
>19.126
17.096
14.451
12.665
9.263
4.78
1.265
0.0
Gravel Road 2045
CrownStudyArea 18,759.1km2
Total: 394.9885 km2
Gravel Road
(%)
>19.126
17.096
14.451
12.665
9.263
4.78
1.265
0.0
Okotoks
High River
Nanton
Pincher Creek
Elkford
Sparwood
Coleman
Fernie
Newgate
Peter Lougheed Provincial Park
Purcell Wilderness Conservancy Provincial Park

Table 12.6-20: Scenario 2 Aquatic Hazard Response

AW	Development	Base Case	Project Case (2038)	Future Case (2055)
Alexander Creek – Mid	Crown Mountain Coking Coal Project	0.57	0.61	0.53
Forsyth Creek - Lower	Bingay Main	0.53	0.55	0.54
Hornickel Creek	Bingay Main	0.51	0.54	0.52
Lake Mountain & Clode	Fording River Ops and Extension	1.0	0.96	0.96
Kilmarnock	Fording River Extension	0.91	0.58	0.58
Swift	Fording River Extension	0.96	0.97	0.67
Chauncey	Fording River Extension	0.69	0.72	0.71
Michel Creek – Mid 1	Michel Coal – Loop Ridge	0.76	0.81	0.81
Michel Creek – Mid 2	Michel Coal - Head	0.77	0.77	0.75

The residual cumulative effects of increased road development in the Aquatic RSA in combination with the effects of other past and present projects or activities in the Aquatic RSA on fish and fish habitat (as represented in the EV-CEMF) are characterized as follows:

- Duration: *Long-term*, the cumulative effect of an increase in road density is linked to an increase in Aquatic Hazard. In some cases, the Aquatic Hazard decreases during peak mining due to the expanding mine removing roads near streams and on steep slopes. Other road related activities such as logging may increase the overall effect of these hazards but are often counterbalanced when road density is lowered. Conversely, the effect of road density increasing can have long term effects on landscapes, especially near streams.
  Magnitude: *Low to Moderate,* the anticipated cumulative impact on fish and fish habitat due to increased road density is anticipated to be low to moderate. The magnitude will be low in the AWs that are impacted by the Project, and others could reach moderate levels. Some AWs also showed no change in Aquatic Hazard such as Michel Creek Mid 2. For the Alexander Creek – Mid AW, the Aquatic Hazard, due to increased road density, increases from 0.57 to 0.61 at Project Case, but then goes down to 0.53 in Future Case once reclamation has been completed. This indicates a moderate level of Aquatic Hazard overall.
- Geographic Extent: *Regional*, the effects of increased road density are expected to occur at the regional scale since roads are often not limited to specific areas, and the access they provide increases angling and impacts from erosion etc. at a larger scale.
- Frequency: *Continuous,* roads are built to be used for long periods of time, unless they are seasonal logging roads; however, the impact during the use of roads is considered continuous and not a one-time only event.
- Reversibility: *Reversible long-term*, the Aquatic Hazard assessment showed that the removal or reduction of road density in an AW could have a substantial impact on fish and fish habitat. In Michel Creek Mid 2 AW for instance, the Aquatic Hazard remains unchanged despite an increase in forest harvesting activity due to road removal counterbalancing the logging operation's increased effects at a landscape scale. The impacts of increased roads are therefore assessed to be reversible in the long term and the removal of roads serves as an important mitigation measure for cumulative effects.

- Context: *Neutral,* fish and fish habitat are expected to have some resilience to increased road development in the Aquatic RSA.

The municipalities of Fernie, Sparwood, and Elkford are simulated to grow out based on the same assumptions used in the EV-CEMF Reference Scenario. Fernie expansion is limited to within 300 m of the pre-existing urban footprint. All municipalities expand into predefined masks identified by Official Community Plans. Growth rates (38,885 m^2, 8,453 m^2, and 9,016 m^2, respectively) were derived from Statistics Canada. Recreational expansion was simulated through ski hill growth and was directed based on the same assumptions used in the EV-CEMF Maximum Scenario, which estimates 7,300 m^2 growth annually. Growth is predicted to occur radially from a predefined centroid into a pre-defined mask (Figure 12.6-13).

The residual cumulative effects of increased urban and recreational development in the Aquatic RSA in combination with the effects of other past and present projects or activities in the Aquatic RSA on fish and fish habitat (as represented in the EV-CEMF) are characterized as follows:

- Duration: *Long-term*, the effects of increased urban and recreational development in the Aquatic RSA is expected to be long-term.
- Magnitude: *Low to Moderate,* in certain AWs the impacts will be low, but in other AWs, especially where communities are already well established such as Fernie and Sparwood, the magnitude is anticipated to be moderate.
- Geographic Extent: *Regional*, the increased urban and recreational development affects fish and fish habitat at a regional scale.
- Frequency: *Continuous,* the effects of urban and recreational development on fish and fish habitat are considered continuous.
- Reversibility: *Reversible long-term*, the Aquatic Hazard assessment indicated that in the 2050s the pressure of urban and recreational development will most likely decline in the Elk Valley.
- Context: *Neutral,* fish and fish habitat are expected to have some resilience to increased urban and recreational development in the Aquatic RSA.

12.6.6.1.3 Scenario 3

This scenario builds off Scenario 2 by adding fire and insect outbreak natural disturbances. Most AWs demonstrate increases in Aquatic Hazard at peak mining, and either decreases or unchanged hazard at 2055 (Table 12.6-21; Figure 12.6-14). Conversely, Lake Mountain & Clode AW and Kilmarnock AW demonstrate decreases in Aquatic Hazard upon peak mining, due to removal of road footprint. In all Aws, hazard is higher, relative to Scenario 2, except at Kilmarnock, Swift, and Lake Mountain & Clode. These AWs have no fire activity relative to the others (Figure 12.6-15). Insect outbreaks at these AWs still act to increase ECA (Figure 12.6-16) and riparian disturbance, relative to Scenario 2, but once scaled from 0 to 1 and averaged with the road indicators, this increase is drowned out.

Fire and Insect Outbreaks

Figure 12.6-15 presents the simulated scenario for fire at Project Case and Future Case. Figure 12.6-16 presents the simulated insect outbreak for Project Case 2038.

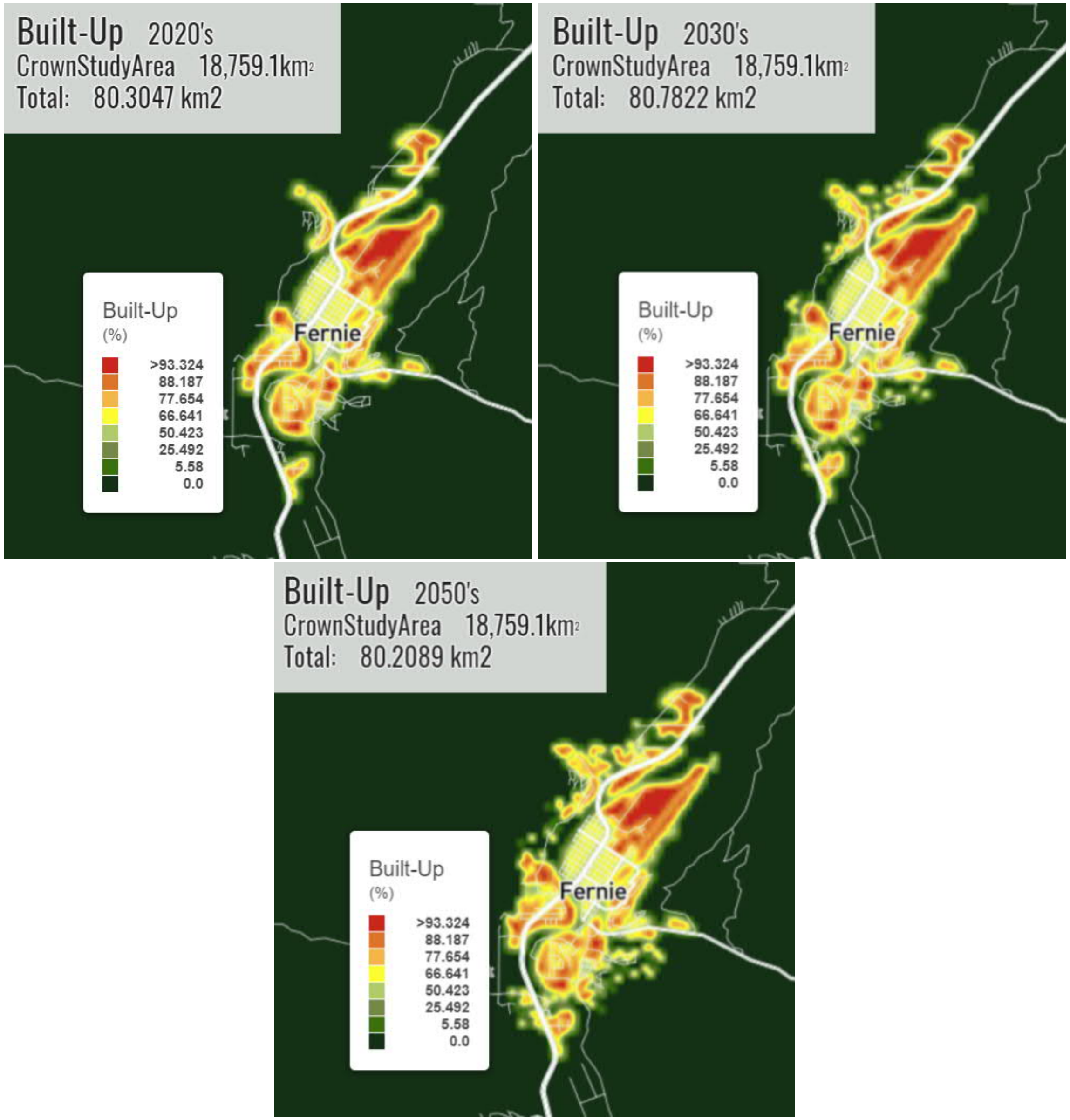
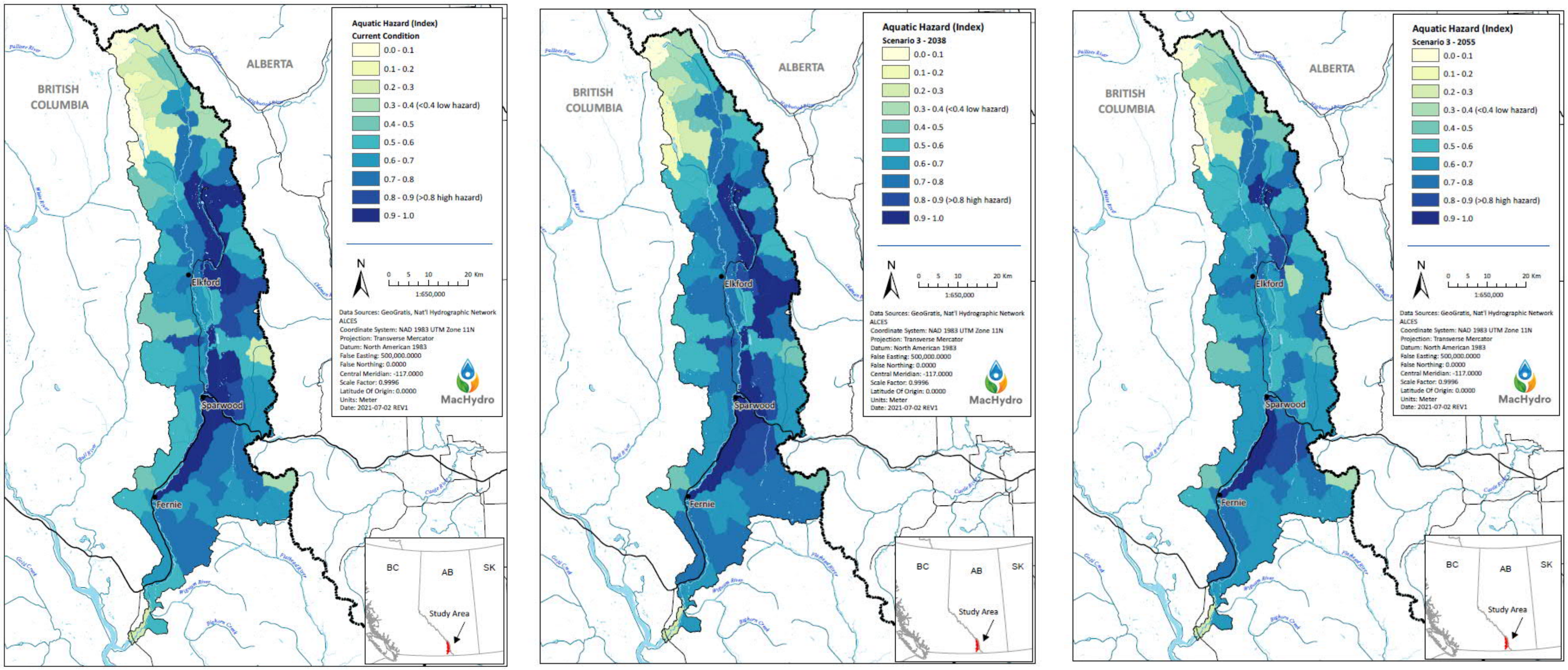
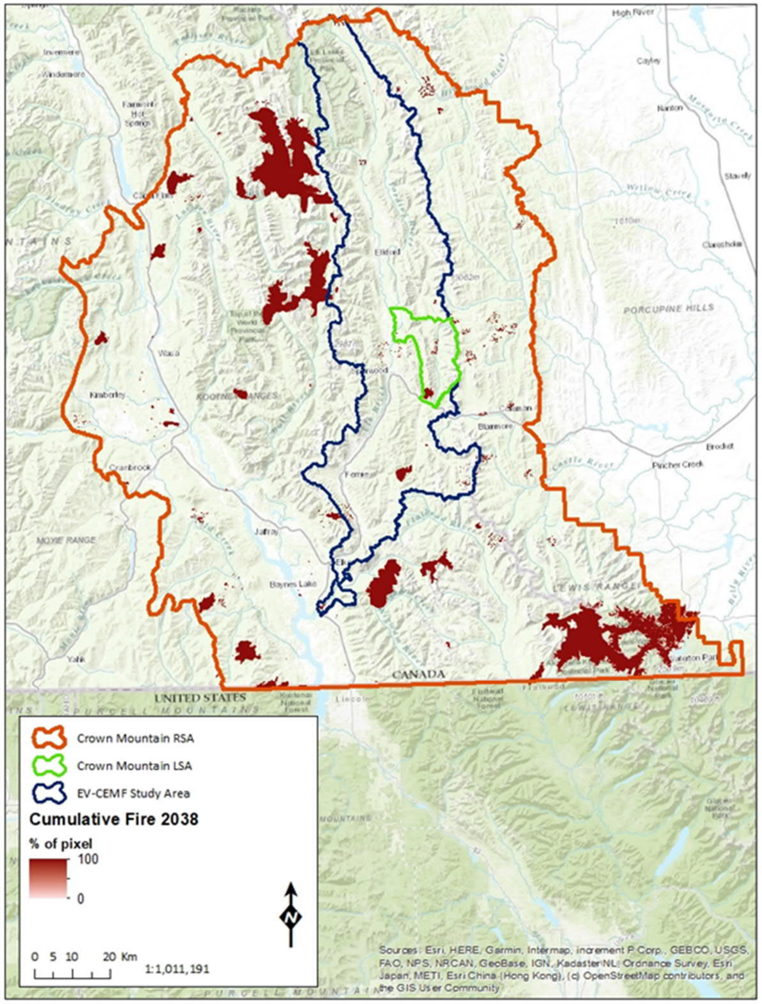


Figure 12.6-13: Scenario 2 Simulated Urban and Recreational Expansion in the 2020s, 2030s, and 2050s


Aquatic Hazard (Index)
Current Condition
0.0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4 (<0.4 low hazard)
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9 (>0.8 high hazard)
0.9 - 1.0
Aquatic Hazard (Index)
Scenario 3 - 2038
Aquatic Hazard (Index)
Scenario 3 - 2055
BRITISH COLUMBIA
ALBERTA
Elkford
Sparwood
Fernie
N
0 5 10 20 Km
1:650,000
Data Sources: GeoGratis, Nat'l Hydrographic Network ALCES
Coordinate System: NAD 1983 UTM Zone 11N
Projection: Transverse Mercator
Datum: North American 1983
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -117.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
Date: 2021-07-02 REV1
MacHydro
BC
AB
SK
Study Area



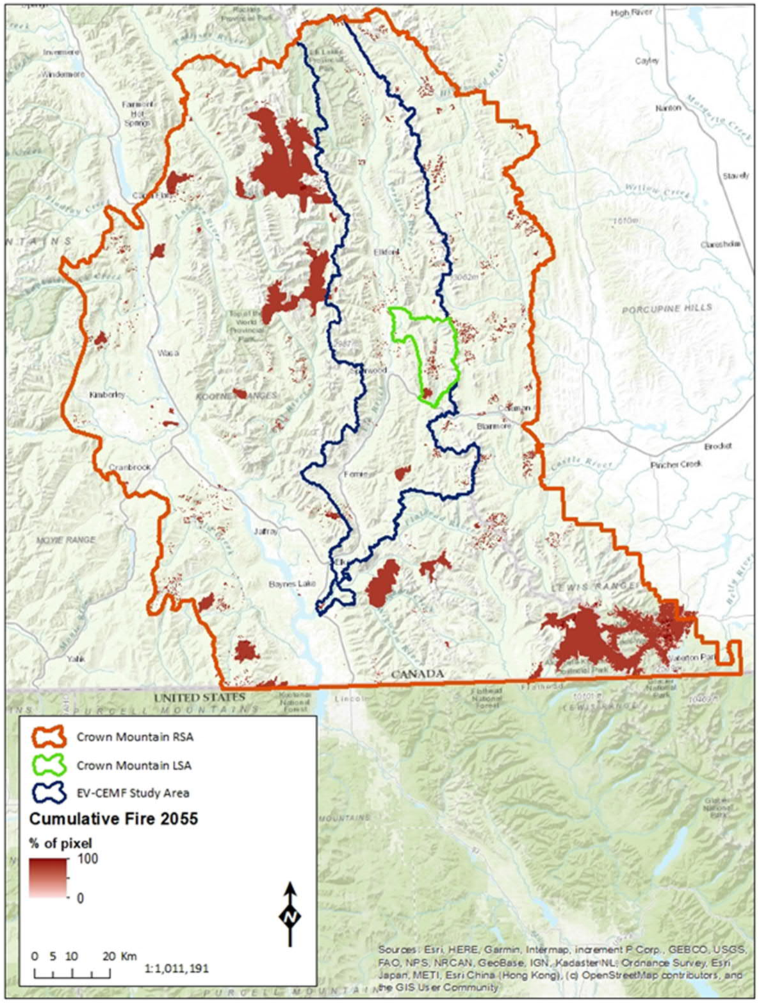


Figure 12.6-15: Simulated Fire Scenario Project Case 2038 (left) and Future Case 2055 (right)

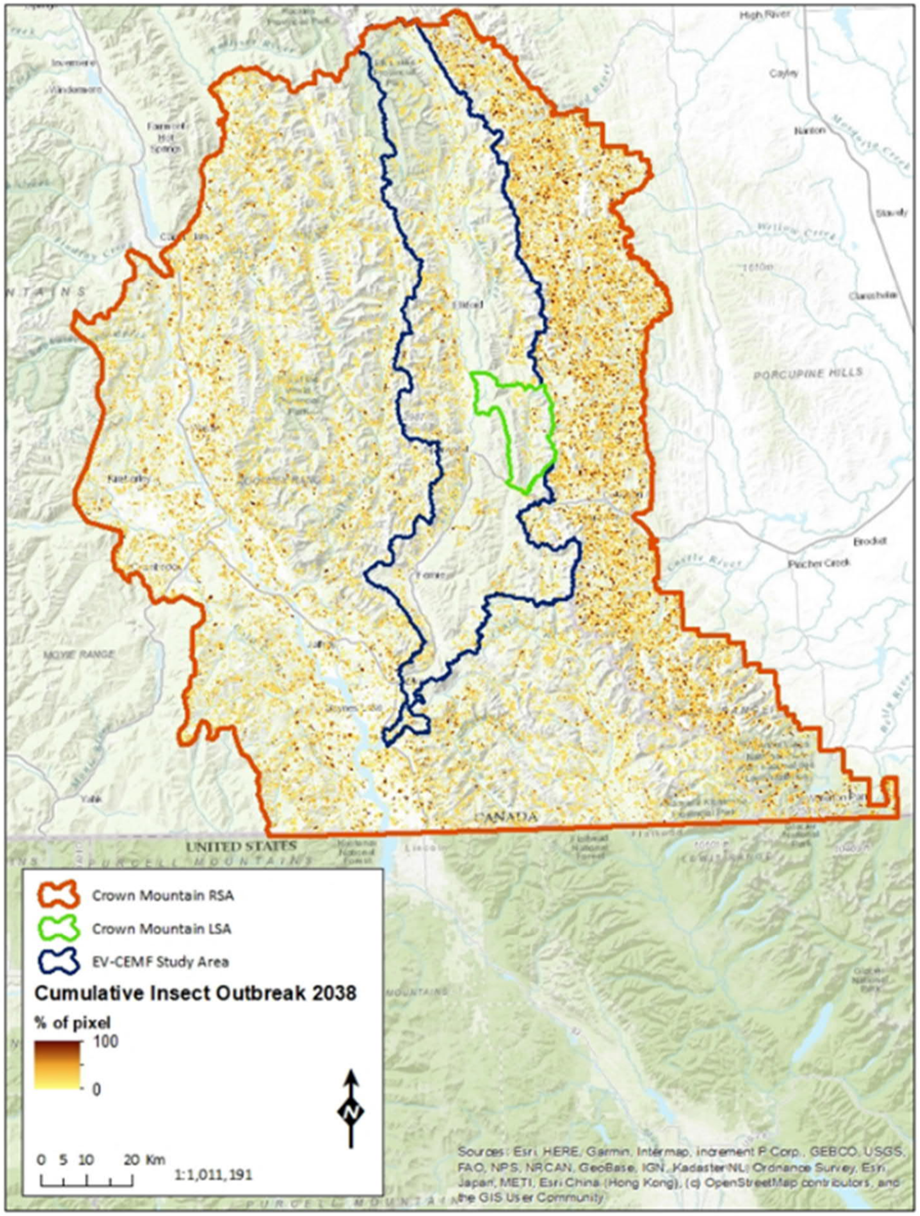


Figure 12.6-16: Simulated Insect Outbreak 2038

Table 12.6-21: Scenario 3 Aquatic Hazard Response

AW	Development	Current Condition	2038	2055
Alexander Creek – Mid	Crown Mountain Coking Coal Project	0.57	0.68	0.65
Forsyth Creek - Lower	Bingay Main	0.53	0.58	0.57
Hornickel Creek	Bingay Main	0.51	0.56	0.54
Lake Mountain & Clode	Fording River Ops and Extension	1.0	0.96	0.96
Kilmarnock	Fording River Extension	0.91	0.58	0.58
Swift	Fording River Extension	0.96	0.97	0.68
Chauncey	Fording River Extension	0.69	0.73	0.73
Michel Creek – Mid 1	Michel Coal – Loop Ridge	0.76	0.82	0.82
Michel Creek – Mid 2	Michel Coal - Head	0.77	0.79	0.79

The residual cumulative effects of increased natural disturbance due to fire and insect outbreaks in combination with the effects of other past and present projects or activities in the Aquatic RSA on fish and fish habitat (as represented in the EV-CEMF) are characterized as follows:

- Duration: *Long-term*, the effects of increased natural disturbance due to fire and insect outbreaks is anticipated to be long-term. The Aquatic Hazard increases from 0.57 to 0.68 at Project Case under this scenario and only decreases to 0.65 in Future Case after reclamation. This difference in recovery from Scenario 2 is due to the impacts associated with natural disturbance and is therefore assessed as being long-term.
- Magnitude: *Low to Moderate,* there are AWs that remain unchanged or even decrease during Scenario 3. Examples include Lake Mountain and Clode AW; however, the majority of AWs showed an increase in Aquatic Hazard with less recovery occurring in the Future Case.
- Geographic Extent: *Regional*, the effects of natural disturbance is anticipated to affect fish and fish habitat at the regional scale.
- Frequency: *Continuous,* the effects of natural disturbances due to fire and insect outbreaks are continuous and can occur over large temporal and spatial scales.
- Reversibility: *Reversible Long-Term to Irreversible*, while most natural disturbances are viewed as being reversible in the long term, the effect of the disturbances, in relation to other cumulative effects as assessed in Scenario 3, did not show a strong recovery in the Future Case and is therefore assessed to be irreversible to possibly reversible long-term.
- Context: *Neutral,* fish and fish habitat are expected to have some resilience to increased natural disturbance due to fire and insect outbreaks in the Aquatic RSA.

12.6.6.2 Habitat Loss Due to Changes in Water Quantity

The water balance and loading model that was prepared for the Aquatic RSA includes the cumulative interactions with effects from ongoing mining operations, forestry activities, and hydroelectric dams in the Elk Valley. The results of model (Chapter 10) indicate that the predicted change in surface water quantity for the Project Case is negligible to non-detectable (i.e., less than 1% compared to baseline), when considering mean annual and mean monthly flows during all Project phases at multiple nodes in the Aquatic RSA. Measurable residual Project effects for surface water quantity are not predicted to occur beyond limited areas within the Aquatic LSA. The residual cumulative effects of changes in surface water quantity were found to vary with respect to magnitude and were generally limited to the upper reaches of the receiving watercourses (refer to Chapter 10). Accordingly, no measurable residual cumulative effects to fish and fish habitat from changes in surface water quantity are predicted beyond the Aquatic LSA boundary, within the remainder of the Aquatic RSA.

The residual cumulative effects of habitat loss due to changes in water quantity in combination with the effects of other past and present projects or activities in the Aquatic RSA on fish and fish habitat are characterized as follows:

- Duration: *Long-term*, the potential for adverse effects to fish and fish habitat resulting from changes in water quantity will generally be limited to the Fish and Fish Habitat LSA of the Project but will be experienced throughout the Project duration.
- Magnitude: *Low*, the potential for negative effects to fish and fish habitat due to changes in water quantity outside the Fish and Fish Habitat LSA is low at all of the assessment nodes in the Aquatic RSA.
- Geographic Extent: *Local*, potential effects to fish and fish habitat are restricted to the Fish and Fish Habitat LSA and are non-detectable in the Aquatic RSA (Elk River and Lake Koocanusa).
- Frequency: *Continuous*, the potential for adverse effects to fish and fish habitat occurs continuously throughout the Project (including mining activities, drainage modifications, and operation of the Main Sediment Pond).
- Reversibility: *Irreversible*, impacts to fish and fish habitat from changes in surface water quantity within the Aquatic RSA are anticipated to be potentially irreversible until after the Post-Closure phase.
- Context: *High*, the effects on fish and fish habitat from changes in water quantity is anticipated to be low at the Aquatic RSA scale and would therefore support high resilience to changes occurring in the Fish and Fish Habitat LSA of the Project.

12.6.6.3 Changes in Water Quality

The cumulative effects assessment of changes in water quality was focused on the single effect that has the potential to result in detectable concentrations of contaminants from the Project in the Aquatic RSA, namely change in surface water quality from sediment pond discharge. No past, present, or reasonably foreseeable future projects or activities that may have an adverse effect on surface water quality are expected to spatially or temporally overlap with the residual effects resulting from a change in surface water quality from the disposal of mine rock and coal rejects or a change in surface water quality from surface water – groundwater interactions, as both residual effects are limited to within the extent of the Project footprint. Therefore, the cumulative effects assessment focuses only on a change in surface water quality from the sediment pond discharge, which has the potential to spatially or temporally overlap with currently operating or proposed projects or activities in the Aquatic RSA.

The residual cumulative effects of changes in water quality (as represented by a change in surface water quality from sediment pond discharge) in combination with the effects of other past and present projects or activities in the Aquatic RSA on fish and fish habitat are characterized as follows:

- Duration: *Long-term*, the cumulative change in surface water quality in Alexander Creek upstream of Highway 3 and in Michel Creek downstream of Erickson Creek is detectable from Operations through Post-Closure, but threshold exceedances do not occur continuously throughout this period.

- Magnitude: *Low to Moderate,* this assessment assumes that through the use of best available current technologies, water quality in Michel Creek through the addition of discharges from the Crown Mountain Coking Coal Project and Michel Coal Project will continue to meet the EV MC2 permit limits of 6 mg/L nitrate and future limit of 20 µg/L selenium in lieu of a regional long-term water quality target for Michel Creek. However, 20 µg/L is above the 19 µg/L benchmark from the EVWQP used as a toxicological benchmark for the assessment of aquatic health risks to fish.
- Geographic Extent: *Regional*, the estimated cumulative change in surface water quality occurs within the Aquatic RSA in Michel Creek downstream of the confluence with Erickson Creek; however, cumulative effects are not detectable in the Elk River at Sparwood or further downstream in the Elk River or Lake Koocanusa.
- Frequency: *Continuous,* the potential for adverse cumulative effects to surface water quality will be ongoing because the Project and current mine operations in the Elk Valley are anticipated to discharge to the Elk River and/or its tributaries continuously.
- Reversibility: *Irreversible*, the cumulative change in surface water quality as a result of sediment pond discharge is anticipated to be potentially reversible over long temporal scales as the assimilative capacity of the affected watercourses may provide some natural resilience to the mine-exposed water, resulting in the potential return to baseline conditions once the sediment pond has been decommissioned after water quality objectives have been met. However, the bioaccumulation that may occur within the biological environment operates at a different temporal scale and is therefore interpreted as being irreversible for fish and fish habitat.
- Context: *Neutral,* the receiving environments of Alexander Creek, Michel Creek, and the Elk River are dynamic systems that naturally experience a wide range of flow and water chemistry conditions. However, fish and fish habitat's resiliency to bioaccumulation is not considered to be high, in particular for benthic communities that are not able to escape unfavourable localized conditions. Fish are more mobile and can move to different parts of the water basin when environmental conditions become less favorable in a particular area. Due to this characteristic, the assessment concluded that the context is most likely neutral, neither low nor high.

12.6.6.4 Functional Riparian Disturbance

- The residual cumulative effects of a change in water quantity in combination with the effects of other past and present projects or activities in the Aquatic RSA on fish and fish habitat are characterized as follows:
- Duration: *Long-term to Permanent,* for those areas of riparian habitat that can be restored, reclamation is anticipated to occur throughout the Reclamation and Closure and potentially beyond the Post-Closure phases. All extents of West Alexander Creek (including subsequent downstream segments of Alexander Creek) will experience reduced water levels through to the end of, and likely beyond, the Post-Closure phase.
- Magnitude: *Low*, the loss of riparian habitat is small relative to the total area in the Landscapes and Ecosystems LSA (i.e., 7%) and is less than the "low" benchmark established under the EV-CEMF (Davidson et al., 2018). The abundance of riparian habitat along middle and lower Alexander Creek and Grave Creek is not likely to detectably change as the difference in flow rate from existing conditions is exceptionally low and within a reasonably assumed range of natural variation. Areas of substantially greater change in water flow rates of the retained lower West Alexander Creek are likely to noticeably reduce the extent of typical high water levels that define the riparian area (i.e., range of natural variation).

- Geographic Extent: *Discrete to Regional*, direct loss of riparian habitat will occur within the Project footprint, as well as indirectly due to reduced water flow rates that could marginally exceed the boundary of the Landscape and Ecosystems LSA.
- Frequency: *Once to Continuous*, although general construction and subsequent mine expansion activities will be conducted throughout the Construction and Pre-Production and Operations Phases, removal of the riparian habitat at any location within the Project footprint can only happen once (i.e., when it is removed, it no longer exists). Loss of riparian habitat is anticipated to occur incrementally and sequenced with timing of key milestones of Project construction in the respective catchment areas (e.g., complete isolation of the Project footprint) and seasonal precipitation cycles. Consequently, the residual effect is contemplated to occur regularly, or continuously throughout the Construction and Pre-Production and Operations phases of development.
- Reversibility: *Reversible Long-Term to Irreversible*, the effects of vegetation removal on riparian areas that are buried by the Mine Rock Storage Facility cannot be reversed, nor where reduced flow rates are anticipated to extend beyond the Post-Closure phase. Where infrastructure is completely decommissioned (powerline and explosives storage area) and watercourse reclamation is successful, there is potential for effects to be reversible within the Post-Closure phase.
- Context: *Neutral*, although reduced in area, riparian habitats in the Landscapes and Ecosystems LSA are likely adapted to natural periods of disturbance. Pending successful restoration of contours and drainage profiles, riparian habitat is likely to restore using reasonably simple revegetation techniques (e.g., willow staking).

12.6.7 Determination of Significance of Residual Cumulative Effects

12.6.7.1 EV-CEMF

While the Aquatic Hazard increases with the cumulative assessments developed in Scenario 2 and 3, these increases are moderate (upper moderate in Scenario 3 2038) and decrease in the Future Case models of these scenarios. The cumulative effects on fish and fish habitat, arising from the Project in conjunction with other projects and activities and natural disturbances are therefore found to be not significant.

12.6.7.1.1 Likelihood and Confidence

A characterization of likelihood is not required for residual cumulative effects from Project activities that are determined to be not significant.

The availability of information related to reasonably foreseeable future projects and activities in the Aquatic RSA is limited; as such the significance determination, was assigned a moderate level of confidence for Project Case and Future Cases.

12.6.7.2 Habitat Loss Due to Changes in Water Quantity

No past, present, or reasonably foreseeable future projects or activities that may have an adverse effect on fish and fish habitat are expected to spatially or temporally overlap with the residual effects resulting from instream habitat loss as a result of changes in water quantity, as this residual effect is limited to within the extent of the Project footprint. The cumulative effects assessment conducted in Chapter 10 found that the reductions in flow due to the Main Sediment Pond were not significant. Accordingly, no measurable residual cumulative effects to fish and fish habitat from changes in surface water quantity are predicted beyond the Aquatic LSA boundary, within the remainder of the Aquatic RSA. The residual cumulative effects of habitat loss due to changes in surface water quantity during all phases of the Project on fish and fish habitat were therefore rated not significant.

12.6.7.2.1 Likelihood and Confidence

A characterization of likelihood is not required for residual cumulative effects from Project activities that are determined to be not significant.

Confidence considers the availability and reliability of data and analytical methods used in the assessment of effects. The long-term water balance and loading (GoldSim) model results are considered to provide a reasonable prediction of the magnitude, timing, and extent of surface water quantity effects related to past and present projects and activities in the Aquatic RSA.

The availability of information related to reasonably foreseeable future projects and activities in the Aquatic RSA is limited and, thus, a quantitative assessment of cumulative impacts on surface water quantity was not possible. Accordingly, there is lower confidence for the Future Case. As such, this significance prediction is assigned a moderate level of confidence for the Future Case, but a high level of confidence for the Base Case and Project Case.

12.6.7.3 Changes in Water Quality

The water quality model that was prepared for the Aquatic RSA includes the cumulative interactions with effects from ongoing mining operations in the Elk Valley. The results of the model indicate that the predicted change in surface water quality for the Project Case is negligible to non-detectable when considering monthly median predicted concentrations during all Project phases at multiple nodes in the Aquatic RSA. Estimated mass contributions of the Project to Michel Creek are minimal and water quality in Michel Creek is expected to continue to meet Teck's permit limits in Michel Creek in lieu of a regional water quality target for this watercourse. Water quality in Michel Creek through the addition of discharges from the Crown Mountain Coking Coal Project and Michel Coal Project will continue to meet the EV MC2 permit limits of 6 mg/L nitrate and future limit of 20 µg/L selenium in lieu of a regional long-term water quality target for Michel Creek. The 20 µg/L is above the 19 µg/L benchmark from the EVWQP. However, the water quality effects on fish and fish habitat are likely to be isolated to within the Fish and Fish Habitat LSA, with little to no effect presented outside the Fish and Fish Habitat LSA. Fish and Fish Habitat VCs that occur outside the Fish and Fish Habitat LSA are therefore not anticipated to be impacted by the Project through changes in water quality from the Main Sediment Pond discharge, and the effect is therefore found to be not significant at the Aquatic RSA scale.

Water quality is the main potential pathway for effects to species in the larger Elk River and Lake Koocanusa watershed. Since this assessment looked at sensitive species across the entire watershed that may be most likely impacted by the Project, it is not anticipated that the Project will have a negative impact on any other aquatic species present in the Elk River watershed.

12.6.7.3.1 Likelihood and Confidence

A characterization of likelihood is not required for residual cumulative effects from Project activities that are determined to be not significant.

Confidence considers the availability and reliability of data and analytical methods used in the assessment of effects. The regional water quality model results are considered to provide a reasonable prediction of the magnitude, timing, and extent of surface water quality effects related to past and present projects and activities in the Aquatic RSA. However, water quality in Michel Creek could not be predicted using the water quality model and is based only on a mass comparison using limited publicly available data; therefore, the significance determination for the Project Case is assigned a moderate level of confidence.

The availability of information related to reasonably foreseeable future projects and activities in the Aquatic RSA is limited, particularly for Michel Creek, and, thus, a quantitative assessment of cumulative effects on surface water quality was not possible. As such, this significance determination was assigned a moderate level of confidence for the Future Case.

12.6.7.4 Functional Riparian Disturbance

Using the thresholds for ranking the level of hazard associated with the extent of loss of riparian habitat provided for by the EV-CEMF (Davidson et al., 2018), the reduction of riparian habitat associated with construction of the Project footprint would be classified as a low risk (refer to Chapter 13).

Although the loss of riparian habitat due to changes in surface water quantity may extend beyond the Landscapes and Ecosystems LSA, the majority of the area affected is considered to be negligible relative to the total area of riparian habitat in the Landscape and Ecosystems LSA. Collectively with removals due to logging, clearing, grubbing, and soil salvage activities, cumulative loss of riparian habitat is considered to be of low magnitude, as the areas that cannot be successfully restored during the Reclamation and Closure phase are likely to be less than the EV-CEMF benchmarks used to define moderate to high risk of impact to riparian habitats (i.e., likely to be less than or equal to 10% loss). That said, as the assumed area of impact caused by the Project footprint has been based on conservatively assigned dimensions for each of the Project components, the final anticipated area of impact to riparian habitat is likely to be lower once site specific opportunities for avoidance can be investigated further during the detailed design stage of engineering. For those areas that cannot be avoided and cannot be restored during the Post-Closure phase of the Project, the loss of riparian habitat will be permanent.

The cumulative loss of riparian habitat within the Landscape and Ecosystems LSA is permanent and potentially irreversible; however, following implementation of the recommended mitigation measures, including applicable ecological restoration measures, the magnitude of the residual effect is considered to be low. Consequently, the residual cumulative effect associated with the adverse change in abundance (or area) of riparian habitat is considered to be not significant.

12.6.7.4.1 Likelihood and Confidence

Given that the predicted residual effect to riparian habitat abundance from changes to surface water quantity caused by the Project is considered to be not significant, an evaluation of likelihood is not required.

Given that the exact areas of riparian habitat to be reclaimed have yet to be determined, and that some species may not respond in complete alignment with the assumptions of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3), there is only moderate confidence in the characterized extent and degree of success in the restoration of riparian habitats. As a result, the significance prediction is ascribed a moderate level of confidence; follow-up and monitoring may improve this level of confidence (refer to Chapter 13 for further details on the Follow-up Strategy for landscapes and ecosystems).

Follow-up monitoring and adaptive management will be conducted for the Post-Closure phase, during which any residual areas of riparian habitat not restored to a trajectory in alignment with baseline conditions shall be evaluated in the certainty of their restoration status. Where residual areas of riparian habitat cannot be reclaimed to baseline conditions within the Project footprint, an equivalent area may be restored in the Landscapes and Ecosystems LSA, or a greater area elsewhere in the Landscapes and Ecosystems RSA, proportionately scaled according to the distance from the Project and the degree of restoration required. Specifically, the area to be restored shall increase with distance from the Project. Additionally, the level of restoration effort shall be inversely proportional to the area to be restored, relative to the area that was permanently impacted due to the Project. For example, if the area to be restored elsewhere in the Landscapes and Ecosystems RSA requires half the effort to restore to an equivalent baseline condition, then twice the area of impact shall be restored. All restoration of riparian habitat outside of the Project footprint shall be completed within the Post-Closure phase. The Post-Closure phase shall be extended until the satisfactory completion of restoration of all areas of impact to riparian habitat, whether inside the Project footprint or elsewhere in the Landscapes and Ecosystems RSA.

12.6.8 Summary of Cumulative Effects Assessment

Residual cumulative effects and the selected mitigation measures, characterization criteria, significance determination, and confidence are summarized in Table 12.6-22. As indicated, there are no significant residual cumulative effects to fish and fish habitat anticipated as a result of the Project.

Table 12.6-22: Summary of Cumulative Effects on Fish and Fish Habitat

Residual Cumulative Effect	Fish And Fish Habitat VCs	Project Phases	Mitigation Measures	Summary of Cumulative Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Increased Road Development	• Westslope Cutthroat Trout • Bull Trout • Kokanee • Burbot • Mountain Whitefish • Longnose Sucker	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Constructing suitable watercourse crossings • Maintenance of riparian habitat at crossings and adjacent to roadways to minimize sedimentation • Lower road density and stream crossings where possible and as soon as possible once road becomes inactive • The reduction in road density and stream crossings functionally reduces hazard by reducing angler access, sediment delivery, and stream fragmentation • Remove existing hanging culverts, with thought given to possible negative effects. • Install effective stream crossing structures, such as bridges, where needed • Improve engineering of roads/crossing structures in the future (i.e., for reduced sediment input, reduced fragmentation, etc.) • Maintain or rehabilitate roads to minimize sediment input	Duration: Long-term Magnitude: Low to Moderate Geographic Extent: Regional Frequency: Continuous Reversibility: Reversible long-term Context: Neutral	Not Significant	Moderate

Residual Cumulative Effect	Fish And Fish Habitat VCs	Project Phases	Mitigation Measures	Summary of Cumulative Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
			• Deactivate roads near streams where possible - this could include varied levels of deactivation from cross ditching to minimize hydrologic effects to complete road roll back in highly sensitive areas			
Increased Urban and Recreational Development in the RSA	• Westslope Cutthroat Trout • Bull Trout • Kokanee • Burbot • Mountain Whitefish • Longnose Sucker	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Development of green areas/no development zones • Establish buffer zones • Improve engineering of roads/crossing structures in the future (i.e., for reduced sediment input, reduced fragmentation, etc.) • Appropriate management of angling recreational licensing and zoning to mitigate the increased pressure on popular angling species • Educational and awareness raising initiatives to protect and promote effective management and utilization of freshwater resources and fish habitat	Duration: Long-term Magnitude: Low to Moderate Geographic Extent: Regional Frequency: Continuous Reversibility: Reversible long-term Context: Neutral	Not Significant	Moderate

Residual Cumulative Effect	Fish And Fish Habitat VCs	Project Phases	Mitigation Measures	Summary of Cumulative Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Increased Natural Disturbance Due to Fire and Insect Outbreaks	• Westslope Cutthroat Trout • Bull Trout • Kokanee • Burbot • Mountain Whitefish • Longnose Sucker	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Planting post-fire • Post-fire salvage harvest, where the goal is to not further disturb riparian areas or significantly affect runoff regimes • Forests subjected to fire and pest disturbance are left to regenerate naturally • Permitting for proposed development should acknowledge nearby pest outbreaks and the potential direction of infestation movement (particularly for spruce budworm). These areas could be targeted for harvest, if appropriate • Carefully designed salvage harvest to help mitigate the spread of pests	Duration: Long-term Magnitude: Low to Moderate Geographic Extent: Regional Frequency: Continuous Reversibility: Reversible long-term to Irreversible Context: Neutral	Not Significant	Moderate
Habitat Loss Due to Changes in Water Quantity	• Westslope Cutthroat Trout • Bull Trout • Kokanee • Burbot • Mountain Whitefish • Longnose Sucker • Benthic Invertebrates	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Site Water Management Plan • Ongoing monitoring to maintain release volumes downstream supporting fish and fish habitat functionality • Site reclamation • Reclamation Monitoring	Duration: Long-term Magnitude: Low Geographic Extent: Local Frequency: Continuous Reversibility: Irreversible Context: High	Not Significant	Moderate

Residual Cumulative Effect	Fish And Fish Habitat VCs	Project Phases	Mitigation Measures	Summary of Cumulative Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Changes in Water Quality	• Westslope Cutthroat Trout • Bull Trout • Kokanee • Burbot • Mountain Whitefish • Longnose Sucker • Benthic Invertebrates	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Diverting clean, non-contact water away from the sediment ponds; where possible • Appropriate sizing of sediment ponds to minimize seepage losses and convey runoff during storm events • Treating water prior to discharge as required to minimize calcite formation • Limiting the mine disturbance footprint through Project design and progressive reclamation • Continued monitoring • Working with other proponents, the provincial government, and the KNC to establish a regional monitoring program and long-term water quality targets for Michel Creek • Collaborating with other proponents to ensure these targets are met through a combination of Project-specific and regional mitigation measures • Teck is currently implementing the EVWQP,	Duration: Long-term Magnitude: Low –to Moderate Geographic Extent: Regional Frequency: Continuous Reversibility: Irreversible Context: Neutral	Not Significant	Moderate

Residual Cumulative Effect	Fish And Fish Habitat VCs	Project Phases	Mitigation Measures	Summary of Cumulative Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
			which was developed to mitigate the effects of mining operations on chemical water quality in the Elk Valley			
Functional Riparian Disturbance	• Westslope Cutthroat Trout • Bull Trout • Kokanee • Burbot • Mountain Whitefish • Longnose Sucker • Benthic Invertebrates	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Delay construction areas of mine components until ready to mine • Project design optimization • Minimum design standards for water management infrastructure • Energy dissipation devices • A riparian planting program is available to help mitigate agricultural riparian disturbance, but it is unknown at this time to what extent the program is being implemented	Duration: Long-term to Permanent Magnitude: Low Geographic Extent: Discrete to Regional Frequency: Once to Continuous Reversibility: Reversible long-term to Irreversible Context: Neutral	Not Significant	Moderate

12.7 Follow-up Strategy

As required by *Canadian Environmental Assessment Act*, 2012, a follow-up program must be defined to verify the effects predictions or the effectiveness of mitigation. Therefore, a comprehensive surface water quality monitoring program will be developed and implemented to facilitate an ongoing examination of surface water quality within the receiving watercourses downstream of the Project footprint, in addition to reference sites upstream of the Project. This follow-up strategy focuses on the implementation of an AEMP, which will include surface water quality, sediment, benthic invertebrate, and fish tissue monitoring (in fish bearing watercourses). The AEMP will include regular surface water quality monitoring at the locations identified in Chapter 11, Section 11.7 and further detailed in the Site Water Management Plan (Chapter 33, Section 33.4.1.8) and Fish and Fish Habitat Management Plan (Section 33.4.1.5) and will include the collection of both *in-situ* field parameters and water samples for laboratory analysis.

As an addition to the AEMP, a fish and fish habitat specific monitoring program (Chapter 33, Section 33.4. 1.5) will be developed to assess fish communities and fish habitat. Through continued monitoring, changes in populations and habitat can be more readily detected and adaptive management strategies applied. The aim of the Fish and Fish Habitat Management Program is to assess mitigations are effective and will provide an adaptive management framework to support early detection of effects, and adequate response procedures for protecting fish and fish habitat.

12.8 Summary and Conclusions

The Project has the potential to affect fish and fish habitat in the Fish and Fish Habitat LSA. The Project is anticipated to result in 31,928 m^2 of instream habitat loss due to mine design in West Alexander Creek, 3,237 m^2 of habitat loss due to changes in water quantity below the Main Sediment Pond in West Alexander Creek, and an estimated 36.13 ha of associated functional riparian habitat removal. The total instream habitat loss in West Alexander Creek is therefore estimated at 35,165 m^2 and accounts for all fish bearing habitat in West Alexander Creek. Limited offsetting opportunities exist in the Fish and Fish Habitat LSA, with most of the available offsetting measures currently located in the Aquatic RSA. As a result, the residual effects of instream habitat loss due to mine design and development and habitat loss due to changes in water quantity were found to be significant for Westslope Cutthroat Trout. Further consultation with DFO and Indigenous stakeholders are required to assess the feasibility of an offsetting strategy.

Changes in water quality were found to be not significant for both pathways of effects to fish and fish habitat, i.e., increased TSS and increased metal concentrations. The water quality model predictions were found to have no significant effect to fish and fish habitat. Based on results provided in Chapter 11 and Chapter 22, the possibility for bioaccumulation exists but is found to be not significant as it relates to aquatic wildlife. Based on the results from the water quality model and the human health and ecological risk assessment, there is no significant threat to fish and fish habitat presented.

The potential of the Project to result in fish mortality was found to be not significant. This is due to the ability of the Project to mitigate all potential mortality pathways around aquatic habitats during all Project phases. The primary mitigative measure will be the salvage of fish from all directly impacted areas. In addition, a permanent fish barrier will need to be designed and installed at the confluence of West Alexander and Alexander Creeks.

The potential of the Project to result in a change in fishing pressure due to greater accessibility to the Project area was found to be not significant, as minimal recreational angling use is anticipated in West Alexander Creek, and access to Alexander Creek will not be increased due to the Project. The primary mitigation measures include implementing the Access Management Plan, including the establishment of No Unauthorized Entry (NUE) areas, securing access areas, and coordination with local conservation enforcement should increases in recreational fishing be observed by NWP employees.

The effect of blasting on fish and fish habitat VCs was found to be not significant. All potentially effects will be fully mitigated by adjusting blasting timing and volume of explosives used. This ensures that all blasts throughout the Project will remain below the 13 mm/s threshold for the protection of fish and fish habitat.

Potential effects to changes in streambed structure were found to be not significant. Three pathways of effect were identified: calcite, increased sediment, and changes in geomorphology. Calcite is anticipated to be fully mitigated through the addition of anti-scalants when and as needed throughout all Project phases. Sediment releases will be mitigated through the Main Sediment Pond at the downstream end of West Alexander Creek and is therefore not anticipated to substantially impact fish and fish habitat. The geomorphology assessment (Appendix 12-A) found that ALE7 has high sensitivity to changes in geomorphology due to the braided characteristic of this reach and the lack of confinement. The section of Alexander Creek below the confluence with West Alexander Creek is less resilient to changes in flow and sediment load and could become aggraded. While the effects of potential changes in geomorphology do not pose substantial risk to fish and fish habitat, continued monitoring will be required to confirm sediment and erosion plans are effective in mitigating the potential risk posed by the Project activities to geomorphology below the confluence.

A cumulative effects assessment was undertaken for the fish and fish habitat VCs because there is a possibility that potential Project residual effects may remain after the implementation of proposed mitigation measures. The potential residual effects identified include instream habitat loss due to mine design and development; habitat loss due to changes in water quantity; changes in water quality; changes in streambed structure; and functional riparian disturbance. The cumulative effects assessment involved the identification of past, present, and reasonably foreseeable future projects or activities followed by an evaluation to characterize cumulative residual effects on fish and fish habitat in the Aquatic RSA under various temporal cases (Base Case, Project Case, and Future Case). The assessment of cumulative effects under the Project Case included all past and present projects/activities that have the potential to contribute to adverse cumulative effects on fish and fish habitat, while the Future Case considers the potential for substantial overlapping of Project effects with those of reasonably foreseeable future projects or activities.

No past, present, or reasonably foreseeable future projects or activities that may have an adverse effect on fish and fish habitat are expected to spatially or temporally overlap with the residual effects resulting from instream habitat loss due to mine design and development and changes in streambed structure, as these residual effects are limited to within the extent of the Project footprint. The habitat loss is anticipated to be compensated following DFO's strategy for offsetting instream habitat losses that result from HADD. The assumption is therefore that, under these regulatory habitat loss restrictions, no other project or activity in the Aquatic RSA would result in habitat loss due to HADD. Given that there is no anticipated spatial and temporal overlap between these residual effects and those of other past, present, and reasonably foreseeable future projects or activities, it follows that cumulative effects are not likely to occur. The cumulative effects assessment therefore focused only on the following residual effects of the Project: habitat loss due to changes in water quantity, changes in water quality, and functional riparian disturbance in the Aquatic RSA. In addition, the following effects of other projects and activities occurring or which may occur in the Aquatic RSA were evaluated as overlapping with the effects of the Project: riparian disturbance, as driven by landscape-scale disturbances associated with forestry harvesting; road development associated with the construction and operation of the Project and after the Project has been decommissioned; increased urban and recreational development in the Aquatic RSA; and increased natural disturbance due to fire and insect outbreaks.

Future disturbance was simulated under the following scenarios: 1) The direct effects of the proposed Project development at maximum build-out and Post-Closure, 2) Project maximum build-out with cumulative effects, and 3) Project maximum build-out with cumulative effects and natural disturbance. The Aquatic Hazard for Scenario 1 increases upon peak mining at 2038 and decreases with mine reclamation at 2055. Compared to an aging forest alone, Aquatic Hazard score would have been 0.58 without mining. Mining acts to increase the Hazard in the AW by 0.04 points. In Scenario 2, most AWs demonstrate increased Aquatic Hazard upon peak mining at 2038 and decreased hazard at 2055 after mine reclamation. Scenario 3 builds off Scenario 2 by adding fire and insect outbreak natural disturbances. Most AWs demonstrate increases in Aquatic Hazard at peak mining and either decreases or have unchanged hazard at 2055. While the Aquatic Hazard increases with the cumulative assessments developed in Scenario 2 and 3, these increases are moderate (upper moderate in Scenario 3 2038) and decrease in the Future Case models of these scenarios. The cumulative effects on fish and fish habitat, arising from the Project in conjunction with other projects and activities and natural disturbances are therefore found to be not significant.

The cumulative effects assessment focuses only on a change in surface water quality from the sediment pond discharge, which has the potential to spatially or temporally overlap with currently operating or proposed projects or activities in the Aquatic RSA. The water quality model that was prepared for the Aquatic RSA includes the cumulative interactions with effects from ongoing mining operations in the Elk Valley. The results of the model indicate that the predicted change in surface water quality for the Project Case is negligible to non-detectable when considering monthly median predicted concentrations during all Project phases at multiple nodes in the Aquatic RSA. Estimated mass contributions of the Project to Michel Creek are minimal and water quality in Michel Creek is expected to continue to meet Teck's permit limits in Michel Creek in lieu of a regional water quality target for this watercourse. Water quality is the main potential pathway for effects to species in the larger Elk River and Lake Koocanusa watershed. Since this assessment looked at sensitive species across the entire watershed that may be most likely impacted by the Project, it is not anticipated that the Project will have a negative impact on any other aquatic species present in the Elk River watershed.

Using the thresholds for ranking the level of hazard associated with the extent of loss of riparian habitat provided for by the EV-CEMF (Davidson et al., 2018), the reduction of riparian habitat associated with construction of the Project footprint would be classified as a low risk. The cumulative loss of riparian habitat within the Landscape and Ecosystems LSA is permanent and potentially irreversible; however, following implementation of the recommended mitigation measures, including applicable ecological restoration measures, the magnitude of the residual effect is considered to be low. Consequently, the residual cumulative effect associated with the adverse change in abundance (or area) of riparian habitat is considered to be not significant.

The water balance and loading model that was prepared for the Aquatic RSA includes the cumulative interactions with effects from ongoing mining operations, forestry activities, and hydroelectric dams in the Elk Valley. The results of model indicate that the predicted change in surface water quantity for the Project Case is negligible to non-detectable (i.e., less than 1% compared to baseline) when considering mean annual and mean monthly flows during all Project phases at multiple nodes in the Aquatic RSA. No measurable residual cumulative effects to fish and fish habitat from changes in surface water quantity are predicted beyond the Aquatic LSA boundary, within the remainder of the Aquatic RSA. The residual cumulative effects of habitat loss due to changes in surface water quantity during all phases of the Project on fish and fish habitat were therefore rated not significant.

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