5.1 Fisheries and Freshwater Habitat

5.1.1 Introduction

This Section of the Environmental Assessment Certificate (EAC) Application/Environmental Impact Statement (hereafter referred to as the EA.) has been prepared by Golder Associates Ltd. (Golder). It addresses the direct, indirect and induced effects of the Proposed BURNCO Aggregate Project (hereafter referred to as the 'Proposed Project') on Valued Components (VCs) associated with Fisheries and Freshwater Habitat. The processes used to select freshwater fish and fish habitat as a VC are described, along with assessment boundaries and existing conditions relevant to freshwater fish and fish habitat. This section provides an evaluation of Proposed Project-related interactions, identification of potential effects, measures to mitigate potential effects, and identification of expected residual effects after effective implementation of mitigation measures. It then provides a determination of the significance of the residual effects.

5.1.2 Regulatory and Policy Setting

The following sections provide a summary of the regulatory and policy setting of the Proposed Project as it relates to Fisheries and Freshwater Habitat.

5.1.2.1 The Federal Fisheries Act and British Columbia Fish Protection Act

The Government of Canada is responsible for managing fisheries resources in Canada through the *Fisheries Act* and its supporting regulations. The *Fisheries Act* (1985) protects the quality and integrity of fish habitats in commercial, recreational, and Aboriginal (CRA) fisheries. Recent changes to sections 32 and 35 of the Act in 2012 prohibit activity that may cause serious harm to fish, defined as the death of fish or any permanent alteration to, or destruction of, fish habitat. In addition, the BC *Fish Protection Act* (*Fish Protection Act 1997*) has been subsumed by the *Water Sustainability Act* (2016) with the exception of sections focused on Riparian Areas which are now covered under the new Riparian Areas Protection Act; these acts together now protect fish species and their habitats residing in freshwater. The *Wild Salmon Policy* (1995) addresses the maintenance of healthy and diverse salmon populations and their habitats and manages fisheries for sustainable benefits.

5.1.2.2 The Water Sustainability Act

In the Province of British Columbia legislation of matters relating to use and flow of surface water and groundwater, and protection of water resources are governed by the *Water Sustainability Act* (WSA) (*Water Sustainability Act* SBC 2014). On February 29, 2016, the Regulations of the *Water Act* (RSBC 1996) were repealed and the WSA was brought into force, along with five new regulations, including the Water Sustainability Regulation (B.C. Reg 36/2016), the Water Sustainability Fees, Rentals and Charges Tariff Regulation (B.C. Reg. 37/2016), and the new Groundwater Protection Regulation (GWPR) (B.C. Reg. 39/2016). The Water Sustainability Regulation includes requirements for the licensing, diversion and use of groundwater and surface water to protect water resources and ecosystems, while the GWPR specifically addresses protection of the groundwater resource and identifies requirements for the construction of wells (discussed in detail in Volume 2, Part B – Section 5.6).

5.1.2.3 The Federal Species at Risk Act

The *Species at Risk Act* protects at-risk wildlife species by mandating recovery planning and, in some cases, prohibiting harm to individual animals or their habitats (*Species at Risk Act* (S.C. 2002, c. 29)). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is a scientific panel that assesses and ranks species status based on conservation concern (i.e., extinct, extirpated, endangered, threatened, special concern, not at risk, or data deficient). In BC, species at risk include those species listed under Schedule 1 of SARA or by COSEWIC and is presented by the CDC, which, under support by MoE, compiles and relays data on plants, animals, and ecosystems at risk.

5.1.3 Assessment Methodology

This section provides a description of the assessment methodology used in preparing the EA related to Fisheries and Freshwater Habitat.

5.1.3.1 Value Component (VC) Selection and Rationale

The assessment of potential effects of the Proposed Project on Fisheries and Freshwater Habitats is based on specific valued components (VCs). In identifying VCs, consideration was given to issues and concerns from Aboriginal groups and regulatory authorities (i.e., BCEAO, DFO, and the CEA Agency), in addition to professional judgment. The approach to selecting VCs was consistent with the Guideline for the Selection of VCs (BCEAO 2013) along with requirements under the former *Canadian Environmental Assessment Act* (CEAA 1992). VC were excluded from the assessment for the following reasons:

- The candidate VC is not known to be present (based on information review) or has not been observed (based on field work) in the study areas;
- The Proposed Project does not have the potential to interact with the candidate VC; and/or
- The candidate VC is better represented by another VC or can be effectively considered within the assessment of another VC (e.g., is it already duplicated by another species, economic activity).

Additional details regarding the methods used to exclude VCs is provided in Part B, Volume 2 – Section 4.2.4.

Selected Fisheries and Freshwater Habitat VCs are:

- Anadromous Coho Salmon (*Oncorhynchus kisutch*), Chum Salmon (*Oncorhynchus keta*), Pink Salmon (*Oncorhynchus gorbuscha*) and Coastal Cutthroat Trout (*Oncorhynchus clarki clarki*) and their habitats; and
- Freshwater resident Coastal Cutthroat Trout (*Oncorhynchus clarki clarki*) and their habitat.

The VCs identified, rationale and measurable indicators used to evaluate Proposed Project-related effects for Fisheries and Freshwater Habitats are provided in **Table 5.1-1**. Candidate VCs were identified for the Proposed Project but were excluded from the assessment based on the criteria outlined above. A summary of candidate VCs and rationale for their exclusion in the assessment is presented in **Table 5.1-2**.

Table 5.1-1: Valued Components and Measurable Indicators

Valued Component	Rationale	Measurable Indicators
Anadromous Chum, Coho, Pink and Cutthroat Trout and their habitats	Fish species are appropriate "indicators" for the overall Freshwater system. Anadromous Chum, Coho and Pink Salmon and Cutthroat Trout are appropriate indicators of seasonal freshwater fish habitats and their use in the Proposed Project Area. VCs were selected that ranked the highest through screening by the following attributes: ▪ Distribution within the Proposed Project Area; ▪ Regulatory status (species at risk); ▪ Selectivity of habitat requirements; ▪ Position in the food chain; ▪ Commercial and recreational economic importance; and ▪ Traditional importance to aboriginal groups.	▪ Freshwater habitat quantity and quality ▪ Freshwater quality ▪ Fish distribution ▪ Abundance of fish within available freshwater habitats
Resident Cutthroat Trout and their habitats	Cutthroat Trout are a resident fish species in watercourses within the Proposed Project Area and an appropriate indicator of the year-round habitat use and conditions. Cutthroat Trout have recreational and economic importance as well as traditional importance to aboriginal groups.	

Table 5.1-2: Rationale for the Exclusion of Valued Components: Fisheries and Freshwater Habitat

Issue	Candidate VCs	Rationale for Exclusion
Fisheries and Freshwater Habitat	Anadromous chinook salmon and their habitats	Observations of chinook salmon within the study area were infrequent. The general habitat requirements of chinook salmon are similar to that of other salmonids that are being considered in the assessment therefore the effects on anadromous Chinook Salmon can be covered within the assessment of the other salmonid VCs.
	Steelhead (rainbow trout) and their habitats	Observations of steelhead within the study area were infrequent. The general habitat requirements of steelhead are similar to that of other salmonids that are being considered in the assessment therefore the effects on steelhead and their habitats can be covered within the assessment of the other salmonid VCs.

5.1.3.2 Assessment Boundaries

5.1.3.2.1 Spatial Boundaries

The spatial boundaries for the EA have been selected to take into account the physical extent of the Proposed Project and the physical extent of Project-related effects. The specific study areas for Fisheries and Freshwater Habitat are provided in Table 5.1-3 and shown in Figure 5.1-1.

Table 5.1-3: Spatial Boundaries

Study Area	Description
Local Study Area (LSA)	▪ The lower reach of the McNab Creek mainstream, which extends from its mouth upstream to the northern edge of the Project Area. The upstream boundary was established based on where the Project had the potential to affect stream flow;

Study Area	Description
	▪ Harlequin Creek; ▪ Watercourses, groundwater-fed watercourses, and other water-bodies (including wetlands as defined by the *Water Sustainability Act*) located within the mine footprint upstream to a natural fish passage barrier; and ▪ Intertidal and subtidal areas within the Proposed Project Area including the proposed marine terminal facilities in Thornbrough Channel (barge loader, conveyor and mooring buoy).
Regional Study Area (RSA)	▪ All mainstem reaches of McNab Creek and tributary catchments of the McNab Creek watershed; and ▪ Marine intertidal and shallow subtidal habitat areas potential affected by Proposed Project activities.

5.1.3.2.2 Temporal Boundaries

The temporal boundaries established for the assessment of adverse Proposed Project effects on freshwater fish and fish habitat encompass three major Proposed Project phases, as defined in Volume 2, Part A - Section 2.0 of the EAC Application/EIS:

- Project construction – up to 2 years;
- Project operations – 16 years; and
- Project reclamation and closure – on-going and 1 year beyond operations.

See Volume 2, Part A - Section 2.0 for a description of activities proposed during these phases of development.

5.1.3.2.3 Administrative Boundaries

There are no administrative boundaries proposed for the Fisheries and Freshwater Habitat assessment.

5.1.3.2.4 Technical Boundaries

There are no technical boundaries proposed for the Fisheries and Freshwater Habitat assessment.

5.1.3.3 Assessment Methods

5.1.3.3.1 Existing Conditions

Fish habitat surveys were conducted from 2009 to 2013 to provide a greater understanding of fish and fish habitat in watercourses in the LSA. Fish and fish habitat surveys included mapping watercourses and conducting fish habitat assessments, which included collecting information regarding habitat characteristics and quality for each watercourse. The surveys were also used to assess fish species assemblage and distribution and characterize seasonal habitat use. Surveys focused on watercourses in the LSA, and along the foreshore and intertidal habitats. Further information on the data collection methods used in the baseline asssessment including specific

methodologies, standards applied, and the specfic locations sampled is presented in the Fish and Fish Habitat Baseline Report presented in Volume 4, Part G – Section 22.0: Appendix 5.1-A.

5.1.3.3.2 Identifying Project Interactions

A preliminary evaluation of identified interactions between the various physical works and activities and the selected VCs across all spatial and temporal boundaries of the Proposed Project was undertaken to characterize interactions as:

a) Positive, none or negligible, requiring no further consideration; or

b) Potential effect, requiring further consideration and possibly additional mitigation.

This evaluation is presented in Section 5.1.5. Rationale is provided for all determinations of no or negligible interaction where no further consideration is required. For those Proposed Project-VC interactions that may result in potential effects requiring further consideration, the nature of the effects (negative or positive) arising from those interactions is described. Potential effects include direct, indirect and induced effects.

Methods used to assess potential effects on VCs related to fish and fish habitat, including loss of habitat, changes in surface water hydrology and potential for fish mortality, have been described in the sections below. Changes in water quality and aquatic health effects are assessed in Volume 2, Part B - Section 5.5: Surface Water Resources.

5.1.3.3.2.1 Loss of Habitat

5.1.3.3.2.1.1 Removal of Upper Segment of WC 2

The potential for Proposed Project design to affect freshwater fish habitat was assessed by relating the Proposed Project design footprint to the fish habitat present in the LSA. Habitat mapping documented the type, quantity and quality of fish habitat in watercourses in the LSA. For the purposes of the assessment, a stream gradient of greater than 25% was considered a fish barrier (Norris and Mount 2009; B.C. Ministry of Forests 1998). Fish distribution information was plotted separately for resident and anadromous fish.

The amount of habitat available in the RSA (McNab watershed) for anadromous Coho, Chum and Pink Salmon and Cutthroat Trout, and resident Cutthroat Trout, was calculated as stream length and compared to the total stream length affected by the Proposed Project Area in the LSA. All Watercourses in the LSA were classified as being either fish bearing or non-fish bearing.

The total area of potential habitat loss was derived from the length of watercourses affected and the channel width measurements taken in the field. For perennial or permanent streams, surface area losses were provided for individual habitat units, derived from detailed habitat mapping information based on stream length and channel widths. The habitat quality of impacted fish-bearing, permanent watercourses was assessed by evaluating the suitability of affected habitat units for VC species at various life stages.

5.1.3.3.2.1.2 Changes in Flows

As described in Volume 2, Part B - Section 5.5: Surface Water Resources, predicted average annual flows of groundwater were used to estimate changes to the surface water flows for all fish-bearing watercourses in the LSA. Changes in flow of less than 3% of the base case condition were lower than the resolution of the hydrogeology model; therefore, only predicted changes in flow greater than 3% from the base case condition were evaluated for potential impacts to fish and fish habitat.

Habitat affected by changes in flow was quantified as changes in wetted surface area. As part of the hydrological assessment, changes in wetted width in watercourses were calculated corresponding to the modelled changes in flow. Field data recorded during detailed habitat mapping including bankfull width, wetted width, bankfull depth, channel length, and substrate composition. This data was used to estimate channel cross-sectional area. Flow predictions were used to calculate wetted widths in the baseline condition, during operations and at the end of mining (year 16).

Hydrologic methods are commonly applied to assess changes in flow regime and identify instream flow thresholds for fish populations and other environmental resources (Hatfield et.al. 2003). Baseline conditions and predicted loss or gain of flow in watercourses was compared to baseline conditions as an indicator of relative fish habitat impact.

5.1.3.3.3 Evaluating Residual Effects

Potential Project-related residual effects were characterized to determine the significance of these effects for each VC. The characterization of residual effects was undertaken following application of appropriate mitigation measures.

Potential residual effects were characterized using the following criteria:

- **Context** – the current and future sensitivity and resilience of the VC to change caused by the Proposed Project;
- **Magnitude** – the expected size or severity of the residual effect;
- **Extent** – the spatial scale over which the residual physical, biological and/or social effect is expected to occur;
- **Duration** – the length of time the residual effect persists;
- **Reversibility** – indicating whether the effect is fully reversible, partially reversible, or irreversible; and
- **Frequency** – how often the residual effect occurs.

The likelihood of potential residual effects occurring was also characterized for each VC using appropriate quantitative or qualitative terms. To derive a likelihood rating that indicates the probability of a certain effect to occur, implementation of mitigation measures were considered. For example, the likelihood of a certain effect is low, if there is a low potential of the event leading to the effect to occur, or if there are effective controls in place that can eliminate or reduce the magnitude or frequency of the effect. The following criteria were used to define likelihood:

- Low - likelihood of occurrence (0 to 40%) – Residual effect is possible but unlikely;
- Medium - likelihood of occurrence (41 to 80%) - Residual effect may occur, but is not certain to occur; and
- High - Likelihood of occurrence (81% to 100%) - Residual effect is likely to occur or is certain to occur.

5.1.3.3.4 Evaluating Significance of Residual Effects

The significance of potential residual adverse effects were determined for each VC based on the residual effects criteria set out above. In the determination of significance, particular consideration was given to magnitude, geographic, context and duration since together they are the key criteria for understanding change in relation to fish and freshwater habitat. The rationale and determinations of the significance of potential residual effects on VCs are provided in Section 5.1.5. The criteria for determining significance are based on the *Fisheries Act* and its specific prohibition of any activity that will cause "*serious harm to fish*". Under the Act, serious harm to fish is defined as the "*death of fish or any permanent alteration to, or destruction of, fish habitat*". The level of each residual effect has been rated as negligible, not significant, or significant, defined as follows:

- **Negligible (and Not Significant)** - Effects will have little to no detectable or measureable effects on the VC and its subcomponents. Detectable or measurable effects may include fish mortality or changes in; fish presence/absence, fish condition, fish abundance, quality and quantity of habitat, and habitat availability for spawning, rearing, foraging, and holding. Negligible effects are not carried forward to the residual effects characterisation or significance section or the cumulative effects assessment;
- **Not significant** - Effects are greater than negligible but do not meet the definition of "significant". Not significant effects are carried forward to the cumulative effects assessment; or
- **Significant** - Effects are any action or process that may lead to the death of fish or any permanent alteration to, or destruction of fish habitat. Significant effects are carried forward to the cumulative effects assessment and are considered for each VC.

5.1.3.3.5 Level of Confidence

The level of confidence is based on expert opinion and the level of uncertainty associated with both the significance and likelihood parameters. The level of confidence reflects the best possible residual effect predictions. The determination of confidence will be based on the following:

- Scientific certainty relative to the quantification of the effect, including the quality and or quantity of data and the understanding of effect mechanisms;
- Scientific certainty relative to the effectiveness of the proposed mitigation; and
- Professional judgment from prior experience predicting effects and effective implementation of proven mitigation measures.

Level of confidence was characterized:

- Low: Limited evidence is available, models and calculations are highly uncertain, and/or evidence about potential effects is contradictory;
- Moderate: Sufficient evidence is available and generally supports the prediction; and
- High: Sufficient evidence is available and most or all available evidence supports the prediction.

Table 5.1-4: Criteria for Characterizing Potential Residual Effects: Fisheries and Freshwater Habitat

VC	Context	Magnitude	Extent	Duration	Reversibility	Frequency
Anadromous Chum, Coho, and Cutthroat Trout and their habitats **Resident freshwater Cutthroat Trout and their habitats**	Context refers primarily to the sensitivity and resilience of the VC to change caused by the Proposed Project: **Resilient:** The system has low susceptibility to potential changes caused by the Proposed Project; **Moderately Resilient:** The system has moderate susceptibility to potential changes caused by the Proposed Project; or **Sensitive:** The system is susceptible to potential changes caused by the Proposed Project.	**Negligible**: Proposed Project is likely have no measurable effect on the relative abundance of fish populations or the function of fish habitat; **Low**: Proposed Project is likely to result in small effects on the relative abundance of fish populations or the function of non-critical fish habitat; **Medium**: Proposed Project is likely to result in moderate effects on the relative abundance of fish populations or the function of moderate or high-quality fish habitat; or **High**: Proposed Project is likely to result in large effects on relative abundance of fish populations, or measureable effects on provincially-listed or SARA-listed fish species, or the function of limiting habitat for provincially-listed or SARA-listed fish species.	**Local**: Effect limited to LSA; **Regional**: Effect limited to RSA including the LSA; or **Beyond-Regional**: Effect beyond the RSA.	**Short-term:** Residual effect occurs for less than one year; **Medium-term:** Residual effect occurs for one fish life-cycle or one to five years; **Long-term**: Residual effect occurs for multiple fish life-cycles or six to twenty-five years; or **Permanent:** Residual effect occurs and is unlikely to recover after Proposed Project closure.	**Fully reversible:** Effect reversible with reclamation and/or over time; **Partially Reversible:** Effect can be reversed partially; or **Irreversible:** Effect irreversible and cannot be reversed with reclamation and/or over time.	**Low:** Occurs rarely or during a specific period; **Medium:** Occurs intermittently; or **High:** Occurs continuously.

5.1.4 Baseline Conditions

This section describes the existing conditions of fish and freshwater habitat, and is based on the results of baseline studies, literature review and synthesis of existing background information on fish habitat, distribution, and abundance within the wider McNab watershed (RSA) and the Proposed Project Area (LSA). Figure 5.1-2 shows all of the watercourses described and Figure 5.1-3 shows fish distribution within the LSA. A full description of fish and fish habitat baseline conditions is included in Appendix 5.1-A (Volume 4, Part G – Section 22.0).

5.1.4.1 Traditional Ecological and Community Knowledge Incorporation

TEK/CK information was gathered from a Project-specific study undertaken by *Sḵwx̱wú7mesh* (Squamish Nation) and from publicly-available sources. The TEK/CK information available at the time of writing was used to inform existing conditions and this effects assessment.

TEK/CK informed BURNCO's understanding of fisheries and freshwater habitat. The main sources of this information include:

- Occupation and Use Study (OUS) undertaken by Skwxwú7mesh (Traditions 2015 a, b).
- An expert report produced on behalf of Tsleil-Waututh Nation for another project (Morin 2015).
- Regulatory documents for other projects in close proximity to the Proposed Project Area (e.g., Eagle Mountain – WGP 2015 a,b; PMV 2015; WLNG 2015).
- Information maintained by Fisheries and Oceans Canada (DFO 2001).

For a full summary of Aboriginal Group use and occupancy of Howe Sound refer to Part C.

TEK/CK sources available at the time of writing provided limited specific information on harvest locations, abundance or quality of anadromous fish, or other environmental knowledge regarding anadromous fish or freshwater habitat in the RSA, including changes to these resources over time. Following is a general discussion of Aboriginal Groups' harvesting of anadromous fish within Howe Sound.

Sḵwx̱wú7mesh report harvesting all five species of salmon, steelhead and Dolly Varden char in freshwater areas. *Kw'ech'tenm*, a village site on McNab Creek, was a significant resource area for *Sḵwx̱wú7mesh* ancestors. The name *kw'ech'tenm* means fish cutting, which may also refer to the north side of the valley being the source location for the slate that was used to make fish cutting knives. Salmon and trout were harvested in McNab Creek and throughout Thornbrough Channel (Traditions 2015 a, b). Tsleil-Waututh Nation also reports harvesting of salmon in Howe Sound (WLNG 2015). *Sḵwx̱wú7mesh* has noted that the ecosystem at *kw'ech'tenm* (McNab Creek) is only just recovering from the impacts of prior forestry activity, and mitigation that would restore habitat for impacted fish species should be considered. Salmon and trout species present in the LSA were considered in the assessment of effects on fisheries and freshwater habitat.

5.1.4.2 RSA - McNab Creek Watershed

McNab Creek is a small, steep, coastal river system flowing for approximately 13 kilometres southeast into the north end of Thornbrough Channel in Howe Sound. The watercourse primarily flows as a sinuous and frequently confined or confined channel, with occasional segments entrenched in bedrock. Mainstem reaches typically have channel widths of 10 to 20 meters, with gradients of 4 to 9 %, a cascade-pool morphology, and predominantly boulder and cobble substrates (Whelan 1999). McNab Creek has a relatively short segment (< 2 kilometres) of low gradient near its mouth which is similar to many coastal river systems. In this low gradient segment, the watercourse flows through a meandering and incised but unconfined channel with gravel and cobble bars, and off-channel areas.

McNab Creek has a catchment area of approximately 6,300 hectares. The watershed has been heavily logged over the last one hundred and twenty years along both sides of the mainstem McNab Creek for most of its length. A hydroelectric transmission line right-of-way (RoW) crosses the McNab valley and the Proposed Project Area near the low gradient segment of McNab Creek. A Terasen gas pipeline RoW extends along the main road on the west side of the valley to Box Canyon. A small strata-lot residential housing development is present on the east bank of McNab Creek near its mouth.

There are no glaciers and few alpine areas of late-persisting snow within the watershed. In addition, lake systems or water storage in the watershed is not considerably present. The region receives an average of 3,120 mm of precipitation a year, with the heaviest precipitation typically occurring during the months of October through March, and the average monthly precipitation ranging between 300 to 450 mm. Subsequently, the highest flows in McNab Creek occur during the autumn and winter months, corresponding with the timing of greatest precipitation. Flow increases abruptly with the onset of the autumn rains in September and October, typical of coastal watersheds. Large tributaries in the McNab Creek watershed include:

- Box Canyon Creek (WSC 900-106300-18700), Marty Creek, and Cascara Creek (WSC 900-106300-63600) on the western slopes;
- Lost Lake Creek (900-106300-03600) on the eastern slope; and
- Two unnamed watercourses (WSC 900-106300-45400, and 900-106300-6120000) that flow from both east and west slopes.

These larger tributaries typically have short low gradient reaches from their confluence with McNab Creek mainstem and then climb steeply to high elevations. Smaller, low-order tributaries flow down steeply sloped valley walls and are often indistinct or steep chutes and cascades at their confluence with McNab Creek mainstem.

Several falls are present along the McNab Creek mainstem which act as barriers to upstream fish migration. Distribution of anadromous fish in McNab Creek is limited by a 10 meter high falls located approximately 5 km upstream of the mouth (DFO 1991; DFO and MoE 2012). Resident fish distribution is limited at another 10 m high falls located approximately 8 km upstream of the mouth (DFO 1991; DFO and MoE 2012). Several other falls, cascades and other fish passage barriers are documented in many of McNab Creek's tributaries.

The McNab Creek watershed supports several species of salmon, trout and non-CRA fish. Fish species present in the watercourses and waterbodies within both the RSA and LSA are listed in Table 5.1-5.

Table 5.1-5: Fish species documented to occur in the Regional and Local Study Areas

Species		RSA	LSA
Common Name	Scientific Name		
Chinook Salmon	*Oncorhynchus tshawytscha*	Yes	Yes
Chum Salmon	*Oncorhynchus keta*	Yes	Yes
Coho Salmon	*Oncorhynchus kisutch*	Yes	Yes
Cutthroat Trout	*Oncorhynchus clarki*	Yes	Yes
Dolly Varden char	*Salvelinus malma*	Yes	No
Pink Salmon	*Oncorhynchus gorbuscha*	Yes	Yes
Sculpin	*Cottus spp.*	Yes	Yes
Steelhead/Rainbow Trout	*Oncorhynchus mykiss*	Yes	Yes
Threespine Stickleback	*Gasterosteus aculeatus*	Yes	Yes

The McNab Creek watershed supports runs of Chum, Pink, Coho, and Chinook Salmon (DFO 1991; DFO and MoE 2012). Historical records of salmon escapements show an average adult salmon return to McNab Creek ranging from 200 to 1,500 spawners and typically averaging less than 500 (DFO and MoE 2012). Chum and Pink Salmon comprise the majority of spawners in escapement records and in spawner counts conducted during field studies between 2009 and 2013.

Historical records indicate low numbers of Steelhead are present in McNab Creek; however, no observations of Steelhead spawners were documented during spawner counts conducted for the Proposed Project. Limited observations of Steelhead have been recorded in the mainstem (DFO 1991), and low numbers of juveniles captured in some mainstem reaches and tributaries (Bates and Ellis 1994; Whelen 1999). Five Steelhead were captured during sampling for the Proposed Project. Other fish sampling efforts in the recent past within McNab watershed did not result in capture of any Steelhead (Sound Energy Inc. 2012).

Dolly Varden char have been historically documented in mainstem reaches of McNab Creek and its tributaries (DFO and MoE 2012; Whelen 1999). However, none were captured during field surveys completed for the Proposed Project or as part of other recent fish sampling efforts in the McNab watershed (Sound Energy Inc. 2012).

Resident and sea-run Cutthroat Trout are documented throughout McNab Creek and many of its tributaries (Bates and Ellis 1994; DFO 1991; DFO and MoE 2012; Whelen 1999). Rainbow Trout have also been documented in Lost Lake and in watercourses reaches upstream and downstream of the lake (Whelen 1999). Sculpins were the only non-salmonids observed to be present in the watershed.

Of the documented fish species in the RSA and LSA, Cutthroat Trout are the only species at risk and they are considered to be of “special concern,” or blue listed within the Province of British Columbia.

Cutthroat Trout, Coho Salmon and sculpins were captured in off-channel and mainstem habitats in McNab Creek during summer fish sampling conducted at representative sites within the LSA. Cutthroat Trout densities ranged from 0.004 to 0.112 fish/m^2 in off-channel habitats and 0.012 fish/m^2 in mainstem habitats. Coho fry were captured in densities ranging from 0.046 to 0.261 fish/m^2 in off-channel habitats and 0.071 fish/m^2 in mainstem habitats.

5.1.4.3 Freshwater Fish Habitat

Freshwater habitat in the LSA consists of lower McNab Creek and smaller man-made and natural groundwater-fed watercourses outside of the McNab Creek watershed, as described in Volume 4, Part G – Section 22.0: Appendix 5.1- A and shown in Figure 5.1-2. Key drainage areas in the LSA potentially affected by Proposed Project activities include:

- Upper and lower segment of WC 2 (i.e., the constructed groundwater-fed watercourse);
- Harlequin Creek;
- Southwest watercourse;
- Northwest watercourses;
- Southwest Watercourses near Harlequin Creek;
- West watercourses; and
- Intertidal groundwater watercourses.

5.1.4.3.1 Constructed Groundwater-fed Watercourse (WC 2)

WC 2 is composed of distinct upper and lower segments, bisected by the BC Hydro transmission line Right of Way (RoW) and a parallel access road located on the south side of the RoW. The upper segment consists of a large, straight, excavated channel flowing from north to south through the property. WC 2 receives year-round groundwater inputs, and seasonal surface flows during heavy rainfall events when water cascades down the steep slope at its northern end. The lower segment of WC 2 below the RoW is tidally influenced with saltwater intrusion reaching approximately 100 m inland. The lower segment of WC 2 provides high value rearing and overwintering habitat for juvenile salmonids.

Adult salmon have been observed infrequently and in low numbers in the upper segment of WC 2 during adult enumeration counts and snorkel surveys (Hatfield 2008). Adult spawner counts conducted from 2004 to 2008 by Hatfield Consultants Ltd. included between 0 to 84 Chum Salmon and 0 to 1 Coho Salmon in the upper segment, and between 0 to 35 Chum Salmon and 0 to 3 Coho Salmon in the lower segment (Hatfield 2008). Adult Chum and Coho Salmon numbers were observed in the lower segment of WC 2 during spawner counts conducted between 2009 and 2013 (Volume 4, Part G – Section 22.0: Appendix 5.1-A).

Use of the intertidal segment of WC 2 by fish was assessed at representative sites with minnow traps during the summer, fall, and spring. Fish captured included juvenile Coho Salmon, Cutthroat Trout, one Rainbow Trout, sculpin, and gunnelfish. Coho fry were the most abundant species captured within WC 2. A more complete description of fish distribution and fish habitat in WC 2 is provided in Appendix 5.1-A (Volume 4, Part G – Section 22.0).

5.1.4.3.2 Harlequin Creek

Harlequin Creek is situated in the south-west corner of the Property. It flows east off Mount Varley, and turns south at the west side of the main access road on the Property, flowing parallel to the road. The creek continues south through a beaver impounded wetland area and flows through a road culvert to the intertidal area.

Harlequin Creek provides abundant cover for fish in the form of instream and overhanging vegetation and woody debris in lower gradient segments, and woody debris with boulders in higher gradient segments. Excellent substrate for spawning is present throughout Harlequin Creek in lower gradient segments, and in pool outlets in the higher gradient segments. Slow flowing and deep pool areas in the wetland of Harlequin Creek provide suitable overwintering habitats for salmonids and other fish species. No physical barriers to salmonid migration were noted along the length of Harlequin Creek within the BURNCO Property and LSA.

Coho Salmon, Cutthroat Trout and sculpin species (*Cottus sp.*) have been captured in Harlequin Creek during electrofishing sampling at representative sites. Coho and Cutthroat were captured in lower segments adjacent to the access road that flowed south, while only Cutthroat Trout were captured in the higher gradient segment further upstream along the western slope.

5.1.4.3.3 South-West Watercourse (WC 5)

The south-west watercourse (WC 5) is located in the southwest corner of the BURNCO property in the vicinity of the hydro RoW, to the north and east of Harlequin Creek, near the proposed processing plant and stockpile. The watercourse flows east from the slopes on the west side of the main access road. Flows from this watercourse slow and accumulate in a wetland area at the base of the slope on the west side of the access road, prior to flowing beneath the road under a constructed log bridge. East of the road, the watercourse continues south-east under the power line towards the foreshore, where it becomes a tidally influenced foreshore inlet. WC 5 has cascade-pool morphology in its upper reaches west of the main road, with moderate gradients of an average 8%, and substrates dominated by gravel with some cobble. Abundant instream cover is provided by large woody debris, overhanging vegetation and boulders. The lower reach and wetland area on the west side of the access road provides high value habitat for rearing and overwintering salmonids. Gravels found in the watercourse provide suitable spawning substrate for trout and, to a lesser extent, salmon species including Coho and Chum. The upper reach provides additional moderate value habitats for rearing and overwintering salmonids with occasional pockets of suitable spawning gravels. No physical fish passage barriers to salmonids were noted along the length of the watercourse within the BURNCO Property.

5.1.4.3.4 Northwest Watercourses (WC 10 to 14)

5.1.4.3.4.1 Watercourse 10

WC 10 has intermittent surface water flows and is located in northwest zone of the property area. It drains east from the west-facing slope of Mount Varley through two 600 mm corrugated steel culverts under the main road into the Proposed Project Area. The water in this watercourse currently flows to ground at its downstream end and has no surface water connection to the fish bearing upper segment of WC 2. No fish have been captured in the wetted habitats during sampling efforts conducted during the winter high flows in this watercourse and as a result WC 10 is considered non-fish bearing.

5.1.4.3.4.2 Watercourses 10a to 10e

Watercourses 10a through to 10e are ephemeral ditches scoured by overland flows originating from WC 10 and fanning out across the lowlands within the proposed pit area. These watercourses flow south and west from water pooling in a low gradient (> 1 %) wooded area in the northwest corner of the proposed pit and eventually infiltrate to ground. Watercourses 10a to 10e have limited surface water and no visible surface connectivity to downstream fish-bearing watercourses and are considered non-fish bearing.

5.1.4.3.4.3 Watercourse 11

Watercourse 11 is an ephemeral drainage flowing southeast from the slope of Mount Varley to the main road. At the main access road, surface water infiltrates to ground or flows overland and into WC 10. Watercourse 11 is considered non-fish bearing due to limited surface water and no downstream connection to fish-bearing waters.

5.1.4.3.4.4 Watercourse 12

Watercourse 12 is an ephemeral drainage that conveys surface water north from WC 11 and groundwater seepage parallel to the main road during high flow events. No fish are present in WC 12 due to limited surface water and an absence of a downstream connection to fish-bearing waters.

5.1.4.3.4.5 Watercourse 13

Watercourse 13 is characterized as an ephemeral watercourse receiving overland water from the western slope. It conveys surface water north for approximately 30 m parallel to the main road where it connects to WC 14, and then flows east through a road culvert, where WC 14 continues on the east side of the access road. Watercourse 13 is considered non-fish bearing due to limited surface water and lack of downstream connection to fish-bearing waters.

5.1.4.3.4.6 Watercourses 14 and 14a

Watercourse 14 collects surface water from the western slope, on the west side of the main road, to the north of the proposed pit area. The surface water in WC 14 is conveyed east under the main access road through two 600 mm culverts, and then continues southeast where it drains down the steep slope at the north end of WC 2. No fish were captured in WC 14 during sampling in its lower segment and it is considered non-fish bearing.

5.1.4.3.5 South-West Watercourses near Harlequin Creek (WC 22 to 25)

Several watercourses are present in the south-west corner of the Proposed Project Area. These watercourses are largely ephemeral with perennial segments present in their lower reaches near Harlequin Creek. Watercourses 25 and 25-N flow into the Harlequin Creek wetland; Watercourses 22 to 24 converge into a single watercourse (WC 22) that drains into the lower segment of Harlequin Creek near the road crossing and outlet to the foreshore. The multiple watercourses are often indistinct and surface water infiltrates to ground with no visible surface connection to the foreshore. These Southwest watercourses have suitable seasonal habitats for rearing and

overwintering salmonids. Pockets of suitable spawning gravels are found throughout these watercourses, but their ephemeral nature likely precludes spawning use. Distribution of salmonids is limited to the lower reaches of these watercourses, where gradients and water velocities are passable to fish and adequate depth and flows are present.

5.1.4.3.6 West Watercourses (WC 6 to 9, 15 to 20, 26)

The west watercourses consist of natural and constructed drainage channels on the mountain slope west of the main access road. These watercourses and ditches are ephemeral and are typically only wetted over periods of regular rainfall during the winter months. The west watercourses have limited connectivity to fish bearing watercourses. Only WC 6 may have a limited connection to WC 5 during times of heavy and persistent rainfall. Due to the lack of connectivity, and the seasonal and ephemeral nature of the western watercourses, no resident or migrant fish are considered to use these watercourses.

5.1.4.3.7 Intertidal Groundwater Watercourses (WC 3 to 4)

There are four intertidal groundwater watercourses located west of WC 2. These groundwater-fed watercourses are identified, east to west, as 3-E, 3, 4-E, and 4-W, and all drain to the marine foreshore.

Watercourse 3 is the only watercourse connected to WC 2. This watercourse is sinuous and slow-flowing with glide and pool habitats. Upper segments of WC 2 are influenced by freshwater, while the lower portions which flow southeast are tidally influenced and brackish. WC 3-E is a wetland watercourse that flows into WC 3 near its outlet to the foreshore.

Both WC 4-E and 4-W are slow-moving wetland watercourses disconnected from other tributaries or surface water watercourses, and drain groundwater into the intertidal flats along the coastline of the property. These watercourses are characterized by fine substrates and moderate growths of freshwater (e.g., skunk cabbage, emergent and reed species) or intertidal (e.g., *Fucus* sp.) vegetation, with clusters of woody debris. WC 3 has high value habitat for rearing and overwintering juvenile Coho Salmon and Cutthroat Trout. It provides abundant cover and food sources, with good connectivity to upstream surface water and freshwater inputs. Some salmon and trout spawning gravels are present in the upper segments of the watercourse, while the lower segment has finer sediments. Watercourse 4-W has numerous refuge areas with cover and food and nutrient sources that provide suitable habitat for rearing and overwintering Coho Salmon juveniles and resident Cutthroat Trout. Watercourses 3-E and 4-E offer limited overwintering and rearing habitat for juvenile Coho and resident Cutthroat Trout, as they are dominated by fines, relatively low fresh-groundwater inputs, and are significantly influenced by tidal waters. These watercourses may have transient fish use during high-tides.

5.1.4.4 Value Components

5.1.4.4.1 Coho Salmon

Coho Salmon can be found in most of the waters draining into the Pacific Ocean, and as such, more populations of Coho exist than any other Pacific salmon species in British Columbia (DFO 2001, Quinn 2005). Adult Coho Salmon enter spawning watercourses late in the season (later than Sockeye and Pink Salmon), generally from September to October during periods of high runoff (Scott and Crossman 1973), although migration can begin as

early as April in some BC rivers (Sandercock 1991). Spawning may occur immediately after migrating into watercourses or early migrating Coho may wait several months before spawning (Sandercock 1991). Adults hold in pools before moving onto spawning grounds located in shallow gravel and cobble areas of riffle-pool habitats with gradients less than 3% (Scott and Crossman 1973; Sandercock 1991). Eggs develop during the winter, hatch in early spring, and the embryos remain in the gravel until they emerge as actively feeding fry in March to late July. Juvenile Coho Salmon generally spend one year rearing in freshwater after emergence, although in northern populations, high proportions of juveniles often spend two or even three years in freshwater before migrating to the ocean (Quinn 2005). Juvenile Coho favour small watercourses, sloughs and ponds, but Coho populations can also be found in lakes and large rivers (Quinn 2005). Preferred habitats include low gradients with low water velocity and abundant instream and overhanging cover. In some coastal watercourses, large numbers of newly emerged Coho fry appear to move to the ocean shortly after emergence (Chapman 1962). Smolts migrate to the ocean between April and July; typically timing migration to coincide with freshet. Coho Salmon spend 2 to 3 years in the ocean before returning to their natal watercourses to spawn, and can typically range in age from 3 to 6 years (Scott and Crossman 1973).

Commercial Coho Salmon catches have declined since the mid-1980s, initially due to the stocks' declining abundance, and more recently because of severe conservation measures (i.e., reduced exploitation rates). However, declining marine survival rates over the last decade have reduced stock productivity to the point where Pacific Scientific Advice Review Committee (PSARC) judged the lower target range to be too high. Near-zero exploitation rates will likely remain in order to stabilize escapements. The other major concern in the decline of Coho Salmon is the loss and degradation of freshwater habitat, due to increasing economic and development pressures, especially in small watercourses in the Sunshine Coast (DFO 2001).

Although the aboriginal harvest of Coho Salmon is small compared with other salmon species, many coastal First Nations rely partly on Coho Salmon for food, social and ceremonial purposes (DFO 2001). These harvests involve Coho Salmon being caught in hook and line, net, and spear fisheries in or near their local watercourses. Coho are also caught incidentally by other salmon fisheries.

Recreational fishing in BC tidal waters is important to many residents and visitors. Chinook and Coho Salmon are the primary species of this fishery, largely because they remain in nearshore waters longer than Sockeye salmon, which are available to anglers only for a short time during their spawning migration back from the high seas (DFO 2001). Coho Salmon have been the mainstay of the recreational fishery in the Salish Sea (Strait of Georgia) and the Sunshine Coast.

5.1.4.4.2 Chum Salmon

Chum salmon have the widest distribution of all Pacific salmon and constitute up to half of the biomass of all other species of salmon found in the North Pacific Ocean (Salo 1991). In BC, Chum Salmon have been observed in over 800 watercourses, with their numbers being relatively spread throughout, and only a few of these watercourses producing large runs (Salo 1991).

Adult Chum Salmon return to their natal watercourses along the South Coast from October through into January, with peaking populations tending to occur in late November and early December (Salo 1991). Chum will spawn in various watercourses from ditches to rivers of various sizes (Salo 1991). Their life-cycle is less specialized than Coho Salmon and their requirements for rearing, growth, and spawning are more easily met within a wide variety

of watercourse conditions (Salo 1991). Spawning adults tend to prefer habitats with upwelling or upstream of turbulent waters, where the females dig out redds in small to large gravel substrates, in water depths that typically range from approximately 13 to 50 cm (Salo 1991). Chum Salmon have been documented spawning in water velocities as high as 168 cm/s and as low as non-flowing water, though the greatest numbers of spawning pairs were observed in flows from 21 to 84 cm/s, with the average preferred water velocity approximating 50 cm/s (Salo 1991). Chum Salmon will spawn in the vicinity of upwelling groundwater and as such, spawning habitat is less affected by fluctuations in temperature and the more consistent temperature regime provides a more stable environment for incubating eggs (Salo 1991). In some coastal watercourses, large numbers of newly emerged fry appear to move directly to the ocean (Quinn 2005).

Smolt migration of Chum occurs in some watercourses as early as March, and will continue into June, with the large pulses of migration occurring within April and May (Salo 1991). The smolts tend to migrate during the evening or night, though many will move in large numbers during the day and will be found along the surface on bright days and closer to the bottom during cloudy days (Salo 1991). Chum smolts feed within estuaries and nearshore environments upon reaching the marine system, and will move offshore when they have increased their size enough to avoid predators and capture larger prey.

5.1.4.4.3 Pink Salmon

Pink Salmon are the most abundant of all of the Pacific Salmon species accounting for about 60% in numbers of all salmon caught commercially in the North Pacific Ocean (Heard 1991). In most systems, Pink salmon are produced in either even or odd years. Major spawning runs occur throughout coastal British Columbia, the largest of which returns to the Fraser River on odd years (Heard 1991). Pink salmon tend to spawn closer to the sea than other Pacific Salmon species and may even select spawning sites in areas that are brackish. Pink Salmon prefer spawning areas situated on moderately shallow riffles with clean, coarse gravel along with a mixture of sand and silt.

After emergence, Pink Salmon fry migrate quickly downstream often traveling at or near the surface of the river or stream. In most cases, migration is direct and completed quite quickly as Pink Salmon juveniles spend less time in freshwater than other salmon species. During this migration, strong schooling behaviour is adopted and little or no feeding occurs during downstream migration. Upon reaching the estuary, Pink salmon fry show a range of dispersal behaviours. Some stocks reside in the estuary environment for several months before moving to offshore waters. Schools of Pink fry tend to follow shorelines and spend much of their time in shallow water where they feed for two to three months before migrating to the open ocean.

5.1.4.4.4 Coastal Cutthroat Trout

Coastal Cutthroat Trout are found in most of the watercourses, sloughs, ponds and lakes of the coastal region in BC as well as major rivers like the Fraser. In particular, coastal Cutthroat Trout are primarily found in the smaller, higher gradient watercourses that flow from coastal mountains (Slaney and Roberts 2005). Three general life-history strategies are exhibited by Coastal Cutthroat Trout in BC and include migratory adfluvial freshwater resident, non-migratory freshwater resident and anadromous forms (Roberge et. al. 2002; Slaney and Roberts 2005). Coastal Cutthroat Trout usually spawn at age 3 or 4, in cool water of headwater watercourses with gravel substrate, and frequently at pool tailouts (Slaney and Roberts 2005, Roberge et. al 2002). Spawning typically

occurs from February to May. Early sea-run populations may migrate between August and September and spawn from October to the spring. Cutthroat Trout have been found to live up to 10 years (Scott and Crossman 1973). Cutthroat Trout, like Steelhead, can spawn more than once; however, most do not live long enough to spawn more than twice. Juvenile Cutthroat Trout of the sea-run life-history remain in fresh water for varying periods, ranging from one to five years. Juvenile Cutthroat are highly adaptable in freshwater and occupy most habitat types, from quickly flowing water to sloughs and ponds.

Cutthroat Trout are a valuable sportfish to recreational anglers. Cutthroat Trout are documented in many of the named and unnamed watercourses within the Proposed Project Area. Many watercourses and channelized watercourses within the Proposed Project Area classified as fish bearing as they have sustained flow and provide suitable riffle-pool morphology and cover to support populations of Cutthroat Trout.

5.1.5 Effects Assessment

5.1.5.1 Project -VC Interactions

A preliminary assessment of identified interactions between the various physical works and activities and the selected VCs across all spatial and temporal phases of the Proposed Project is presented in Table 5.1-6 and Table 5.1-7.

Potential Project-VC interactions are characterized as:

a) Positive, none or negligible, requiring no further consideration; or

b) Potential effect requiring further consideration and possibly additional mitigation.

For those Proposed Project-VC interactions that may result in potential direct, indirect and induced effects requiring further consideration, the nature of the effects (both adverse and positive) arising from those interactions is described below.

Table 5.1-6: Project-VC Interaction Table: Anadromous Chum, Coho, Pink Salmon and Cutthroat Trout and their Habitats

Project Activities	Description	Anadromous Chum, Coho, and Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
Construction			
1. Crew and equipment transport	▪ Daily water taxi movements ▪ Tug and barge transport of machinery/materials ▪ Barge household and industrial solid waste barged off-site	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.
2. Site preparation, including the construction of the berms and dyke	▪ Logging, clearing and grubbing ▪ Grading ▪ Berm and dyke construction ▪ Compaction and laying of gravel base ▪ Limited improvements to existing on-site road infrastructure	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.
3. Processing area installation, including conveyors and materials handling system)	▪ Installation and use of portable concrete batch plant for construction ▪ Installation of concrete foundations ▪ Installation of screens, crushers, wash plant, conveyor system and automated materials-handling system (i.e., reclaim tunnels) ▪ Installation of groundwater well as a source of make-up water for the wash plant	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2

Project Activities	Description	Anadromous Chum, Coho, and Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
4. Substation construction and connection	▪ Construct electrical substation adjacent to existing BC Hydro transmission line ▪ Construct outdoor switchyard, electric building, and 100 m transmission line	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2
5. Marine loading facility installation	▪ Remove existing mooring dolphins ▪ Steel pile installation ▪ Installation of conveyor, barge movement winch and mooring dolphins	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.
6. Pit development	▪ Dry excavation to remove overburden/topsoil ▪ Installation of clamshell and floating conveyor	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.

Project Activities	Description	Anadromous Chum, Coho, and Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
7. Other ancillary land-based construction works	▪ Temporary construction infrastructure set up (trailers, temporary power, etc.) ▪ Upgrades to the existing heavy equipment maintenance shop and warehouse ▪ Upgrades to the existing fuelling facility for the storage of diesel and gasoline for on-site equipment ▪ Construct site office, communications building, workers lunch/dry room, caretaker's cabin, first aid facility and helipad ▪ Install contained washroom facilities ▪ Construct pump room for well/stream intake water distribution and fire-fighting	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.
8. Other ancillary marine construction works	▪ Removal of existing small craft dock; install temporary dock for worker access ▪ Construct new floating small craft dock, the with tie-up area for a float plane.	O	▪ Potential effects related to in-water marine works are addressed in Volume 2, Part B – Section 5.2: Marine Resources.
Operations			
9. Crew transport	▪ Daily water taxi	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.

Project Activities	Description	Anadromous Chum, Coho, and Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
10. Aggregate mining	▪ Use of electric powered floating clamshell dredge ▪ Primary screening and conveyance of extracted material to processing area ▪ Install channel plug in WC 2	●	▪ Loss of fish habitat due to: - Removal of upper segment of WC 2; and - Removal of riparian vegetation along the upper segment of WC 2. ▪ Changes to surface water and groundwater flows due to the removal of the upper segment of WC 2 and the development of the pit. ▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Changes to surface water and groundwater flows due to aggregate mining. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.

Project Activities	Description	Anadromous Chum, Coho, and Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
11. Processing (screening, crushing, washing)	▪ Screening to separate aggregate sizes ▪ Oversized gravels crushed ▪ Operation of wash plant fed using recycled water from two large storage tanks, supplemented with make-up water by a groundwater well. ▪ Drying and storage of fines and silt in the Fines Storage Area	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2
12. Progressive reclamation	▪ Ongoing earth works (including site clearing, surface material removal) ▪ Fines and silt mixed with organic overburden material and used for infilling, re-vegetation and landscaping	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.

Project Activities	Description	Anadromous Chum, Coho, and Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
13. Stockpile storage	▪ Processed sand and gravel conveyed to stockpile area ▪ Storage of processed materials in stockpiles	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.
14. Marine loading	▪ Transfer of stored material using marine conveyor system ▪ Barge loading ▪ Facility and navigational lighting	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.
15. Shipping	▪ Barge traffic (delivery/collection) in Howe Sound, Ramillies Channel, Thornbrough Channel, and Queen Charlotte Channel ▪ Tug and barge transport of fuel and consumables ▪ Navigational lighting	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.
16. Refueling and maintenance	▪ Refueling and maintenance of on-site equipment	●	▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems.
Reclamation and Closure			
17. Crew and equipment transport	▪ Daily water taxi movements ▪ Tug and barge transport of machinery/materials ▪ Barge household and industrial solid waste barged off-site	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.

Project Activities	Description	Anadromous Chum, Coho, and Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
18. Removal of land-based infrastructure	▪ Remove surface facilities, including clamshell dredge, conveyor system, screens, crushers, wash plant, automated materials-handling system, heavy equipment maintenance shop and warehouse, fuelling facility, site office, communications building, workers lunch/dry room, caretaker's cabin, first aid facility, helipad and contained washroom facilities	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.
19. Removal of marine infrastructure	▪ Remove marine facilities, in marine load out facility, jetty, conveyors and piles	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.
20. Site reclamation	▪ Final completion of the pit lake, landscaping and re-vegetation to develop a functional ecosystem in the freshwater pit ▪ Landscaping and re-vegetation of processing area, berms and dyke	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Changes to surface water and groundwater flows due to site reclamation and the final completion of the pit lake. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.

Notes:
O = Potential effect of Proposed Project activity on VC is positive, none or negligible; no further consideration warranted.
● = Potential effect of Proposed Project activity on VC that may require mitigation/benefit enhancement; warrants further consideration

Table 5.1-7: Project -VC Interaction Table: Resident Cutthroat Trout and their Habitats

Project Activities	Description	Resident Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
Construction			
1. Crew and equipment transport	▪ Daily water taxi movements ▪ Tug and barge transport of machinery/materials ▪ Barge household and industrial solid waste barged off-site	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.
2. Site preparation, including the construction of the berms and dyke	▪ Logging, clearing and grubbing ▪ Grading ▪ Construction of the berms and dyke ▪ Compaction and laying of gravel base ▪ Limited improvements to existing on-site road infrastructure	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.
3. Processing area installation, including conveyors and materials handling system)	▪ Installation and use of portable concrete batch plant for construction ▪ Installation of concrete foundations ▪ Installation of screens, crushers, wash plant, conveyor system and automated materials-handling system (i.e., reclaim tunnels) ▪ Operation of wash plant fed using recycled water from two large storage tanks, supplemented with make-up water by a groundwater well.	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.

Project Activities	Description	Resident Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
4. Substation construction and connection	▪ Construct electrical substation adjacent to existing BC Hydro transmission line ▪ Construct outdoor switchyard, electric building, and 100 m transmission line	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.
5. Pit development	▪ Dry excavation to remove overburden/topsoil ▪ Installation of clamshell and floating conveyor	●	▪ Loss of fish habitat due to: - Removal of upper segment of WC 2; ; - Removal of riparian vegetation along the upper segment of WC 2; and - Changes to surface water and groundwater flows due to the removal of the upper segment of WC 2 and the development of the pit. ▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems.

Project Activities	Description	Resident Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
6. Other ancillary land-based construction works	▪ Temporary construction infrastructure set up (trailers, temporary power, etc.) ▪ Upgrades to the existing heavy equipment maintenance shop and warehouse ▪ Upgrades to the existing fuelling facility for the storage of diesel and gasoline for on-site equipment ▪ Construct site office, communications building, workers lunch/dry room, caretaker's cabin, first aid facility and helipad ▪ Install contained washroom facilities ▪ Construct pump room for well/stream intake water distribution and fire-fighting	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.
7. Other ancillary marine construction works	▪ Removal of existing small craft dock; install temporary dock for worker access ▪ Construct new floating small craft dock, the with tie-up area for a float plane.	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.
Operations			
8. Crew transport	▪ Daily water taxi	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.

Project Activities	Description	Resident Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
9. Aggregate mining	▪ Use of electric powered floating clamshell dredge ▪ Primary screening and conveyance of extracted material to processing area ▪ Install channel plug in WC 2	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Changes to surface water and groundwater flows due to aggregate mining. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.
10. Processing (screening, crushing, washing)	▪ Screening to separate aggregate sizes ▪ Oversized gravels crushed ▪ Operation of wash plant fed using recycled water from two large storage tanks, supplemented with make-up water by a groundwater well. ▪ Drying and storage of fines and silt in the Fines Storage Area	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.

Project Activities	Description	Resident Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
11. Progressive reclamation	▪ Ongoing earth works (including site clearing, surface material removal) ▪ Fines and silt mixed with organic overburden material and used for infilling, re-vegetation and landscaping	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.
12. Stockpile storage	▪ Processed sand and gravel conveyed to stockpile area ▪ Storage of processed materials in stockpiles	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.
13. Marine loading	▪ Transfer of stored material using marine conveyor system ▪ Barge loading ▪ Facility and navigational lighting	○	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.
14. Shipping	▪ Barge traffic (delivery/collection) in Howe Sound, Ramillies Channel, Thornbrough Channel, and Queen Charlotte Channel ▪ Tug and barge transport of fuel and consumables ▪ Navigational lighting	○	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.

Project Activities	Description	Resident Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
15. Refueling and maintenance	▪ Refueling and maintenance of on-site equipment	●	▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems.
Reclamation and Closure			
16. Crew and equipment transport	▪ Daily water taxi movements ▪ Tug and barge transport of machinery/materials ▪ Barge household and industrial solid waste barged off-site	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.
17. Removal of land-based infrastructure	▪ Remove surface facilities, including clamshell dredge, conveyor system, screens, crushers, wash plant, automated materials-handling system, heavy equipment maintenance shop and warehouse, fuelling facility, site office, communications building, workers lunch/dry room, caretaker's cabin, first aid facility, helipad and contained washroom facilities	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.
18. Removal of marine infrastructure	▪ Remove marine facilities, in marine load out facility, jetty, conveyors and piles	O	▪ Potential effects on fish in the marine environment related to in-water marine activities are addressed in Volume 2, Part B – Section 5.2: Marine Resources.

Project Activities	Description	Resident Cutthroat Trout and their habitats	
		Potential Interaction (See Notes)	Potential Effect / Rationale for Exclusion
19. Site reclamation	▪ Final completion of the pit lake, landscaping and re-vegetation to develop a functional ecosystem in the freshwater pit ▪ Landscaping and re-vegetation of processing area, berms and dyke	●	▪ Change in habitat quality (i.e., reduced surface water quality) due to: - Increases in suspended sediments in fish habitat from run-off due to exposed soils from surface erosion or dust migration; - The release of cement (alkaline) material from concrete works (construction phase); and - The use of artificial light during nighttime. ▪ Changes to surface water and groundwater flows due to site reclamation and the final completion of the pit lake. ▪ Accidental chemical spills or other fugitive releases related to the operation or maintenance of machinery may be transported by runoff into surface water systems. ▪ The assessment of potential effects related to changes in water chemistry on freshwater fish is provided in the Aquatic Health assessment in Volume 2, Part B – Section 5.5.5.4.2.

Notes:
O = Potential effect of Proposed Project activity on VC is positive, none or negligible; no further consideration warranted.
● = Potential effect of Proposed Project activity on VC that may require mitigation/benefit enhancement; warrants further consideration

5.1.5.2 Potential Project-Related Effects

This section describes potential effects to fish and fish habitat associated with each phase of Proposed Project development. To avoid redundancy, effects on anadromous and resident fish in fresh water habitat have been described together. Potential effects associated with chemical spills and suspended sediments on water quality and aquatic health are discussed in Surface Water Resources (Volume 2, Part B - Section 5.5). Potential environmental effects of the Project on anadromous salmon and Cutthroat Trout and their habitats during construction, operations and reclamation/closure include:

- Direct loss of fish habitat due to creation of the mine pit and associated the Pit Lake Containment Berm (Figure 5.1-4; operations phase);
- Indirect loss of fish habitat through changes in flows due to the creation of the mine pit (operations and reclamation and closure);
- Changes is habitat quality though increases in suspended sediments in run-off due to surface erosion and dust (all phases);
- Changes in habitat quality through the release of cement (alkaline) material from concrete works (construction phase);
- Changes in habitat quality due to artificial lighting (All phases);
- Potential injury or mortality from underwater noise generated during impact pile driving (construction); and
- Accidental release of deleterious substances due to accidental spills of hazardous, toxic or aggregate material (all phases).

5.1.5.2.1 Construction

Activities occurring during the construction phase of the mine development that have the potential to interact with anadromous salmon and Cutthroat Trout are:

- Site preparation, including construction of the Pit Lake Containment Berm;
- Processing area installation, including conveyors and materials handling system;
- Substation construction and connection;
- Pit development; and
- Other ancillary land-based and marine construction works.

5.1.5.2.1.1 Changes to Surface Water Quality - Suspended Sediments

During the construction phase, anadromous and resident freshwater fish VC habitat may be affected by changes in water quality caused by soil disturbance during construction activities causing increased levels of suspended sediments in watercourses. Site clearing and grubbing activities and site preparation will create large areas of exposed and disturbed soils which may be subject to surface erosion. Excavation and grading activities as well

as transport of materials to and from active work areas associated with construction of mine infrastructure, and ancillary works will also create areas of exposed and disturbed soils. Precipitation on active construction areas and areas of disturbed ground can result in erosion and high levels of suspended sediments in run-off water. Wind action on exposed and disturbed soils can result in the generation of dust. Dust can be transported to and deposited in freshwater habitat resulting in higher levels of suspended sediments.

Erosion and dust could result in increased levels of turbidity and total suspended sediments (TSS) in the watercourses that may result in a disruption of feeding by visual fish predators (Berg and Northcote 1985). As the suspended particles settle out, they have the potential to smother fish habitat including fish rearing and/or spawning habitats, as well as fill in spaces occupied by fish prey, depending on the habitat characteristics where the disturbance occurs. High levels of suspended sediments can have lethal effects on fish (Birtwell 1999). Other potential effects are avoidance and displacement, sub lethal stress responses, reduced egg survival and reduced primary productivity, reducing food availability to fish (Birtwell 1999). The introduction of sediments into watercourses may also result in increased concentrations of pollutants in the water, such as trace metals that are mainly adsorbed onto particles of smaller size fractions (Chapman 1992; Horowitz 1985). Once suspended, these pollutants can be ingested by smaller fish and transferred through the food chain to higher trophic species such as salmon (CCME 2016).

Due to their proximity to the Proposed Project Area, WC 5 and Harlequin Creek are the most likely fish bearing watercourses to be affected by increased levels of suspended sediments as a result of Proposed Project construction activities (Figure 5.1-2). In addition, the lower segment of WC 2 as well as WC 3 could be affected by increased suspended sediments during activities to remove the upper segment of WC 2. Coho Salmon, Cutthroat Trout and sculpin species (*Cottus sp.*) have been observed in in these watercourses. WC 5 has habitat to support rearing and overwintering salmonids as well as suitable spawning habitat for trout and, to a lesser extent, salmon species including Coho and Chum in the lower segment. Excellent substrate for spawning is present throughout Harlequin Creek in lower gradient segments, and in pool outlets in the higher gradient segments. Slow flowing and deep pool areas in the wetland of Harlequin Creek provide suitable overwintering habitats for salmonids and other fish species. The lower segment of WC 2 provides high value rearing and overwintering habitat for juvenile salmonids. WC 3 has high value habitat for rearing and overwintering juvenile Coho Salmon and Cutthroat Trout. Some salmon and trout spawning gravels are present in the upper segments of the watercourse, while the lower segment has finer sediments. Juvenile and larval fish would be particularly sensitive to smothering and toxic effects of increased levels of turbidity and other contaminants, or from indirect effects of reduced food base caused by Proposed Project activities.

Potential effects related to changes to surface water quality related to suspended sediments from construction activities are carried forward in the assessment.

Potential effects on anadromous and resident freshwater fish VCs related to the suspension of marine sediments as a result of in-water marine works are considered similar to those described for marine fish and are discussed in Volume 2, Part B – Section 5.2: Marine Resources.

5.1.5.2.1.2 Changes to Surface Water Quality - Cementitious (alkaline) Material

Concrete works related to the construction phase of the Proposed Project through substation, conveyor system, and processing plant foundations and structure can result in the introduction of cement and concrete material into

freshwater habitat. Uncured concrete is highly alkaline (>9 pH) when it contacts water and is highly corrosive and toxic to fish and other biota.

Sources of environmental concern from concrete works include (i) toxicity from the alkaline pH of concrete and (ii) physical effects of smothering through the release of solids. Uncured concrete produces a highly alkaline material when it contacts water. The degree of alkalinity (or conversely the acidity) of a substance can be expressed in terms of the pH scale. The pH scale ranges from a pH of 0 (extremely acidic) to a pH of 14 (extremely alkaline). The middle of the pH scale, pH 7, represents a neutral pH. Safe levels for the protection of aquatic life in freshwater waters range from 6.5 to 9.0 pH units (CCME 2016). At pH values greater than 9, the alkaline pH begins to have a corrosive effect on the gills and other external tissues (e.g., the eye) with mortality being reported at just slightly higher values. The pH of uncured concrete and wash-off water from concrete is 12 pH units at a temperature of 25°C. At lower temperatures, more likely to be encountered in BC waters, the pH of concrete water increases. At these pH values, uncured concrete will rapidly kill fish and must be kept out of surface waters, even for brief episodes. In addition to toxic effects, concrete also contains a considerable amount of fine sediments. When these are washed or otherwise enter the aquatic environment, the fine sediments can cause similar effects to those described above related to changes in water quality as a result of suspended sediments.

Potential effects related to changes to surface water quality related to cementitious materials from construction activities are carried forward in the assessment.

5.1.5.2.1.3 Effects of Artificial Lighting

Limited lighting of the Proposed Project Area will be necessary to ensure a safe and secure facility during evening and night-time periods throughout the Proposed Project. It is expected that construction activities will be limited to daytime operations therefore further limiting the amount of nighttime lighting required. It is expected that some navigational lighting will be required around the marine loading conveyor and the barge load out jetty. Further details regarding light associated with the Proposed Project is provided in Volume 2, Part B – Section 7.4: Visual Assessment.

Potential effects from artificial lighting on anadromous salmon and Cutthroat Trout depend on a variety of factors including levels of ambient light, species, life history stage, environmental factors and light spectrum. Artificial lighting can influence foraging and schooling behaviours, distribution, predation risk, migration patterns and reproduction.

For salmon, behavioural responses to artificial light are correlated with the foraging strategy of the species. Coho Salmon who occupy and defend territories, are not active at night and do not demonstrate strong behavioural reactions when exposed to nighttime lights (Godin 1982, Hoar 1951, and Northcote 1978 in Nightingale et al 2006). Species who disperse to nursery lakes and estuaries, such as Pink Salmon who typically demonstrate schooling behaviours and are active at night, tend to show stronger negative reactions when exposed to nighttime lighting (Godin 1982, Hoar 1951 in Nightingale et al 2006). Life history stage also influences reactions to artificial light. Smolts react stronger than fry, scattering wildly when exposed to nighttime light and exhibiting longer cover reactions. Smolts also tend to have higher aggregation tendencies, lower simulative thresholds and are more active at night (Folmar and Dickhoff 1981, Hoar 1976, McInerney 1964 Hoar 1951 in Nightingale et al 2006). Behavioural reaction to artificial light may also be affected by environmental factors. Salmonids change nocturnal strategies when water temperatures are low resulting in differing behavioural reactions to nighttime lighting during

the winter versus the summer (Fraser and Melcalfe 1997). Light spectrums also play a role in the behavioural response of fish to light. Freshwater species tend to be more sensitive to lights in the red and yellow spectrum more common in these environments, whereas ocean and open water species tend to more sensitive to blue lights due to the presence of bioluminescent plankton in marine environments (Beatty 1966, Folmor and Dickhoff 1981, Hobson et al. 1981 in Nightingale et al 2006). Fish are rarely exposed to incandescent and fluorescent light associated with most human activity in the wild. Puckett and Anderson (1987 in Nightingale et al 2006) found that juvenile salmon were attracted to incandescent light.

Due to their proximity to the Proposed Project Area, WC 5 and Harlequin Creek are the most likely fish bearing watercourses to be affected by artificial light as a result of Proposed Project activities (Figure 5.1-2). These watercourses maintain rearing, overwintering and spawning habitats and could support smolts that are particularly sensitive to artificial lights. Although understood to be particularly sensitive to artificial lights, Pink Salmon are unlikely to be affected by Project lighting as they were not observed during baseline studies in WC 5 and Harlequin Creek. Based on the literature, Coho Salmon are unlikely to be negatively affected by artificial lighting as they do not demonstrate strong behavioural reactions when exposed to nighttime light. In summary, Project generated lighting may cause light-dependent behaviour in fish (e.g., attractant, increased predatory behaviour) or suppressive behaviour (e.g. avoidance, scattering and cover behaviour). Potential effects related to artificial lighting from construction activities are carried forward in the assessment.

5.1.5.2.1.4 Effects of Underwater Noise

The main sources of Project-generated underwater noise considered in the marine fish assessment include:

- Impact pile driving (construction);
- Vessel traffic (all Proposed Project phases); and
- Loading of aggregate onto barges (operations)

The potential impacts of underwater noise on anadromous salmon and Cutthroat Trout will be similar to the effects assessed for marine fish and are discussed in Volume 2, Part B - Section 5.2: Marine Resources and is not discussed further in this Section.

5.1.5.2.2 Operations

Operational activities that have the potential to interact with anadromous salmon and Cutthroat Trout are:

- Aggregate mining;
- Processing (screening, crushing, washing);
- Progressive reclamation;
- Stockpile storage; and
- Refueling and maintenance.

5.1.5.2.2.1 Loss of Habitat

Loss of fish habitat will occur through two mechanisms: 1) the direct loss of instream and riparian habitat due to the removal of the upper segment of WC 2, and 2) loss of instream habitat in the lower segment of WC 2 caused by a reduction in surface water baseflows from the removal of the upper segment. Habitat that will be lost as a result of Project activities is summarized in Table 5.1-8.

5.1.5.2.2.1.1 Removal of Upper Segment of WC 2

The creation of the mine pit and associated Pit Lake Containment Berm within the Proposed Project Area will result in a loss of the upper segment of WC 2. This segment of WC 2 provides rearing, migration, and overwintering habitat for adult Chum, and Coho Salmon (Hatfield 2008). Approximately 3,307 m^2 of freshwater habitat is estimated to be lost by the development of the pit (Figure 5.1-4). The limited availability of suitable spawning gravels in the upper segment of WC 2 precludes the loss of spawning habitat. Most of the habitat in the upper segment of WC 2 is of low gradient (<1%) with long stretches of uniform dimensions which are relatively flat bottomed in cross-section. Water moves slowly through this upper segment forming glide habitat and providing mainly rearing and overwintering habitat. A smaller proportion of the habitat in the upper segment consists of riffles and pools located near its upper extent.

The riparian habitat loss associated with the removal of the upper segment of WC 2 is calculated to be approximately 1,560 m^2. The length of the upper segment of WC 2 corresponds to approximately 17 % of the overall length of all known fish-bearing watercourses in the LSA. Appendix 5.1-A and 5.1-B (Volume 4, Part G – Section 22.0) provides a detailed description of the methods used to characterize and quantify the habitat in the upper segment of WC 2.

5.1.5.2.2.1.2 Piling Installation in the Marine Foreshore

In the foreshore portion of the LSA, 18 pilings that will be 42 cm in diameter will be installed (Figure 5.1-4) for the barge loading system. The direct fish habitat loss associated with their installation is estimated to be less than 5 m^2. The narrow width (< 2 m), height above the water (> 5m) and orientation (North/South) of the conveyer structure indicate that it is unlikely to cause any shading effects on intertidal or shallow subtidal habitats. Potential effects on anadromous and resident freshwater fish VCs related to marine infrastructure will be similar to those described for marine fish and is discussed in Volume 2, Part B – Section 5.2.

5.1.5.2.2.1.3 Changes in Flows

Excavation of the mine pit will produce a primarily groundwater-fed pit lake. Results of the surface water and groundwater assessment and modelling indicate that the discharge of groundwater to watercourses in the LSA may change with the development and operation of the mine. The surface water assessment results (Volume 2, Part B – Section 5.5: Table 5 5.5-11) indicate that during the operational phase, changes to groundwater flows will result in higher baseflow rates in McNab Creek, WC 3, WC 3-E, WC 4-E, WC 4-W, and WC 5 and an increase in the wetted area of the Foreshore Minor Streams. McNab Creek currently experiences periods of very low or no surface flow during the summer low-flow period when loss of groundwater from McNab Creek is greater than calculated discharge. With the reduction in groundwater loss and the corresponding increase in McNab Creek

base flows, it is expected that these summer low-flow periods will be reduced in duration and severity. These effects were considered **positive** effects on anadromous and resident freshwater fish VCs and their habitats and are therefore not carried forward in the effects assessment. Potential other beneficial effects to freshwater habitats could include increased groundwater discharge to watercourses providing increased water levels and additional wetted area. Increases in groundwater discharges can also improve fish passage and extend distribution of fish species.

The surface water assessment (presented in Volume 2, Part B – Section 5.5) results indicate that during the operational phase, the Project would result in a reduction in baseflows in the lower segment of WC 2 of between 19% and 37%, compared to baseline conditions (Year 0). This reduction in baseflow entering the lower segment of WC 2 will lead to a reduction of approximately 116 m^2 of wetted area and fish habitat in the lower segment of WC 2. The reduction in baseflow in the lower segment of WC 2 as a result of the Proposed Project activities is considered as a **negative** potential effect on anadromous and resident freshwater fish VCs and their habitats in the lower segment of WC 2, requiring further consideration in the residual effects assessment. Potential effects due to changes in groundwater flows could include permanent dewatering and loss of seasonal or permanent habitats for anadromous and resident freshwater fish VCs at various life history stages including spawning, incubation, rearing, migration, and overwintering. Potential effects may also include the impediment of fish migration resulting from lower surface water levels in watercourses.

The mine was specifically designed to avoid any additional loss of groundwater discharge to McNab Creek, limiting potential adverse effects to surface water and at the same time minimize the loss of groundwater and surface water flows to other watercourses in the LSA. The design of the mine (e.g., location, surface area, proximity to McNab Creek, depth and slope) involved an iterative process involving incorporation of the surface water and hydrogeological assessment and modelling results to avoid and limit potential adverse effects associated with changes to groundwater losses and surface water flows.

Potential effects related to the loss of habitat from the removal of upper segment of WC 2 as well as due to the changes in flow in lower segment of WC 2 from operational activities are carried forward in the assessment.

Table 5.1-8: Summary of Habitat Area Affected by the Proposed Project

Habitat Component	Instream Habitat Loss (m^2)	Riparian Habitat Loss (m^2)
Upper segment of WC 2 (physical footprint)	3,307*	1,560
Lower segment of WC 2 (20 m segment below the culvert; physical footprint)	112	NA
Loss of wetted area in the lower segment of WC 2 due to reduction in baseflow	116	NA
Marine Foreshore Intertidal 8 Steel pilings (42cm diameter)	1.1	NA
Marine Foreshore Subtidal 10 Steel pilings (42cm diameter)	1.4	NA
Total Area Affected	**3,538**	**1,560**

5.1.5.2.2.2 Changes to Surface Water Quality – Suspended Sediments

During operations, anadromous and resident freshwater fish VCs and their habitats may be affected by suspended sediments. These effects were assessed as part of the construction phase, as described in Section 5.1.5.2.1.1.

5.1.5.2.2.3 Effects of Artificial Lighting

During operations, anadromous and resident freshwater fish VCs and their habitats may be affected by artificial lighting. These effects were assessed as part of the construction phase, as described in Section 5.1.5.2.1.3.

5.1.5.2.3 Reclamation and Closure

Reclamation and closure activities that have the potential to interact with anadromous salmon and Cutthroat Trout are:

- Removal of land-based infrastructure; and
- Site reclamation.

5.1.5.2.3.1 Changes in Flows

During reclamation and closure, anadromous and resident freshwater fish VCs and their habitats may be affected by changes in surface water flows. These effects are assessed as part of the operations phase, as described in Section 5.1.5.2.2.1.3. Closure plans for the Proposed Project include the construction of an outflow structure for the pit lake. This structure will allow water to be retained in the pit lake at the design water level. The design water level will be selected to maintain baseflows in McNab Creek slightly above baseline conditions. The design of the outflow structure will be refined at the closure phase of the Project, based on groundwater level and pit lake water level monitoring data collected throughout the operational years of the Proposed Project.

At the closure, it is anticipated that McNab Creek will have a slightly greater volume of water than compared with conditions prior to the development of the aggregate pit. This net increase in water volume will result in a greater area of available habitats for anadromous and resident salmonids within McNab Creek itself. Natural groundwater-fed watercourses within the Proposed Project Area are also expected to receive slightly higher volumes once operations have ceased, providing consistent flows into the foreshore groundwater-fed watercourses, the lower segment of WC 2, and the proposed extension. These effects were considered **positive** effects on anadromous and resident freshwater fish VCs and their habitats and are therefore not carried forward in the effects assessment.

5.1.5.2.3.2 Changes to Surface Water Quality - Suspended Sediments

During reclamation and closure, anadromous and resident freshwater fish VCs and their habitats may be affected by suspended sediments. These effects are assessed as part of the construction phase, as described in Section 5.1.5.2.1.1.

5.1.5.2.3.3 Effects of Artificial Lighting

During reclamation and closure, anadromous and resident freshwater fish VCs and their habitats may be affected by artificial lighting. These effects were assessed as part of the construction phase, as described in Section 5.1.5.2.1.3.

5.1.5.2.4 Accidents and Malfunctions

Project activities can degrade freshwater quality and affect fish habitat through the accidental release of contaminants and chemicals such as gasoline, grease, hydraulic oil, and motor oil. Potential effects could result in degradation of fish habitats as well as fish mortality. Potential effects on surface water quality related to accidents and malfunctions from chemical spills are discussed in Volume 2, Part B – Section 5.5: Surface Water Resources.

Activities that may result in accidents and malfunctions, in relation to chemical spills, during the different phases of the Proposed Project are identified and mitigation is discussed in Volume 2, Part B – Section 5.5.5.2.2.4 and 5.5.5.3.4: Surface Water Resources.

Loss of containment of the Pit Lake during operations or after closure has the potential to negatively affect downstream fish and fish habitat. A loss of containment may result in increased flow and sediment transport beyond the capacity of the stream channels below the Pit Lake. The high flow and sediment movement could impact fish, and fish habitats downstream of the release. Increased levels of erosion and sediment movement could kill fish directly or destroy fish habitat either through scour or smothering. Changes to the groundwater fed channels downstream of the Pitt Lake caused by either erosion or deposition as a result of a containment loss, may reduce the suitability of the downstream habitat for both resident and anadromous fish species.

The potential effects of a containment loss of the Pit Lake would depend upon the location, rate and volume of the release. Direct mortality of fish could occur through abrasion and smothering effects caused by high levels of suspended sediment and bedload movement; however, these effects would be localized to the area of the plume.

The magnitude and duration of effects to fish habitat would also depend upon the location, rate and volume of the release. A smaller release that was still beyond the transportation capacity of the downstream channels could lead to levels habitat alteration that would be similar to a flood event with recolonization and recovery within the same year. A larger loss of containment could lead to the washout of existing channels and the creation of new channels. The altered habitat would be recolonized by fish and invertebrates relatively quickly within the first few years however full recovery of habitat function and value following such a large loss of containment could take a decade or longer to recover some features such as fully functioning riparian habitat.

5.1.5.3 Mitigation

This section provides a description of the proposed mitigation measures specifically related to Proposed Project effects on anadromous and resident freshwater fish VCs and are summarized in Table 5.1-9.

The mitigation strategy outlined below forms the basis for the commitments that the Proposed Project is making with respect to fisheries and freshwater habitat. A detailed list of all commitments of the Proposed Project are provided in Volume 3, Part F – Section 19.

Mitigation measures to be used during construction include, but are not limited to, the following:

- Lighting for the purposes of the aggregate mining will not be permitted between dusk to dawn at seasonally appropriate times;
- All lighting near waterbodies will have baffles to direct light away from the water surface;
- Limited lighting will be maintained through the night only for safety purposes;
- Implementation of an Air Quality and Dust Control Plan. Details provided in Volume 3, Part E - Section 16.0.
- The pit lake will be designed such that lake elevation can be used to manage hydrostatic pressure through the course of operations so changes to groundwater flow do not lead to a loss of flow within McNab Creek;
- The elevation of the pit lake will be used to manage baseflows in the natural groundwater watercourses below the pit lake;
- Based on DFO's Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting (DFO 2013c) a Fish Habitat Offset Plan will be implemented and is provided in Volume 4, Part G – Section 22.0: Appendix 5.1-B and described in Section Volume 3, Part E – Section 16.0;
- Implementation of a Fisheries Habitat Protection and Mitigation Plan (details described in Section Volume 3, Part E – Section 16.0) which will include, but may not be limited to, the following measures:
  - Sensitive areas will be avoided when possible (e.g., use existing roads, trails, or cut lines);
  - Disturbance to riparian areas will be minimized and will follow riparian clearing procedures;
  - All components of the processing plant will be located outside of setbacks around fish bearing watercourses, riparian areas and mature forest stands as defined by the *Forest and Range Practices Act* (2002) *Forest Planning and Practices Regulation* (2002, Division 3 — Riparian Areas - Section 47 of the regulation);
  - All in-water works will be conducted in isolation of flowing water. Fish salvage will be completed prior to dewatering;
  - In-water works will be limited to the in-water work windows for the Howe Sound Area as possible, particularly for activities with the potential to disrupt sensitive fish life stages (MoE 2006a). If this is not possible, then additional mitigation will be considered including those identified in DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013) and MoE measures to avoid harm to fish and the BC Standards and Best Practices for Instream Works (MoE 2004).
  - Optimal timing of construction activities to avoid impacts to fish and their habitats will be followed as possible (i.e., conduct construction activities during frozen periods on wet terrain, avoid doing certain activities work during heavy rainfall);
  - Re-vegetation of riparian areas will follow the DFO guidance on Riparian Re-vegetation;
  - Vegetation and debris from clearing will not be deposited within watercourses;

- Work around watercourses will follow specific procedures and will follow the relevant guidance (MoE 2006a, MoE 2004, DFO 2013);
- Water quality will be monitored for turbidity in adherence to the BC water quality guidelines for the protection of aquatic life (fresh, marine, estuarine; see Volume 3, Part E – Section 16.0, Table 16-1);
- An Invasive Plant Species Management Plan will be implemented (e.g., cleaning/washing procedures for Proposed Project vehicles and equipment taken off-site to areas where weeds may be present. See Volume 3, Part E – Section 16.0); and
- Compliance monitoring and reporting requirements in accordance with the recent revisions to the fisheries protection provisions of the *Fisheries Act*.

■ Implementation of Erosion and Sediment Control Plan which is provided in Volume 4, Part G – Section 22.0: Appendix 3 (additional details provided in Volume 3, Part E – Section 16.0) that will include the following measures:

- Sediment and erosion control measures will be implemented as necessary. The plan will include details on how, when and where to implement and remove control measures. In general, measures will be implemented before starting work to prevent entry of sediment into watercourses;
- Control measures will be inspected regularly during the course of their use and all necessary repairs made promptly if any damage occurs;
- Procedures to be used during excavation, clearing, and other construction activities with the potential to result in erosion and/or sedimentation;
- Steep slopes, stockpiles, and disturbed areas will be protected from erosion during storm events; and
- Unstable soils will be restored to the equivalent of its original condition which may include re-vegetation.

■ Implementation of Spill Prevention and Emergency Response Plans include the following measures (details provided in Volume 3, Part E – Section 16.0):

- No washing of machinery or equipment will take place at the marine foreshore or near freshwater environments;
- Refueling will not be done adjacent to environmental buffers or waterways;
- Inspection of equipment being used on and off site will be continued through the reclamation phase as identified in the CEMPs (defined above for construction);
- Emergency spill kits should be maintained on site. Operating personnel will be familiar with the contents and use of spill response equipment and the location and operation of emergency ‘shut-offs’;
- All fuel, lubricant and other chemicals use, handling and transfer activities will be conducted by properly trained personnel according to pre-established formal procedures to prevent accidental releases and fire and explosion hazards. Documented procedures will include all aspects of the delivery or loading operation from arrival to departure, including connection of grounding systems, verification of proper hose connection and disconnection, and adherence to no-smoking and no-naked light policies;

- In a case of a spill of a toxic or deleterious material, all efforts will be made to contain and recover the substance and act according to the plan and procedures that will encompass different scenarios of potential spills. The level of response will depend on the circumstances of the spill; and
- In a case of reportable spill, the closest Canadian Coast Guard Station (1-800-889-8852) or Emergency Coordination Centre (1-800-OILS-911) will be contacted. The Spill Prevention and Emergency Response Plans will list the amounts and types of reportable substances as defined by the *Spill Reporting Regulation* under the *Environmental Management Act*.

■ Implementation of an Emergency Response Procedure (details provided in Volume 3, Part E – Section 16.0).

5.1.5.3.1 Habitat Offsetting

To offset the loss of habitat and predicted reduction of flow caused by removal of the upper segment of WC 2 segment of WC 2 will be extended by approximately 770 m (Volume 4, Part G – Section 22.0: Appendix 5.1-B, Figure 6). The majority of the extension (i.e., the offset habitat) of the lower segment will be constructed prior to the decommissioning of the upper segment. Changes in the elevation of groundwater in the area associated with the flooded pit will lead to a substantial increase in wetted area (Volume 2, Part B – Section 5.5: Surface Water Resources, Table 5.5-12) and fish habitat within the extension as well as the lower segment of WC 2. The flooded pit will increase available ground water in down gradient areas but it will not spill any surface water during operations. The surface water hydrodynamic model indicates that following operations, the flooded pit will only spill surface water between October and April when lake surface water temperature effects will not be a concern. For additional details regarding the hydrodynamic model see Volume 4, Part B – Section 22.0: Appendix 5.5-B. The spilled water from the pit lake will be directed into the channel extension where it will provide additional wetted area during the winter months. The extension will create approximately 4,213 m^2 of new fish habitat and add approximately 19,196 m^2 of new riparian habitat (Volume 4, Part G – Section 22.0: Appendix 5.1-B).

Habitat offset monitoring will be conducted for the offset habitat to confirm that habitat offset measures outlined in the Fish Habitat Offset Plan are followed and to assess the functionality of the offset habitat over the long term. The habitat will be monitored upon completion of construction and an initial monitoring report with as-built drawings will be provided to FLNRO and DFO. The initial monitoring report will confirm whether the construction of the offset habitat meets the performance criteria outlined in the Fish Habitat Offset Plan. The offset habitat will then be monitored during years 1, 2, 3 and 5 (if necessary) and monitoring reports will be provided to FLNRO and DFO. If the long-term performance objectives of the offset habitat are not being met, DFO and FLNRO will be consulted to identify appropriate remediation measures. The habitat offset monitoring will be conducted by a QEP with experience monitoring habitat compensation Proposed Projects. The Fish Habitat Offset Plan is provided in Appendix 5.1-B (Volume 4, Part G – Section 22.0).

If the recommended mitigation strategies, including habitat offsetting, are implemented, it is anticipated that they would be effective in avoiding or limiting adverse effects on Fisheries and Freshwater Habitat associated with direct loss of fish habitat and indirect loss of fish habitat through changes in surface flows.

5.1.5.3.2 Monitoring

5.1.5.3.2.1 Construction Monitoring

Construction monitoring is intended to confirm the implementation of mitigation measures and avoidance of harm to aquatic habitat. The Fisheries Habitat Protection and Mitigation Plan will include the following:

- Construction monitoring will be conducted by a Qualified Environmental Professional (QEP) to manage effects to fish and fish habitat during construction activities.
- The environmental monitor will be on-site during all Proposed Project activities conducted below High Water.
- The environmental monitor will carry out measurements, make visual observations and provide information regarding compliance to the contractor, in regards to construction activities in and around the marine environment and the application of identified mitigation measures.
- The monitor will also assess the effectiveness of the mitigation measures being applied and confirm the Proposed Project footprint is as expected.
- The environmental monitor will prepare and submit to FLNRO and to DFO regular (based on an agreed to schedule) environmental monitoring reports. The regular reports will document construction activities, effectiveness of mitigation measures, incidents, non-compliant events, corrective action taken and photograph documentation.
- In accordance with the recent revisions to the fisheries protection provisions of the *Fisheries Act*; in the event of a non-compliant incident the monitor will contact DFO's Observe, Record and Report (ORR) line (1-800-465-4336) and report the incident.

5.1.5.3.2.2 Follow-up Monitoring

Follow-up monitoring is intended to confirm the predictions of the effects assessment. Monitoring will also determine the effectiveness of the Proposed Project design and mitigation measures. The Fisheries Habitat Protection and Mitigation Plan will include the following:

- Clear objectives for monitoring the continued use of habitats by fish and integrity of fish habitat;
- Fish habitat assessments within the fish-bearing watercourses of the LSA to determine if there are any measurable changes to fish habitat structure and function;
- Fish community assessments within the fish-bearing watercourses of the LSA to determine if there are any measurable changes to fish abundance and distribution;
- Benthic macro-invertebrate sampling within the watercourses of the LSA to determine if there are any measurable changes to the food supply within the creeks; and
- A technical report, at the end of the monitoring period, detailing the results of the monitoring program and assessing the effectiveness of the mitigation measures and the Proposed Project effects on fish and fish habitat.

Follow-up monitoring will be used to identify the need for additional or alternate mitigation or contingencies to ensure no significant adverse residual effects occur to fish and fish habitat due to Proposed Project activities.

Table 5.1-9: Identified Mitigation Measures: Fisheries and Freshwater Habitat

Potential Effect	Mitigation	Anticipated effectiveness
Construction		
Changes to Surface Water Quality – Suspended Sediments	▪ Disturbed areas should be vegetated as soon as possible and where possible by planting and seeding with native trees, shrubs, and grasses. ▪ Disturbed areas adjacent to watercourses should be covered with mulch for sediment control. ▪ Placement of erosion control measures to keep soil in place. ▪ Sediment and erosion control measures should be maintained until re-vegetation is achieved. ▪ Implementation of an Erosion and Sediment Control Plan. Details provided in Volume 3, Part E - Section 16.0. ▪ Implementation of an Air Quality and Dust Control Plan. Details provided in Volume 3, Part E - Section 16.0.	High
Changes to Surface Water Quality - Cementitious (alkaline) Material	▪ Complete isolation of work area is required to ensure waterbodies do not become more alkaline. ▪ pH should be monitored in surrounding waterbodies during concrete pouring. ▪ BMPs should be implemented during setting, mixing, and pouring of concrete to ensure activities meet requirements of applicable legislation. ▪ Pre-cast concrete structures whenever possible. ▪ Keep carbon dioxide tank with regulator, hose, and gas diffuser readily available during concrete works.	High
Effects of Artificial Lighting	▪ Lighting for the purposes of the aggregate mining will not be permitted between dusk to dawn at seasonally appropriate times. ▪ All lighting nearby waterbodies will have baffles to direct light away from the water surface. ▪ Limited lighting will be maintained through the night only for safety purposes.	High
Operations		
Loss of Habitat	▪ Implementation of the Fish Habitat Offset Plan (Volume 4, Part G – Section 22.0: Appendix 5.1-B). Extension of the lower segment WC 2 will collect surface flow diverted through loss of the upper segment and will increase the wetted area within the extension and the lower segment of WC 2. ▪ Designing the pit lake such that lake elevation can be used to manage hydrostatic pressure through the course of operations so changes to groundwater flow does not lead to a loss of flow within McNab Creek. ▪ Similarly, the elevation of the pit lake will be used to manage baseflows in the natural groundwater watercourses below the pit lake.	High

Potential Effect	Mitigation	Anticipated effectiveness
Changes to Surface Water Quality – Suspended Sediments	▪ Fines/silt cakes stored in the Fines Storage Area (Figure 5.1-4) will be vegetated as soon as and where possible by planting and seeding with native trees, shrubs, and grasses. ▪ Placement of erosion control measures to prevent dust. ▪ Sediment and erosion control measures should be maintained at all times around the crushing areas and until vegetation is established on the Pit Lake Containment Berm, the McNab Creek Flood Control Dyke, the Fines Storage Area, and the Processing Area Dirt Berm. ▪ Crushing area should receive water-misting during dry weather events to reduce dust release. ▪ Implementation of an Erosion and Sediment Control Plan. ▪ Implementation of an Air Quality and Dust Control Plan.	High
Effects of Artificial Lighting	▪ Lighting for the purposes of the aggregate mining will not be permitted between dusk to dawn at seasonally appropriate times. ▪ All lighting nearby waterbodies will have baffles to direct light away from the water surface. ▪ Limited lighting will be maintained through the night only for safety purposes.	High
Reclamation and Closure		
Loss of Habitat	▪ Implementation of the Fish Habitat Offset Plan (Volume 4, Part G – Section 22.0: Appendix 5.1-B). Extension of the lower segment WC 2 will collect surface flow diverted through loss of the upper segment and will increase the wetted area within the extension and the lower segment of WC 2. ▪ Designing the pit lake such that lake elevation can be used to manage hydrostatic pressure through closure so changes to groundwater flow does not lead to a loss of flow within McNab Creek. ▪ Similarly, the elevation of the pit lake will be used to manage baseflows in the natural groundwater watercourses below the pit lake.	High
Changes to Surface Water Quality – Suspended Sediments	▪ Disturbed areas should be vegetated as soon as possible and where possible by planting and seeding with native trees, shrubs, and grasses. ▪ Disturbed areas adjacent to watercourses should be covered with mulch for sediment control. ▪ Placement of erosion control blankets to keep soil in place. ▪ Sediment and erosion control measures should be maintained until re-vegetation is achieved. ▪ Implementation of a Erosion and Sediment Control Plan. ▪ Implementation of an Air Quality and Dust Control Plan.	High

Potential Effect	Mitigation	Anticipated effectiveness
Effects of Artificial Lighting	▪ Lighting for the purposes of the aggregate mining will not be permitted between dusk to dawn at seasonally appropriate times. ▪ All lighting nearby waterbodies will have baffles to direct light away from the water surface. ▪ Limited lighting will be maintained through the night only for safety purposes.	High
Accidents and Malfunctions		
Toxic and Hazardous Material Spills	▪ Adherence to Spill Prevention and Emergency Response Plan (SERP)	High
Loss of Pit Lake Containment	▪ Adherence to BC Dam Safety Regulation ▪ Monitoring	High

5.1.5.4 Residual Effects Assessment

Potential Project-related residual effects on fish and fish habitat following the application of the appropriate mitigation measures described above were characterized using the assessment criteria described in Section 5.1.3.3.3. Potential Project-related residual effects have been characterized for each VC in Table 5.1-10 and Table 5.1-11 . The likelihood of potential residual effects occurring following the application of mitigation proposed in Section 5.1.5.3 is presented in Table 5.1-12.

5.1.5.4.1 Construction, Operation, Reclamation and Closure

5.1.5.4.1.1 Loss of Habitat

The mitigation measures proposed to reduce the loss of freshwater fish habitat are expected to be effective. To offset the loss of 3,307 m^2 of instream freshwater habitat along with the loss of 116 m^2 of wetted area caused by removal of the upper segment of WC 2 and the predicted reduction of flow respectively , the lower segment of WC 2 will be extended (i.e., offset). The majority of the extension (i.e., all but the last 70 m connecting to the pit lake) will be constructed prior to the decommissioning of the upper segment to allow the establishment of fish habitat in the extension and the migration of fish into this habitat prior to the removal of habitat in the upper segment of WC 2. This will create approximately 3,562 m^2 of instream fish habitat during operations. At closure, once the last 70 m have been constructed, the extension of WC 2 along with the increased elevation of groundwater in the area associated with the flooded pit will lead to a substantial increase in wetted area (i.e., fish habitat) within the extension. The extension will create approximately 4,213 m^2 of new instream fish habitat. In addition, to offset the loss of 1,560 m^2 of riparian habitat caused by the removal of the upper segment of WC 2 the extension will create approximately 19,196 m^2 of new riparian habitat. The construction and planting of riparian habitat will also be initiated prior to the losses of riparian habitat to allow for the establishment and greening of the vegetation around the extension prior to the removal of riparian habitat in the upper segment of WC 2. Details regarding the Fish Habitat Offset Plan are provided in Volume 4, Part G – Section 22.0: Appendix 5.1-B.

Given the reduced stock productivity of Coho Salmon and that risks to Coho Salmon include the loss and degradation of freshwater habitat especially in small watercourses in the Sunshine Coast (DFO 2001), Coho salmon are considered to be susceptible to potential changes caused by the loss of habitat as a result of the Proposed Project (context is sensitive). All other anadromous and resident freshwater fish VCs are considered to have stable fish populations and have access to other suitable stable habitat in the area therefore, these VCs are considered to have a low susceptibility to potential changes caused by the Proposed Project (context is resilient). The magnitude of the loss of habitat is considered to be low for all anadromous and resident freshwater fish VCs (only small changes in the relative abundance of fish populations or habitat) due to the construction of similar function habitat (i.e., salmonid rearing and overwintering habitat) in the extension. In addition, the proposed extension is expected to provide higher value habitat as a result of the presence of a functional and improved riparian area and the incorporation of instream cover structures into the watercourse. The extent of the effect is confined to the LSA and considered local, and fully reversible with the implementation of offsetting habitat. The frequency is considered low for the removal of WC 2 (occurs once during the operations phase) and high for loss in habitat related to reductions in flow in the lower segment of WC 2 (effect occurs throughout the Project). The duration of the effect of loss of habitat is considered medium term (one to five years) as the functionality of the extension may not be fully realised within the first year. The likelihood of this effect occurring is considered low given the construction of more new and notably improved fish habitat (4,213 m^2 instream and 19,196 m^2 riparian)

than will be lost or disrupted by the Proposed Project (3,538 m^2 instream and 1,560 m^2 riparian). The level of confidence that the effect will not be greater than predicted is high due to the predicted effectiveness of the proposed offsetting habitat as it will be based on the characteristics of the lower segment of WC 2, which is known to be functioning as high value rearing and overwintering habitat for juvenile salmonids.

5.1.5.4.1.2 Changes to Surface Water Quality – Suspended Sediments

The mitigation measures proposed to avoid or minimize changes to freshwater fish habitat as a result of suspended sediment in surface water are expected to be effective. Due to their proximity to the Proposed Project Area, WC 5 and Harlequin Creek are the most likely fish bearing watercourses to be affected by increased levels of suspended sediments as a result of Proposed Project activities (Figure 5.1-2). In addition, the lower segment of WC 2 as well as WC 3 could be affected by increases suspended sediments through the works to remove the upper segment of WC 2. Given that these watercourses maintain rearing, overwintering and spawning habitats and could support juvenile and larval fish that are particularly susceptible to increases in suspended sediments, the context for all anadromous and resident freshwater fish VCs is considered sensitive (existing system is considered to be susceptible to potential changes caused by the Proposed Project). Given the application of known and effective mitigation, the magnitude of any changes to surface water quality are predicted to be low (potential measurable change but within the scope of natural variability with no population level effects anticipated). The geographic extent is local since the residual effect will be restricted to the LSA. The duration is considered short-term and the reversibility is considered low (the effect can be reversed) as potential effects would be limited to certain high risk activities and the system would return to pre-activity conditions once the activity ceases or adaptive mitigation is implemented to limit the effects. The frequency of the effect is considered to be low as the potential for the residual effect would be related to a specific combination of activities and meteorological conditions (i.e., heavy rains; Table 5.1-10 and Table 5.1-11). The likelihood of this effect occurring is considered low given the application of known and effective mitigation measures and best practices. The level of confidence that the effect will not be greater than predicted is high due to the predicted effectiveness of the proposed mitigation.

5.1.5.4.1.3 Changes to Surface Water Quality – Cementitious (alkaline) Materials

The mitigation measures proposed to avoid or minimize changes to freshwater fish habitat as a result of cementitious (alkaline) materials in surface water are expected to be effective. Due to their proximity to the Proposed Project Area, WC 5 and Harlequin Creek are the most likely fish bearing watercourses to be affected by cementitious (alkaline) materials as a result of Proposed Project construction activities (Figure 5.1-2). Given that these watercourses maintain rearing, overwintering and spawning habitats and could support juvenile and larval fish that are particularly susceptible to increases in suspended sediments, the context for all anadromous and resident freshwater fish VCs is considered sensitive (existing system is considered to be susceptibility to potential changes caused by the Proposed Project). Given the application of known and effective mitigation, the magnitude of any changes to surface water quality are predicted to be low (potential measureable change but within the scope of natural variability with no population level effects anticipated). The geographic extent is local since the residual effect will be restricted to the LSA. The duration is considered short-term and the reversibility is considered low (the effect can be reversed) as potential effects would be limited to cast in-place curing activities during construction. The frequency of the effect is considered to be low as the potential for the residual effect would be related to a specific combination of activities and meteorological conditions (i.e., heavy rains; Table 5.1-10 and

Table 5.1-11). The likelihood of this effect occurring is considered low given the application of known and effective mitigation measures and best practices. The level of confidence that the effect will not be greater than predicted is high due to the predicted effectiveness of the proposed mitigation.

5.1.5.4.1.4 Effects of Artificial Light

The mitigation measures proposed to avoid or minimize effects to anadromous and resident freshwater fish VCs and their habitats as a result of artificial light are expected to be effective. Due to their proximity to the Proposed Project Area, WC 5 and Harlequin Creek are the most likely fish bearing watercourses to be affected by artificial light as a result of Proposed Project activities (Figure 5.1-2). Given that these watercourses maintain rearing, overwintering and spawning habitats and could support smolts who are particularly sensitive to artificial lights, the context for all anadromous and resident freshwater fish VCs is considered sensitive (existing system is considered to be susceptible to potential changes caused by the Proposed Project). Given the application of known and effective mitigation and the limited use of nighttime lighting to security lighting only (all construction, operational and reclamation work will occur during daylight hours) the magnitude of the effect is predicted to be low (potential measurable change but within the scope of natural variability with no population level effects anticipated). The geographic extent is local since the residual effect will be restricted to the LSA. The duration is considered long-term as security lighting will be required throughout the Proposed Project. The reversibility is considered low (the effect can be reversed) as the most sensitive species may avoid habitats affected by nighttime lighting altogether but will likely be able to find other areas in close proximity to relocated to. The frequency of the effect is considered to be high as the potential for the residual effect would occur continuously during the nighttime (Table 5.1-10 and Table 5.1-11). The likelihood of this effect occurring is considered low given the application of known and effective mitigation measures and best practices. The level of confidence that the effect will not be greater than predicted is high due to the predicted effectiveness of the proposed mitigation.

5.1.5.4.2 Accidents and Malfunctions

5.1.5.4.2.1 Toxic and Hazardous Material Spills

The mitigation measures proposed to prevent, reduce and control releases of deleterious substances (e.g. Hydrocarbon spills) in the freshwater environment as a result of accidental events are expected to be effective.

Potential accidents that could result in spills to the freshwater environments include equipment blow-outs, vehicle collisions or rollovers, or spills during refueling. Most of the released fuel would undergo rapid weathering and evaporation processes and would be contained and cleaned by emergency response crews. Concentrations of hydrocarbons in water and potentially sediment would likely exceed established guidelines (CCME 2016; BC MoE 2006b) and subsequently result in adverse toxic effects on benthic invertebrates, and potentially fish.

The context of all anadromous and resident freshwater fish VCs is considered sensitive to change caused by potential toxic spills as a result of the Proposed Project, as a spill could impact sensitive life history fish stages depending on the timing of the spill. The magnitude of effect of a potential hydrocarbon spill is assessed as high. The predicted effect is considered local to beyond regional in extent as a spill in a freshwater watercourse in the LSA could be carried out to sea and short-term in duration since spilled hydrocarbons would likely biodegrade within one or two months of an event (NOAA 1992), however chronic (long term) toxic effects from contamination may persist longer. The frequency of this potential effect is considered is low (occurs rarely) and fully reversible.

With the proposed mitigation in place as well as the limited use of equipment that require fuel/oils to function (many of the large pieces of equipment on-site (e.g., conveyor) will use electricity) the likelihood of a major hydrocarbon spill is considered low. Confidence that the effect will not be greater than predicted is moderate as scientific evidence regarding species-specific responses to spills is limited; however, the mitigation is expected to be effective in limiting the effects.

5.1.5.4.2.2 Loss of containment of the Pit Lake

The mitigation measures proposed to prevent a loss of containment of the Pit Lake into the freshwater environment as a result of accidental events are expected to be effective.

Potential accidents or malfunctions that could result in a loss of containment into the freshwater environments are limited to a structural failure of the containment structures (the dam). The effects on fish and fish habitat would depend on the location and volume of water and material released. A small release that could be contained within existing channels would have effects similar to a natural flood event where increased scour and sedimentation would be minor and effects temporary with recovery of habitat function within a single year. A larger release beyond the capacity of the existing channels could lead to extensive scour and sediment deposition that would form new channels. Habitat remediation and adaptive management measures would need to be implemented to manage potential loss of habitat productivity.

All anadromous and resident freshwater fish VCs is considered sensitive to change caused by increased erosion and sediment deposition associated with a loss of containment of the Pit Lake. A loss of containment could impact sensitive life history fish stages depending on the timing of the loss. The magnitude of effect of a potential loss of containment is assessed as high. The predicted effect is considered local in extent as a loss of containment in a freshwater watercourse in the LSA could reach the foreshore, moderate-term in duration since most habitat effects could take several years to recover however chronic (long term) effects (loss of riparian habitat) may persist longer. The frequency of this potential effect is considered is low (occurs rarely) and reversible. With the proposed mitigation in place the likelihood of a major loss of containment is considered low. Confidence that the effect will not be greater than predicted is high as there is good scientific evidence regarding species-specific responses to increased levels of erosion and sedimentation; however, the mitigation is expected to be effective in limiting the effects.

Table 5.1-10: Characterization of Potential Project-Related Residual Effects: Anadromous Coho Salmon, Chum Salmon, and Cutthroat Trout and their Habitats

Project-Related Effect	Residual Effect Assessment Criteria					
	Context	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
Construction						
Changes to Surface Water Quality – Suspended Sediments	S	L	L	ST	FR	L
Changes to Surface Water Quality – Cementitious (alkaline) Materials	S	L	L	ST	FR	L
Effects of Artificial Lighting	S	L	L	LT	FR	H
Operations						
Loss of Habitat	S to R	L	L	MT	FR	L to H
Changes to Surface Water Quality – Suspended Sediments	S	L	L	ST	FR	L
Effects of Artificial Lighting	S	L	L	LT	FR	H
Reclamation and Closure						
Loss of Habitat	S	L	L	MT	FR	L to H
Changes to Surface Water Quality – Suspended Sediments	S	L	L	ST	FR	L
Accidents and Malfunctions						
Toxic and Hazardous Material Spills	S	H	L to BR	ST	FR	L
Loss of Pitt Lake Containment	S	H	L	LT	PR	L

Assessment Criteria: Context: S - Sensitive, R - Resilient
Magnitude: N – Negligible, L – Low, M – Medium, H – High;
Geographic Extent: L – Local, R – Regional, BR – Beyond Regional;
Duration: ST – Short-tern, MT – Medium-term, LT – Long-term;
Reversibility: FR - Fully Reversible, PR - Partially Reversible, IR - Irreversible
Frequency: L – Low, M – Medium, H – High

Table 5.1-11: Characterization of Potential Project-Related Residual Effects: Resident Cutthroat Trout and their Habitats

Project-Related Effect	Residual Effect Assessment Criteria					
	Context	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
Construction						
Changes to Surface Water Quality – Suspended Sediments	S	L	L	ST	FR	L
Changes to Surface Water Quality – Cementitious (alkaline) Materials	S	L	L	ST	FR	L
Effects of Artificial Lighting	S	L	L	LT	FR	H
Operations						
Loss of Habitat	S to R	L	L	MT	FR	L to H
Changes to Surface Water Quality – Suspended Sediments	S	L	L	ST	FR	L
Effects of Artificial Lighting	S	L	L	LT	FR	H
Reclamation and Closure						
Loss of Habitat	S to R	L	L	MT	FR	L to H
Changes to Surface Water Quality – Suspended Sediments	S	L	L	ST	FR	L
Effects of Artificial Lighting	S	L	L	LT	FR	H
Accidents and Malfunctions						
Toxic and Hazardous Material Spills	S	H	L to BR	ST	FR	L
Loss of Pit Lake Containment	S	H	L	MT	FR	L

Assessment Criteria: Context: S - Sensitive, MR – Moderately Resilient; R - Resilient
Magnitude: N – Negligible, L – Low, M – Medium, H – High;
Geographic Extent: L – Local, R – Regional, BR – Beyond Regional;
Duration: ST – Short-tern, MT – Medium-term, LT – Long-term;
Reversibility: FR - Fully Reversible, PR - Partially Reversible, IR - Irreversible
Frequency: L – Low, M – Medium, H – High

Table 5.1-12: Likelihood of Occurrence of Potential Residual Effects: Fisheries and Freshwater Habitats

VC	Residual Effect	Likelihood	Rationale
Construction			
Anadromous Coho Salmon, Chum Salmon, and Cutthroat Trout and their habitats	Changes in Surface Water Quality – Suspended Sediments	Low	Mitigation measures and best practices are anticipated to reduce the likelihood of the effect.
	Changes in Surface Water Quality – Cementitious (alkaline) material	Low	Mitigation measures and best practices are anticipated to reduce the likelihood of the effect.
	Effects of Artificial Lighting	Low	Limited use of artificial nighttime lighting along with mitigation measures is anticipated to reduce the likelihood of the effect.
Resident Cutthroat Trout and their Habitats	Changes in Surface Water Quality – Suspended Sediments	Low	Mitigation measures and best practices are anticipated to reduce the likelihood of the effect.
	Changes in Surface Water Quality – Cementitious (alkaline) material	Low	Mitigation measures and best practices are anticipated to reduce the likelihood of the effect.
	Effects of Artificial Lighting	Low	Limited use of artificial nighttime lighting along with mitigation measures is anticipated to reduce the likelihood of the effect.
Operations			
Anadromous Coho Salmon, Chum Salmon, and Cutthroat Trout and their habitats	Loss of Habitat	Low	Habitat offsetting will generate more instream and riparian habitat than is predicted to be lost.
	Changes in Surface Water Quality – Suspended Sediments	Low	Mitigation measures and best practices are anticipated to reduce the likelihood of the effect.
	Effects of Artificial Lighting	Low	Limited use of artificial nighttime lighting along with mitigation measures is anticipated to reduce the likelihood of the effect.
Resident Cutthroat Trout and their Habitats	Loss of Habitat	Low	Habitat offsetting will generate more instream habitat than is predicted to be lost.
	Changes in Surface Water Quality – Suspended Sediments	Low	Mitigation measures and best practices are anticipated to reduce the likelihood of the effect.
	Effects of Artificial Lighting	Low	Limited use of artificial nighttime lighting along with mitigation measures is anticipated to reduce the likelihood of the effect.

VC	Residual Effect	Likelihood	Rationale
Reclamation and Closure			
Anadromous Coho Salmon, Chum Salmon, and Cutthroat Trout and their habitats	Loss of Habitat	Low	Habitat offsetting will generate more instream and riparian habitat than is predicted to be lost.
	Changes in Surface Water Quality – Suspended Sediments	Low	Mitigation measures and best practices are anticipated to reduce the likelihood of the effect.
	Effects of Artificial Lighting	Low	Limited use of artificial nighttime lighting along with mitigation measures is anticipated to reduce the likelihood of the effect.
Resident Cutthroat Trout and their Habitats	Loss of Habitat	Low	Habitat offsetting will generate more instream and riparian habitat than is predicted to be lost.
	Changes in Surface Water Quality – Suspended Sediments	Low	Mitigation measures and best practices are anticipated to reduce the likelihood of the effect.
	Effects of Artificial Lighting	Low	Limited use of artificial nighttime lighting along with mitigation measures is anticipated to reduce the likelihood of the effect.
Accidents and Malfunctions			
All anadromous and resident freshwater fish VCs	Toxic and Hazardous Material Spills	Low	Spills are unlikely to occur after mitigation applied.
All anadromous and resident freshwater fish VCs	Loss of Pitt Lake Containment	Low	Containment loss is unlikely to occur after mitigation applied.

5.1.5.5 Significance of Residual Effects

The significance of potential residual adverse effects will be determined for each VC based on the residual effects criteria and the likelihood of a potential residual effect occurring, a review of background information and available field study results, consultation with government agencies, First Nations, and other experts, and professional judgement. A summary of significance determinations is presented in Table 5.1-13.

The determination of significance of residual adverse effects is rated as negligible-not significant, non-significant, or significant, which are generally defined as follows:

- **Negligible** – Not Significant - Effects will have little to no detectable or measureable effects on the VC and its subcomponents. Detectable or measurable effects may include fish mortality or reductions in; fish presence/absence, fish condition, fish abundance, quality and quantity of habitat, and habitat availability for spawning, rearing, foraging, and holding. Negligible effects are not carried forward to the cumulative effects assessment;
- **Not significant** - Effects are greater than negligible but do not meet the definition of “significant”. Not significant effects are carries forward to the cumulative effects assessment; or

- **Significant** - Effects are any action or process that may lead to the death of fish or a permanent reduction in the quality or quantity of available fish habitat. Significant effects are carried forward to the cumulative effects assessment and are considered for each VC.

Detailed rationale for significance determinations is provided below.

5.1.5.5.1 Loss of Habitat

The Fish Habitat Offset Plan provides more new and notably improved fish habitat (4,213 m^2 instream and 19,196 m^2 riparian) than will be lost or disrupted by the Proposed Project (3,538 m^2 instream and 1,560 m^2 riparian). The fish habitat created by the extension of the lower segment of WC 2 is expected to fully offset the habitat losses associated with the Proposed Project effects. The upper segment of the WC 2 currently provides a similar function (i.e., salmonid rearing and overwintering habitat) to what will be provided by the extension of the lower segment of WC 2, although the proposed extension will provide higher value habitat as a result of the presence of a functional and improved riparian area and the incorporation of instream cover structures into the channel. As a result the significance of this residual effect is considered to be negligible – not significant (Table 5.1-13).

5.1.5.5.2 Changes to Water Quality – Suspended Sediments

Potential changes to anadromous and resident freshwater fish VCs and their habitats as a result of increases in suspended sediments in surface water during Project activities are expected to be controlled with mitigation. Any residual effects would be restricted to specific combination of activities and meteorological conditions (i.e., heavy rains). With the application of known and effective mitigation (i.e., in-water works during fisheries work windows, environmental monitoring by a qualified EM, and implementation of a CEMP), the significance of this residual effect is considered to be negligible – not significant (Table 5.1-13).

5.1.5.5.3 Changes to Water Quality – Cementitious (alkaline) Materials

Potential changes to anadromous and resident freshwater fish VCs and their habitats as a result of cementitious materials in surface water during Project activities are expected to be controlled with mitigation. Any residual effects would be restricted to cast-in place curing activities in combination with meteorological conditions (i.e., heavy rains). With the application of known and effective mitigation (i.e., used of pre-caste when possible, environmental monitoring by a qualified EM, and implementation of a CEMP), the significance of this residual effect is considered to be negligible – not significant (Table 5.1-13).

5.1.5.5.4 Accidents and Malfunctions

The magnitude of a potential hydrocarbon spill was assessed as high for all anadromous and resident freshwater fish VCs. However, adherence to the Proponent's SERP and compliance with the applicable safety regulations (for vehicles) will result in a low likelihood of occurrence. With the application of mitigation measures the significance of this residual effect is considered to be negligible – not significant (Table 5.1-13).

Table 5.1-13: Significance of Potential Residual Effects: Fisheries and Freshwater Habitats

VC	Residual Effect	Significance	Rationale
Construction			
Anadromous Chum, Coho, Pink Salmon and Anadromous and Resident Cutthroat Trout and their habitats	Changes to Surface Water Quality – Suspended Sediments	Negligible– Not Significant	Residual effects restricted to specific combination of activities and meteorological conditions (i.e., heavy rains). Mitigation and monitoring works are expected to be effective.
Anadromous Chum, Coho, Pink Salmon and Anadromous and Resident Cutthroat Trout and their habitats	Changes to Surface Water Quality – Cementitious (alkaline) materials	Negligible– Not Significant	Residual effects restricted to specific combination of caste-in-place concrete and meteorological conditions (i.e., heavy rains). Mitigation and monitoring works are expected to be effective.
Anadromous Chum, Coho, Pink Salmon and Anadromous and Resident Cutthroat Trout and their habitats	Effects of Artificial Lighting	Negligible– Not Significant	Limited use of artificial nighttime lighting. Mitigation is expected to be effective.
Operations			
Anadromous Chum, Coho, Pink Salmon and Anadromous and Resident Cutthroat Trout and their habitats	Loss of Habitat	Negligible – Not Significant	The habitat offsetting will provide more new and notably improved fish habitat 3,562 m^2 instream and 15,863 m^2 riparian) during operations than will be lost or disrupted by the Proposed Project (3,538 m^2 instream and 1,560 m^2 riparian).
Anadromous Chum, Coho, Pink Salmon and Anadromous and Resident Cutthroat Trout and their habitats	Changes to Surface Water Quality – Suspended Sediments	Negligible – Not Significant	Residual effects restricted to specific combination of activities and meteorological conditions (i.e., heavy rains). Mitigation and monitoring works are expected to be effective.
Anadromous Chum, Coho, Pink Salmon and Anadromous and Resident Cutthroat Trout and their habitats	Effects of Artificial Lighting	Negligible – Not Significant	Limited use of artificial nighttime lighting. Mitigation is expected to be effective.

VC	Residual Effect	Significance	Rationale
Reclamation and Closure			
Anadromous Chum, Coho, Pink Salmon and Anadromous and Resident Cutthroat Trout and their habitats	Loss of Habitat	Negligible – Not Significant	The habitat offsetting will provide more new and notably improved fish habitat (3,562 m^2 at operations + 650 m^2 of instream habitat at closure and 15,864 m^2 at operations + 3,332 m^2 of riparian habitat at closure) at closure than will be lost or disrupted by the Proposed Project (3,538 m^2 instream and 1,560 m^2 riparian).
Anadromous Chum, Coho, Pink Salmon and Anadromous and Resident Cutthroat Trout and their habitats	Changes to Surface Water Quality – Suspended Sediments	Negligible – Not Significant	Residual effects restricted to specific combination of activities and meteorological conditions (i.e., heavy rains). Mitigation and monitoring works are expected to be effective.
Anadromous Chum, Coho, Pink Salmon and Anadromous and Resident Cutthroat Trout and their habitats	Effects of Artificial Lighting	Negligible – Not Significant	Lighting will be directed onto work areas and be localised to water surfaces directly adjacent to those facilities.
Accidents and Malfunctions			
Anadromous Chum, Coho, Pink Salmon and Anadromous and Resident Cutthroat Trout and their habitats	Toxic and Hazardous Material Spills	Negligible – Not Significant	The implementation of mitigation including the SERP reduces the likelihood of this effect as well as the magnitude in the unlikely event of an accidental spill.
Anadromous Chum, Coho, Pink Salmon and Anadromous and Resident Cutthroat Trout and their habitats	Loss of Pit Lake Containment	Negligible – Not Significant	The implementation of mitigation including adherence to dam design and monitoring requirements reduces the likelihood of this effect as well as the magnitude in the unlikely event of an accidental loss of containment.

5.1.5.6 Level of Confidence

The level of confidence of predicted residual effects is provided in Table 5.1-14. The prediction confidence of the assessment on each VC is based on scientific information and statistical analysis, professional judgement and effectiveness of mitigation (rated as High, Moderate, and Low confidence).

Table 5.1-14: Level of Confidence in Potential Residual Effect Predictions: Fisheries and Freshwater Habitats

Residual Effect	Level of Confidence (LOC) in Residual Effect Prediction	LOC Rationale
Construction		
Changes to Surface Water Quality – Suspended Sediments	High	Predicted effectiveness of proposed mitigation. Environmental monitoring by qualified EM. Adherence to EMP.
Changes to Surface Water Quality – Cementitious (alkaline) materials	High	Predicted effectiveness of proposed mitigation. Environmental monitoring by qualified EM. Adherence to EMP.

Residual Effect	Level of Confidence (LOC) in Residual Effect Prediction	LOC Rationale
Effects of Artificial Lighting	High	Limited use of artificial nighttime lighting. Potential effects will be limited to a few watercourses. Mitigation measures are anticipated to be effective at reducing light pollution on water surfaces.
Operations		
Loss of Habitat	High	Conservative estimates incorporated in the surface water and groundwater models. Assessment of habitat losses are based on detailed field studies (Volume 4, Part G – Section 22.0: Appendix 5.1-B). The potential effects associated with reduced baseflow are well understood and the proposed offsetting is using the lower segment of WC 2, which is known to be functional, as a template.
Changes to Surface Water Quality – Suspended Sediments	High	Predicted effectiveness of proposed mitigation. Environmental monitoring by qualified EM. Adherence to EMP.
Effects of Artificial Lighting	High	Limited use of artificial nighttime lighting. Potential effects will be limited to a few watercourses. Mitigation measures are anticipated to be effective at reducing light pollution on water surfaces.
Reclamation and Closure		
Loss of Habitat	High	Conservative estimates incorporated in the surface water and groundwater models. Assessment of habitat losses are based on detailed field studies (Volume 4, Part G – Section 22.0: Appendix 5.1-B). The potential effects associated with reduced baseflow are well understood and the proposed offsetting is using the lower segment of WC 2, which is known to be functional, as a template.
Changes to Surface Water Quality – Suspended Sediments	High	Predicted effectiveness of proposed mitigation. Environmental monitoring by qualified EM. Adherence to EMP.
Effects of Artificial Lighting	High	Limited use of artificial nighttime lighting. Potential effects will be limited to a few watercourses. Mitigation measures are anticipated to be effective at reducing light pollution on water surfaces.

Residual Effect	Level of Confidence (LOC) in Residual Effect Prediction	LOC Rationale
Accidents and Malfunctions		
Toxic and Hazardous Material Spills	Moderate	Adherence to SERP. Scientific information regarding species-specific responses to hydrocarbon spills is lacking.
Loss of Pit Lake Containment	High	Predicted effectiveness of proposed mitigation. Design and monitoring of the structure by a qualified professional. The effects of increased flow and sedimentation on fish and fish habitat are well understood.

5.1.5.7 Cumulative Effects Assessment

VCs that were determined to have not-significant or significant residual effects were carried forward in the cumulative effects assessment. All potential Project-related residual adverse effects to Fisheries and Freshwater VCs were determined to be negligible – not significant and requiring no further consideration. No residual effects were carried forward to a cumulative effects assessment. Additional information on the methods used for the cumulative effects assessment is provided in Volume 2, Part B – Section 4.5.5

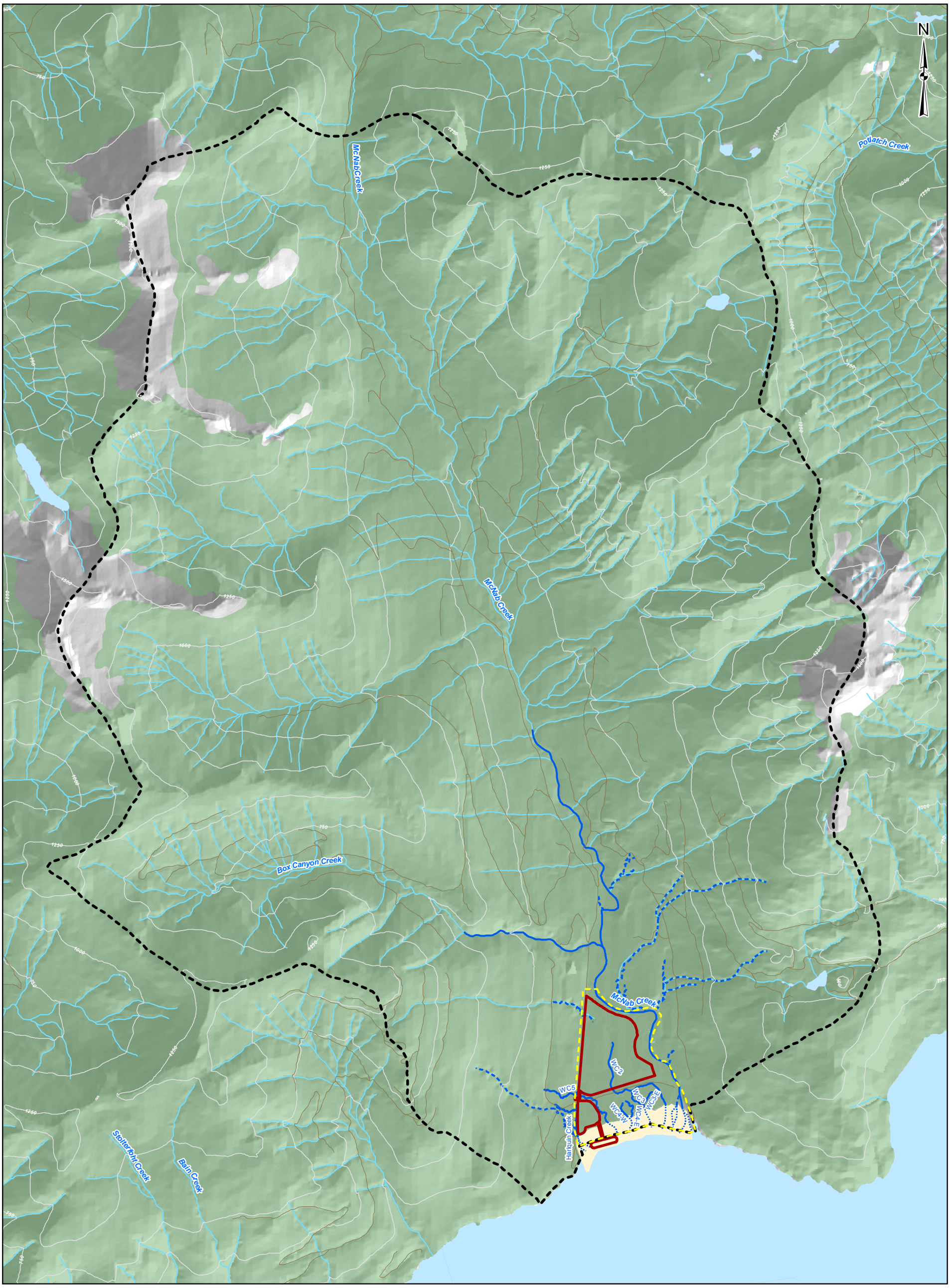
5.1.6 Conclusions

Based on the Fisheries and Freshwater Habitat assessment, the Proposed Project will not lead to a reduction in the quantity or quality of fish habitat. The loss of the riparian and instream habitat associated with the upper segment of WC 2 will be adequately offset by the extension of the lower segment of WC 2. The extension is predicted to lead to an increase in both instream and riparian habitat for anadromous salmonids and resident Cutthroat Trout.

The majority of the Project-related residual effects can be mitigated through Project planning and implementation of known and effective mitigation measures, including a comprehensive Environmental Management Program involving: Spill Prevention and Emergency Response Plans, Erosion and Sediment Control Plan and a Fish Habitat Offset Plan.

Net residual effects for anadromous and resident freshwater fish VCs are predicted to be negligible – not significant given the magnitude, and ecological context.

All potential Project-related residual adverse effects were determined to be negligible – not significant and requiring no further consideration. No residual effects were carried forward to a cumulative effects assessment



LEGEND

- Project Area
- Local Study Area
- Regional Study Area
- Vegetation
- McNab Creek Estuary
- Resource Road
- Contour (250m)
- Watercourse
- Permanent / Perennial Watercourse
- Intermittent Watercourse
- Intertidal Watercourse

1,000 0 1,000

SCALE 1:40,000 METRES

PROJECT

BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

TITLE

FISH AND FISH HABITAT STUDY AREAS

	PROJECT NO. 11-1422-0046			PHASE No.	
Golder Associates	DESIGN	DC	01 May 2015	SCALE AS SHOWN	REV. 1
	GIS	DL	17 May 2016	FIGURE 5.1-1	
	CHECK	DC	01 Mar 2016		
	REVIEW	SR	01 Mar 2016		

REFERENCE

Contours from TRIM positional data. DEM from Geobase. Vegetation from Canvec. Watercourses from the Province of British Columba and field data. Resource roads from the Province of British Columbia. All rights reserved. McNab Creek Estuary digitized from Province of BC, 1999. Projection: UTM Zone 10 Datum: NAD 83

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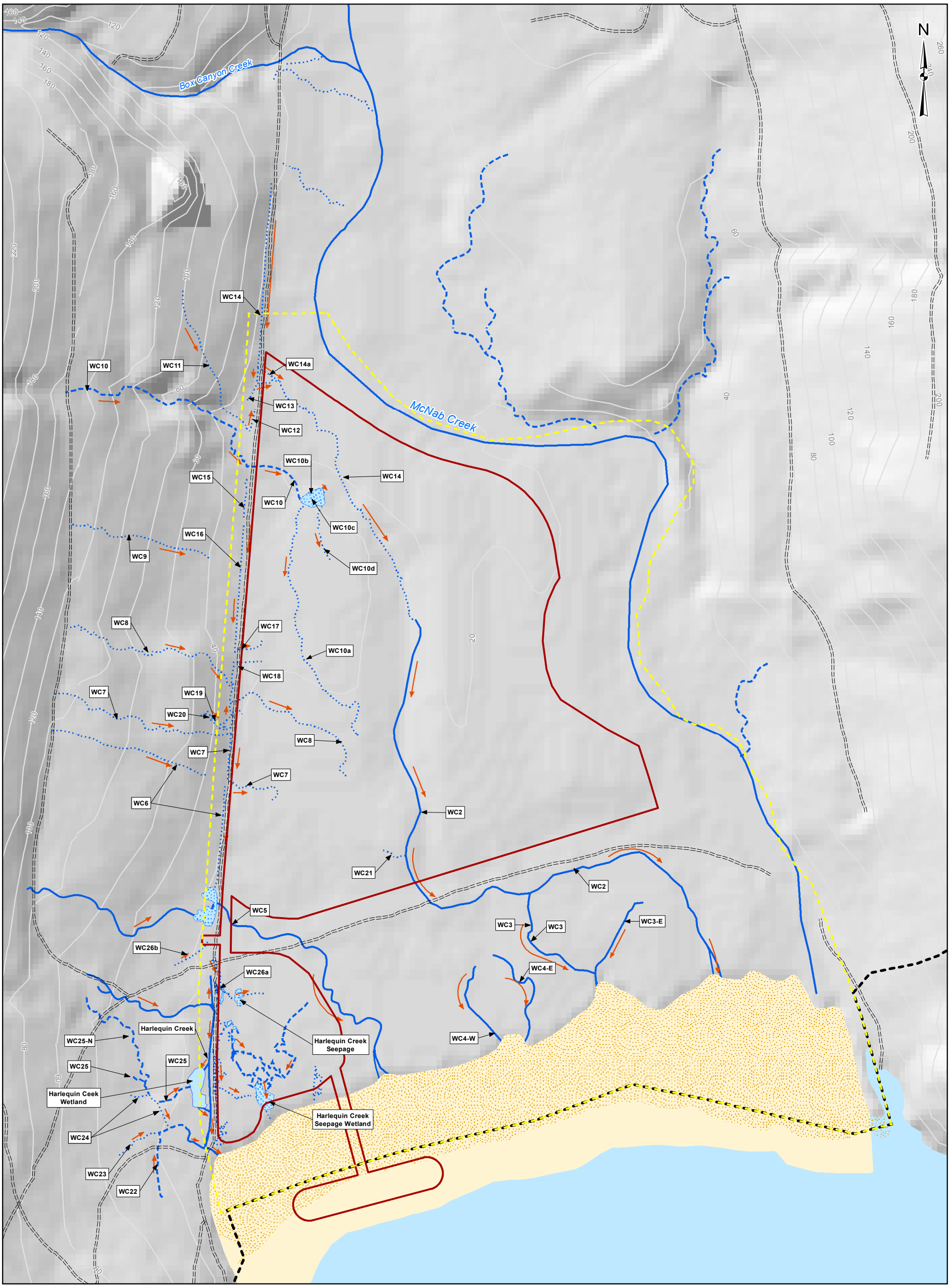

LEGEND

- Project Area
- Local Study Area
- Regional Study Area
- McNab Creek Estuary
- Low Lying Wetted Area
- Beaver Impounded Wetted Area
- Waterbody
- Intertidal Zone
- Road (Existing)
- Contour (20m)
- Permanent / Perennial Watercourse
- Intermittent Watercourse
- Ephemeral Watercourse
- Direction of Flow

200 0 200

SCALE 1:7,000 METRES

REFERENCE

DEM from Geobase. Watercourses from the Province of British Columbia and field data. Base data from the Province of British Columbia. Contours from TRIM positional data. McNab Creek Estuary digitized from Province of BC, 1999.
Projection: UTM Zone 10 Datum: NAD 83

PROJECT

BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

TITLE

WATERCOURSES

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No.	
DESIGN	DC	01 May 2015	SCALE AS SHOWN	REV. 1
GIS	DL	17 May 2016		
CHECK	DC	01 Mar 2016		
REVIEW	SR	01 Mar 2016		

FIGURE 5.1-2

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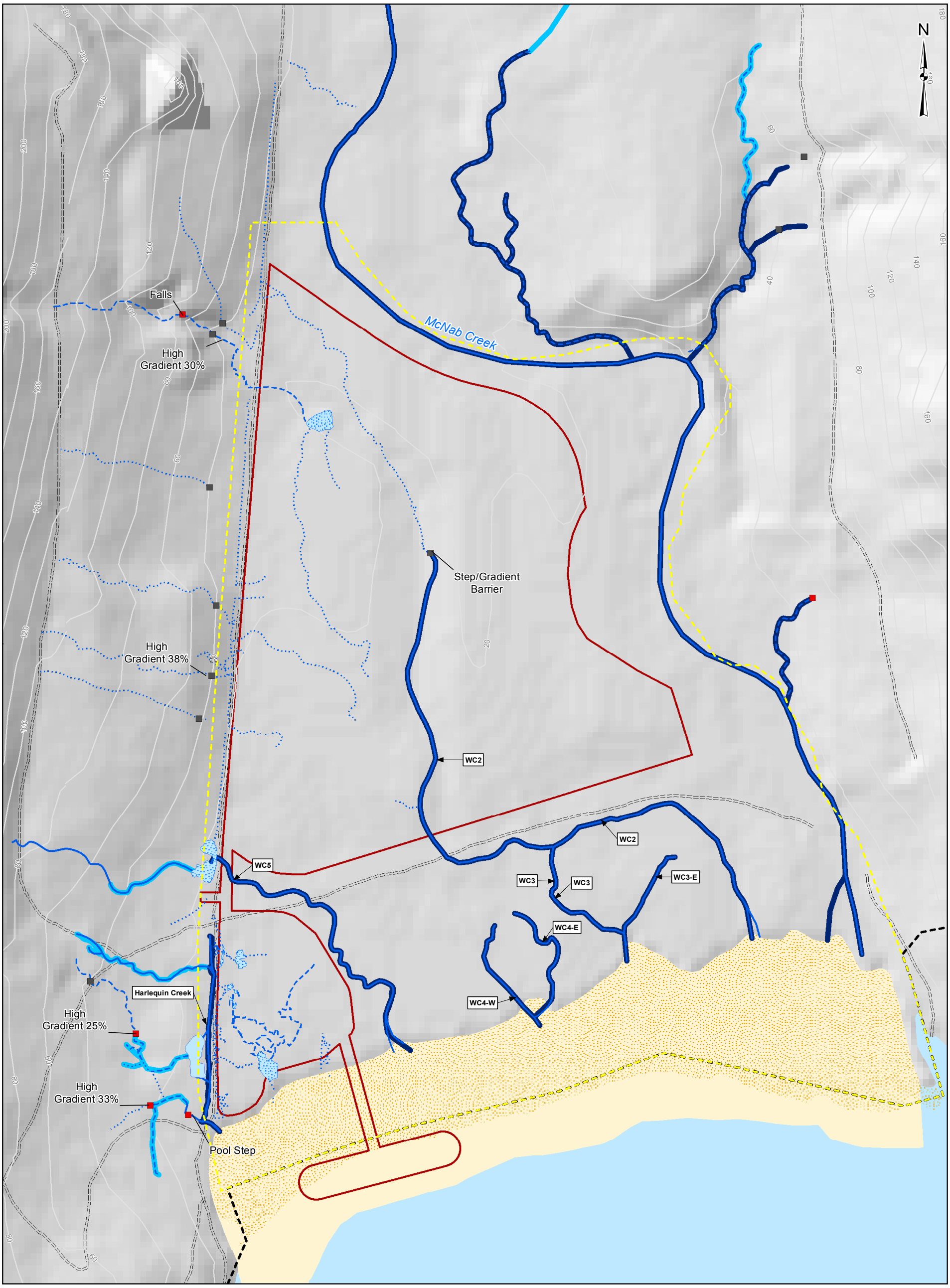

LEGEND

- Field Observed
- Gradient greater than 25% *
- Project Area
- Local Study Area
- Regional Study Area
- McNab Creek Estuary
- Low Lying Wetted Area
- Beaver Impounded Wetted Area
- Waterbody
- Intertidal Zone
- Road (Existing)
- Contour (20m)
- Permanent / Perennial Watercourse
- Intermittent Watercourse
- Ephemeral Watercourse
- Anadromous/Resident Fish Presence
- Resident Fish Presence

REFERENCE

* Gradient greater than 25% determined based on TRIM Positional data and Geobase DEM. DEM from Geobase. Watercourses from the Province ofBritish Columbia and field data. Base data from the Province of British Columbia. Contours from TRIM positional data. McNab Creek Estuary digitized from Province of BC, 1999. Projection: UTM Zone 10 Datum: NAD 83

200 0 200

SCALE 1:6,500 METRES

PROJECT

BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

TITLE

FISH DISTRIBUTION AND BARRIERS

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No.	
DESIGN	DC	01 May 2015	SCALE AS SHOWN	REV. 1
GIS	DL	17 May 2016		
CHECK	DC	01 Mar 2016		
REVIEW	SR	01 Mar 2016		

FIGURE 5.1-3

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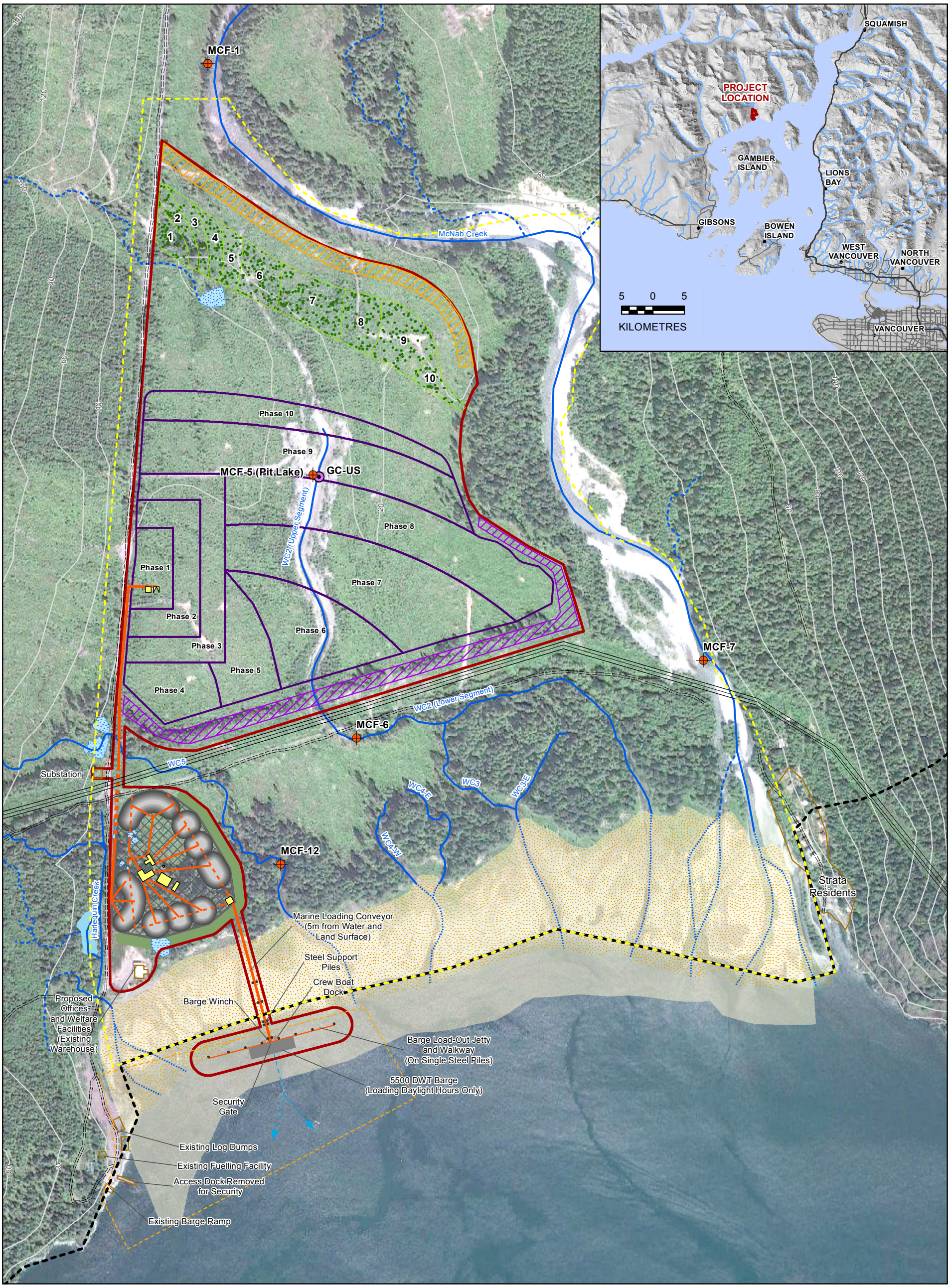

LEGEND

- Predicted Water Quality Location
- Station Locations (ID)
- Project Area
- Local Study Area
- Regional Study Area
- Proposed Aggregate Pit Phase
- Processing Area
- Existing Feature
- Existing Log Tenure Area
- Product Stockpiles
- Possible Processing Plant Configuration
- Fines Storage Area
- McNab Creek Flood Protection Dyke
- Pit Lake Containment Berm
- Processing Area Berm
- Low Lying Wetted Area
- Intertidal Zone
- McNab Creek Estuary
- Elevated Conveyor
- Underground Conveyor
- Barge Load-out
- Transmission Line
- Permanent / Perennial Watercourse
- Intermittent Watercourse
- Intertidal Watercourse
- Barge Route
- Contour (20m)
- Road (Existing)
- Pile

REFERENCE

Contours from TRIM positional data. Additional detailed site features provided by McElhanney. Watercourses from the Province of British Columbia and field data. Base data from the Province of British Columbia. Base Imagery from Google Maps 20100807. McNab Creek Estuary digitized from Province of BC, 1999. Projection: UTM Zone 10 Datum: NAD 83

200 0 200

SCALE 1:6,500 METRES

PROJECT

BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

TITLE

FISH AND FISH HABITAT SITE PLAN

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No.	
DESIGN	DC	01 May 2015	SCALE AS SHOWN	REV. 1
GIS	DL	17 May 2016		
CHECK	DC	08 Mar 2016		
REVIEW	SR	08 Mar 2016		

FIGURE 5.1-4

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