Fish Habitat

Fish Habitat Assessment Procedures

As recommended in the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* (B.C. Ministry of Environment, 2016), surveys focused on habitat predicted to be permanently affected as a result of the proposed Project. The two primary types of potential loss of fish habitat related to the Project include:

- Direct habitat loss (e.g., placement of mine rock, excavation, etc.); and
- Indirect habitat loss (e.g., potential flow reduction).

Interactions between the Project and fish and fish habitat are further discussed in Section 12.5. Reaches with the potential for direct habitat loss were assessed following the B.C. *Fish Habitat Assessment Procedures* (FHAP) Level 1 (Johnston and Slaney, 1996). The baseline fish habitat surveys were completed on the fish bearing reaches of Alexander Creek (ALE7 to ALE10) and West Alexander Creek (WAL1 and WAL2), as described in the Fish Community methods section below. Fish inventories were not completed on reaches with prior knowledge of fish bearing status in the provincial Habitat Wizard Fish and Fish Habitat Database (ALE7, GRA1 to GRA4; Government of B.C., 2018). The FHAP surveys for WAL1, WAL2, and ALE8 to ALE10 occurred in August 2014. The FHAP survey for ALE7 was completed in October 2017. Lower Alexander Creek, Grave Creek, and the two unnamed Grave Creek tributaries did not require a Level 1 FHAP survey because the Project is not anticipated to affect those areas.

Systematic stratified subsampling was used to sample every fourth habitat unit of each meso-habitat type (e.g., pool, riffle, glide, and cascade). Measurements were collected for 25% of each meso-habitat type. In addition to FHAP data, substrate descriptions and depth-velocity profiles were also completed to facilitate assessments using the Habitat Suitability Index (HSI). The habitat data recorded included:

- Habitat type (i.e., cascade, glide, pool, riffle, or other);
- Habitat length (metres [m]);
- Gradient in percent (%);
- Bankfull and water depth (m);
- Bankfull and wetted width (m);
- Residual pool depth (m);
- Bed material type and spawning gravel presence;
- Total large woody debris;
- Number of functional large woody debris;
- Cover type (instream and overhead) and rating;
- Off-channel habitat;
- Disturbance indicators;
- Riparian vegetation; and
- Barriers.

Bathymetry, as requested by the EIS Guidelines (Canadian Environmental Assessment Agency, 2015), is not relevant to this assessment since the Fish and Fish Habitat LSA only includes shallow creeks.

Instream Flow Study

Instream flow studies are used to assess fish habitat changes that may result from reductions in the quantity of stream flow. Flow reductions resulting from the Project were identified as a possibility in Grave Creek, where water storage and withdrawal are proposed, and in West Alexander Creek and Alexander Creek downstream of the confluence with West Alexander Creek. Streamflows were monitored by ECCC at Station Number 08NK019 (Grave Creek at the Mouth) from 1970 to 1999. These data were used to determine mean annual flow. A screening level assessment of the withdrawal scenario determined that water withdrawal would not result in an increased number of days when Grave Creek discharge was below 20% Mean Annual Discharge (MAD); a threshold triggering a full instream flow study as per the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* (B.C. Ministry of the Environment, 2016). Instead, a modified instream flow study was conducted that focused on effects to fish passage as a result of water withdrawal, rather than a traditional instream flow study that serves to quantify changes in habitat availability as a result of a proposed Project. This was a conservative assessment aimed to corroborate the implications of the screening assessment.

Depth and velocity were measured in the field at various transects within the withdrawal reach of Grave Creek over a range of flows; however, this passage assessment focused on depth as the critical passage criterion. Data were primarily collected in riffles and cascades, as these habitat unit types were identified as the first to likely experience passage issues under reduced flows. Data were secondarily collected in glides for the purpose of developing stage-discharge relationships with staff gauges at water level logger stations. Flows were collected from August 1, 2018 to June 6, 2019. In combination with the hydrology baseline assessment (refer to Chapter 10 for more information), this information was assessed as part of the modified instream flow study that focused on effects to fish passage as a result of water withdrawal within Grave Creek.

Calcite Assessment

Calcite formation can change the characteristics of stream substrate by cementing rocks together, adversely affecting habitat for fish and invertebrates. Calcite formation has been observed in the Elk Valley in both streams downstream of mining activities, and to a lesser extent, in reference streams unaffected by mining (Robinson and MacDonald, 2014). As a result, calcite management is a key outcome of the EVWQP (Teck, 2015). Calcite field survey methods were based on Robinson et al. (2013). The surveys began with a visual assessment of the streambed while wading through the stream and physically inspecting individual rocks for calcite over a minimum length of 100 m. Where calcite was observed, a modified Wolman pebble count (Wolman, 1954) was conducted to quantify the degree of calcite presence (Cp) with two metrics used to calculate a Calcite Index (CI). These metrics, Cp and calcite concretion (Cc), are ultimately summed to calculate a CI value for each site.

Geomorphology Assessment

Clarke Geoscience Ltd. was retained by NWP to complete a fluvial geomorphology assessment of Alexander Creek for the Project (Clarke Geoscience Ltd., 2021; Appendix 12-A). The geomorphological assessment was conducted within the Fish and Fish Habitat LSA, for the purposes of making the assessment applicable to other disciplines including the fish and fish habitat effects assessment. Grave Creek was not assessed as the hydrological impact from the Project was found to be negligible. To this end, the assessment made use of the same reaches (within the West Alexander and Alexander Creeks) that were identified and assessed by Lotic Environmental (2020).

Alexander Creek lies within a large glacially-scoured (U-shaped) valley, characterized by a relatively broad, flat valley bottom and steep valley side slopes that extend upwards into mountainous headwaters. Sediment is generated from steep, bedrock and colluvium-mantled slopes and transferred downslope to the valley bottom. Where there is direct connection with tributary creeks, or the mainstem channel, there is potential for sediment delivery. Sediment sources influence the composition of the streambed (i.e., substrate), influence the nature of channel bedload (i.e., sediment that is entrained in flow), and influence the character of stream channel morphology. Reconnaissance-level terrain stability mapping is available for the Alexander Creek watershed (iMap B.C., 2006). The mapping indicates that the valley bottom hillslopes above the stream channel are predominantly "stable". There are limited areas of steep valley side slopes that are classified as "potentially unstable" and that are directly connected to the creek. Large-scale natural sediment sources to Alexander Creek, and to the lower reach of West Alexander Creek (downstream of the Project area), are identified and mapped on the most recent (2017) orthophotos (see Figures B1 to B4 in Appendix B of Appendix 12-A). Detailed site-level sediment sources are not identified due to the photo scale and resolution and the fact that this stage of the study is a desktop assessment and does not include field assessments and ground-truthing.

Based on a review of air photos and imagery, the fluvial geomorphology characteristics for each reach were distinguished. All study reaches, downstream of the proposed Project, are relatively low gradient (<2%) and have a predominantly riffle-pool channel morphology, with short sections with a slightly steeper cascade-pool morphology. Study reaches vary in confinement and channel pattern (Table 12.4-3).

Table 12.4-3: Fluvial Geomorphological Characteristics of Study Reaches

Reach No.	Confinement	Channel Pattern
West Alexander Creek		
WAL 1 d/s	Channel is partially connected to the adjacent steep valley side slopes. There is potential for channel movement across the lower gradient areas approaching the confluence with Alexander Creek.	West Alexander Creek is a narrow channel that is obscured from view due to mature forest cover. It appears to have some sinuosity and possible side channels where the gradient remains low.
Alexander Creek		
ALE1	Confined between steep hillslopes and Highway 3. Short sections become less confined.	Single channel with slightly sinuous pattern. Short sections with a wider floodplain allow for some channel movement. Localized bank erosion and hillslope sediment sources.
ALE2	Tightly confined within a narrow valley that is shared with Highway 3.	Singular channel, lacking sinuosity due to confinement. Relatively stable morphology, although subject to high flows and localized bank erosion.
ALE3	Partial confinement at the confluence with a valley tributary at the mouth of the Alexander Creek valley.	Singular channel with noted valley bottom wetland areas that are likely engaged during high flows. The wider valley bottom allows for greater sinuosity and reduced flow velocities

Reach No.	Confinement	Channel Pattern
ALE4	Channel has down cut through valley-bottom glaciofluvial terrace deposits and has become fairly well-confined between steep, unconsolidated scarp slopes.	A narrow valley bottom limits ability for channel movement. Bank erosion on the outside meander bends often leads to bank or scarp slope instability. There are numerous large sediment sources along this reach.
ALE5	Channel is not well-confined but the valley bottom is narrowed due to colluvial fans or aprons of colluvial material along the valley side slopes.	The valley bottom floodplain opens up, but the channel remains predominantly single channel with occasional side channels. Mature riparian forest makes it difficult to observe channel changes, but the historical sequence indicates some evidence of past channel instability through this reach.
ALE6	Channel is tightly confined within banks that are likely bedrock-controlled. There is a lack of valley bottom sediment sources.	The channel is single and sinuous, lacking visible channel instability or braiding. There is little visible within-channel sediment storage It is a steeper reach that is characterized as a transport reach.
ALE7	Channel is relatively unconfined within a wide valley bottom. Alignment is influenced and, at times, redirected along short sections due to tributary fans, valley side slopes, or large landslides.	Alexander Creek is highly sinuous and often braided, with numerous side channels. When partially confined, the channel is steeper and less sinuous. Where unconfined, the channel pattern is irregular. This is attributed to movement around large-woody debris jams and accumulated sediment.

Fish Community

Fish Inventory and Distribution

Fish inventories were completed to determine fish distribution, identify migratory barriers, and confirm stream reaches. Fish inventories were not completed on reaches with prior knowledge of fish bearing status in the provincial Habitat Wizard Fish and Fish Habitat Database (ALE7, GRA1 to GRA4; Government of B.C., 2018). Sampling was completed on a total of 14 reaches on 8 streams during 2014 and 2017. As per the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* (B.C. Ministry of Environment, 2016), in order to confirm a site as non-fish bearing, it had to be sampled for two consecutive years resulting in no captures or observations.

Sampling was completed on a total of 14 fish bearing reaches on 8 streams during 2014 and 2017. Local fish bearing streams sampled included: Alexander Creek (Reaches 1, 2, and 7 to 10), West Alexander Creek (Reaches 1 and 2), Grave Creek (Reaches 3 and 4), unnamed tributary of Grave Creek 1, and unnamed tributary of Grave Creek 2 (Reach 1).

Fish inventory assessments were reach-based with one site per reach. Sampling was conducted by a two-person backpack electrofishing crew. Electrofishing was completed as a single, open pass over a site length of greater than 100 m or that of 10 times the bankfull width. A minimum of two baited minnow traps were set and left overnight at each electrofishing location if conditions permitted (e.g., sufficient water depth). Streams were assessed for fish bearing status based on historical data and barrier information (B.C. database). The status was confirmed by fish inventory sampling, which used electrofishing and/or minnow traps when possible. This sampling was conducted by Lotic Environmental for two consecutive years to confirm if a stream was fish bearing or not.

Captured fish were identified to species, measured to fork length (to the nearest mm), weighed (to the nearest 0.1 gram (g) for fish > 100 mm and nearest 1 g for fish < 100 mm), and photographed. DELT assessments were performed on all fish handled. Established regional fork length at age ranges were used to determine age classes for Westslope Cutthroat Trout, Bull Trout, and Eastern Brook Trout; details are provided in the Fish and Fish Habitat Baseline Assessment (Appendix 12-B).

Rearing

Fish community assessments were completed in all fish bearing reaches with the exception of WAL2, which is a short, high-gradient reach with decreased habitat potential. Fish community sampling used a combination of fish presence and associated habitat data to describe use during the summer rearing period.

Fish density estimates were made from the depletion pattern of fish captured during three-pass, depletion removal electrofishing over closed site conditions (i.e., site was isolated by stop nets to prevent fish from leaving the site during sampling) as per the *Reconnaissance 1:20,000 Fish and Fish Habitat Inventory Standards and Procedures* (RISC, 2001). Fish density and corresponding fish habitat data (described above) were collected over longer, multi-channel unit sites with data recorded at a channel unit scale. The fish density data were supported by the collection of detailed habitat information, as per the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* (B.C. Ministry of Environment, 2016). Observations of species, fork length (mm), weight (g), and external health were recorded for all fish captured. The field surveys were completed at ALE7, ALE8, ALE9, ALE10, WAL1d/s, WAL1u/s, GRA3, GRA4, UTG1, and UTG2-1 from August 22 to October 10, 2017, and at ALE1 and ALE2 from September 12 to 13, 2019.

Fish abundance and fish density estimates were calculated using the MicroFish 3.0 computer software (Van Deventer and Platts, 2006).

Spawning

Spawning surveys were completed to document spawning use by spring and fall spawning species within the Fish and Fish Habitat LSA. Two rounds of spawning surveys were completed each spring. Survey dates were chosen to target the descending limb of the hydrograph, when WCT typically spawn (Magee et al., 1996). ALE7, ALE10, WAL1, WAL2, GRA3, UTG1, and UTG2 were assessed in June of 2014 and 2017. GRA4 was assessed only in June 2017.

Fall surveys were completed similarly to spring spawning and were completed in early October in 2014 and 2017 at ALE10 and WAL1. A follow-up survey was completed in late September 2019 to include ALE7. A two-person crew surveyed each stream in an upstream direction from the start of each fish bearing reach to the previously determined limit of fish distribution. Redd locations were described by habitat unit type (e.g., pool, riffle, glide, or cascade), substrate type, and association with cover. If no redds were found, observations of potential suitable spawning habitat were recorded. Suitable habitat was based on cover availability, proximity to holding water, adequate flows, and suitable gravel size for each species.

Overwintering

Direct fish capture during winter months was not possible due to site access limitations and significant avalanche risk. Instead, the suitability of fish overwintering potential in the Fish and Fish Habitat LSA was determined using parameters such as water temperatures, dissolved oxygen (DO) levels, water depth, ice cover, and flow rates. Overwintering surveys were conducted in the upper portions of the Alexander Creek watershed where safely accessible. ALE7, ALE8, ALE10, WAL1d/s, WAL2, and UTG2-1 were surveyed for overwintering potential on March 14, 2014 when flows were likely the lowest.

Water depth, temperature, and DO parameters were used to classify overwintering potential as "good", "moderate", or "poor". Areas with flowing water, adequate DO concentrations, and depths greater than 0.2 m were considered to have good overwintering potential. Flowing water was considered a requirement to good overwintering potential as it delivers oxygenated water and reduces (but does not prevent) ice formation. DO levels were compared to the CCME *WQG for the Protection of Aquatic Life* (CCME, 1999). For life to be sustained in a cold-water system, the minimal threshold of 6.5 mg/L (milligram/litre) DO must be met (CCME, 1999). Overwintering fish survival relies heavily on water temperature; therefore, 1°C was set as the lower threshold of a "good" thermal habitat range.

Population Study

To improve knowledge on Westslope Cutthroat Trout habitat use, a population study was conducted over a one-year period from 2020 to 2021. The aim of the study was to radio tag Westslope Cutthroat Trout and track their movements over a one-year period to provide important data on habitat use during winter periods, spawning periods, and year-round movements in remote areas of the Alexander and West Alexander Creek valleys. Angling was conducted during 15 days is August, 2 days in early September, and 3 days in early October, for a total of approximately 270 angler-hours of effort during 2020. Additional details on the population study methods, including tagging procedures, are described in the Alexander Creek Westslope Cutthroat Trout Population Study (Lotic Environmental, 2022; Appendix 12-C.

Benthic Invertebrate Community

Benthic invertebrate community sampling was conducted in October 2014 and October 2017 at sites on Alexander Creek (ALE7 to ALE11), West Alexander Creek, unnamed tributaries of West Alexander Creek, Grave Creek, and the unnamed tributaries on Grave Creek (where streams were considered fish bearing). Lentic benthic invertebrate sampling is described in Section 12.4.2.1.2. Alexander Creek sites ALE1 and ALE2 were sampled in September 2019. Benthic invertebrate sampling followed the CABIN field protocols (Environment Canada, 2012). Samples were collected from riffle/glide habitats using a 400 µm (micrometre) dip net. The sampler kicked vigorously for three minutes; zig-zagging the entire width of the stream while moving upstream. Care was taken not to disturb the stream before the invertebrate sample collection occurred. Samples were transferred to labelled containers and preserved with 10% formalin before being submitted to a CABIN certified taxonomy laboratory (Cordillera Consulting) for taxonomic identification. Habitat data collected at each site included: stream gradient, channel width, depth, velocity, habitat type, vegetation coverage (both riparian and aquatic), substrate characteristics (including a 100-pebble count), disturbance indicators, land use, and weather conditions. General water quality parameters (DO, pH, and water temperature) were also collected using an YSI multimeter.

CABIN compares the benthic invertebrate communities to reference sites through the Benthic Assessment of Sediment (BEAST) and the Reference Condition Approach (RCA; Environment Canada, 2012). The benthic invertebrate community data was analyzed in the Columbia/Okanagan reference model (Gaber, 2012). The model determined five habitat characteristics that were best at distinguishing between invertebrate communities at the reference sites in the region: average water depth, latitude and longitude of the sampling location, percentage of the catchment area that has permanent ice cover, and the percentage of the catchment area that has a slope of less than 30%. Based on these predictor variables, all sites in the Fish and Fish Habitat LSA were assigned to reference group 3, which has 17 reference sites that were used to compare against. Ordination plots were used to assign a potential level of impairment to each test site (reference condition, mildly divergent, divergent, or highly divergent). CABIN also uses the River Invertebrate Prediction and Classification System (RIVPACS) to calculate the ratio of taxa collected at a site to taxa expected to be at a site based on their presence at 70% of all the reference sites in the Columbia/Okanagan model. A RIVPACS ratio >1.00 can indicate community enrichment, while a ratio <1.00 can indicate impairment.

Periphyton Community

Periphyton sampling occurred in riffle and glide habitat at all sites where invertebrates were collected. Periphyton sampling was conducted at most sites in September 2014 and October 2017, while ALE1 and ALE2 were added to the program in September 2019. Samples were collected for taxonomy (community composition) and two biomass measurements: ash-free dry biomass (AFDM) and chlorophyll-a (chl-a). Each sample was collected as a composite of five rocks, and triplicate samples were collected at 10% of the sites to assess within-site variability. Types and amounts of riparian vegetation on right and left banks, degree of shade, stream gradient, water depth, substrate composition, and depth and velocity at which each rock was sampled were also recorded. AFDM and chl-a samples were analyzed by ALS Environmental and taxonomic samples were analyzed by Plankton R Us Inc.

Periphyton community metrics are not developed as well as invertebrate metrics for assessing aquatic health. Periphyton biomass estimates can indicate site impairment if values decrease over time. Alternatively, high periphyton biomasses are a nuisance and indicate nutrient enrichment at a site. Chl-a values were compared against the provincial recommended guideline of 100 mg/m^2 (milligram/square metre) for maintaining good aquatic health (B.C. Ministry of Environment, 2001).

Aquatic Health

Aquatic sediment and fish, benthic invertebrate, and periphyton tissue samples were collected in 2017 and 2019. A summary of the samples collected in lotic ecosystems is provided in Table 12.4-4. The following subsections outlines the methods used to collect the aquatic health baseline data. For additional details, refer to the Aquatic Health Baseline Sampling Report in Appendix 12-D (Lotic Environmental, 2020b).

Table 12.4-4: Summary of Aquatic Health Sampling in Lotic Ecosystems

Site ID	2017				2019		
	Fish	Invertebrate	Periphyton	Sediment	Invertebrate	Periphyton	Sediment
ALE1					x	x	
ALE2					x	x	x
ALE7	x	x	x	x			
ALE8	**	x	x	x			

Site ID	2017				2019		
	Fish	Invertebrate	Periphyton	Sediment	Invertebrate	Periphyton	Sediment
ALE9	x		x	x			
ALE10		x		x			
WAL1	x	x	x	x			
GRA3	x	x	x	x			
GRA4	x	x	x	x*			
UTG1	x	x*	x*	x			

Notes:
* Site sampled in triplicate.
** Sampled on July 12; however, no fish were captured.

Fish Tissue

Seven sites were electrofished to collect WCT for non-lethal tissue sampling (Table 12.4-4). WCT were the targeted species as they were found in all sampled streams in the Fish and Fish Habitat LSA. Fish tissue sampling was conducted from July 12 to August 3, 2017. A three-person backpack electrofishing crew complete a single, open pass until eight WCT (fork length range of 147 to 255 mm) were captured for each reach. The *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* (B.C. Ministry of Environment, 2016) recommends targeting eight replicates per site to describe both within-site and between-site variability. The fish were processed with appropriate quality control measures in place and frozen tissue samples analyzed for percentage moisture and metals by ALS Environmental.

Selenium concentrations were compared to the B.C. guideline for selenium in fish tissue of 4 mg/kg dw (Beatty and Russo, 2014). There are no other Canadian guidelines for metals in fish tissue pertaining to aquatic health. The U.S. EPA selenium guidelines are 8.5 mg/kg dw for whole bodies, 15.1 mg/kg dw for eggs or ovaries, and 11.3 mg/kg dw for muscle (U.S. EPA, 2016).

Benthic Invertebrate Tissue

The ten sites in Table 12.4-4 were sampled for benthic invertebrates (the locations where CABIN invertebrate community surveys were conducted for fish communities and fish habitat surveys). Sampling occurred in riffle habitats and a minimum of three kicks of the kick-net. Samples were placed in a single jar to create a composite sample, with appropriate quality control measures in place. Frozen composite samples were analyzed for metals and percentage moisture by ALS Environmental.

Selenium concentrations in benthic invertebrate tissue were compared to the current interim B.C. guideline for selenium in invertebrate tissue of 4 mg/kg dw (Beatty and Russo, 2014). The U.S. EPA invertebrate tissue guideline upper limit for selenium is 8.5 mg/kg dw (U.S. EPA, 2016), which was used as an upper threshold for the aquatic health assessment.

Periphyton Tissue

The ten sites outlined in Table 12.4-4 were also sampled for periphyton. The periphyton collection procedures followed the general procedures outlined in Clark (2003). Samples were collected from representative habitats/species by scraping a minimum of five cobble-sized stones with a stainless-steel scraper over a defined area of 209 cm^2 (square centimetre). The scrapings from five randomly selected rocks were placed into a single jar to form the composite sample. Frozen composite samples were analyzed for metals and percentage moisture by ALS Environmental.

There are currently no provincial or federal guidelines for periphyton in Canada. For the purposes of the aquatic health assessment, the U.S EPA guideline for fish body concentrations was used as it serves to also protect invertebrates (U.S. EPA, 2016). Windward et al. (2014) found that a concentration of 484 mg/kg dw for manganese, 31.5 mg/kg dw for nickel, and 179 mg/kg dw for zinc served as a localized baseline reference in the Elk Valley; however, none of these elements have official tissue guidelines in Canada.

Sediment Quality

Sediment was sampled at nine lotic ecosystem sites (Table 12.4-4) and analyzed for low-level PAHs, total organic carbon (TOC), metals, and particle size. Details on collection procedures for each sample type are provided in Appendix 12-D. Metals were analysed for the <63 µm substrate fraction as described in the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* (B.C. Ministry of Environment, 2016), to normalize for large scale changes in the deposition regime. At each sampling site, supporting field data were collected and included water depth, sediment texture and colour, the presence of organic debris, and odours or sheens. Approximately 500 m of stream at each site was assessed to find appropriately sized silt/clay. The top 1 to 3 cm (centimetre) of sediment was then sampled.

Sediment metal and PAH results were compared to B.C. *Working Sediment Quality Guidelines* (WSQG) for aquatic health (B.C. Ministry of Environment, 2020; Table 12.4-5). The CCME (2001) also has federal guidelines for sediment quality. If the CCME has no value for a constituent, then the B.C. WSQG is provided. The Lower WSQG provides a concentration that should protect aquatic life in most situations. The Lower WSQG is the same as the CCME Interim Sediment Guidelines (ISQG), which are guidelines that have been created based on ecologically relevant species, but information gaps still exist (CCME 2001). The Upper WSQG provides a concentration that if exceeded, will likely cause severe effects on aquatic life, and is the same as the CCME Probable Effects Level (PEL). Concentrations between the Lower and Upper WSQG may cause some effects to aquatic life, but situations must also be considered, such as sensitive species present, life history stages, and combination of constituents.

Table 12.4-5: Upper and Lower Aquatic Sediment Guidelines (B.C. WSQG, CCME ISQG).

Analyte		Lower WSQG Guideline Value (mg/kg)	Upper WSQG Guideline Value (mg/kg)	CCME Guideline?
Metals	Arsenic (As)	5.9	17	Y
	Cadmium (Cd)	0.6	3.5	Y
	Chromium (Cr)	37.3	90	Y
	Copper (Cu)	35.7	197	Y
	Iron (Fe)	21,200	43,766	N
	Lead (Pb)	35	91.3	Y
	Manganese (Mn)	460	1,100	N
	Mercury (Hg)	0.17	0.486	Y
	Nickel (Ni)	16	75	Y
	Selenium (Se)	2	NA	N

Analyte		Lower WSQG Guideline Value (mg/kg)	Upper WSQG Guideline Value (mg/kg)	CCME Guideline?
	Silver (Ag)	0.5	NA	Y
	Zinc (Zn)	123	315	Y
Polycyclic Aromatic Hydrocarbons	Acenaphthene	0.00671	0.0889	Y
	Acenaphthylene	0.00587	0.128	Y
	Anthracene	0.0469	0.245	Y
	Benz(a)anthracene	0.0317	0.385	Y
	Benzo(a)pyrene	0.0319	0.782	Y
	Benzo(g,h,i)perylene	0.17	0.32	N
	Benzo(k)fluoranthene	0.24	13.4	N
	Chrysene	0.0571	0.862	Y
	Dibenz(a,h)anthracene	0.00622	0.135	Y
	Fluoranthene	0.111	2.355	Y
	Fluorene	0.0212	0.144	Y
	Indeno(1,2,3-c,d)pyrene	0.2	3.2	N
	2-Methylnaphthalene	0.0202	0.2	Y
	Phenanthrene	0.0419	0.515	Y
	Pyrene	0.053	0.875	Y

12.4.2.1.2 Lentic Ecosystems

During the baseline surveys, 27 wetland sites were surveyed for fish habitat in July 2019. Of these wetlands, six were identified as being of importance to fish and were further surveyed for fish and aquatic health parameters in September 2019 (Table 12.4-6; Figure 12.4-6). One lentic site (WL17) was situated within the Six Mile Creek drainage, another one was located in the Grave Creek drainage (WL11.1), and the rest (WL1, WL4, WL5.1, WL6) were located along the Alexander Creek drainage (Figure 12.4-6). Each wetland was described with regards to the potential for fish absence/presence, general observations (substrate, depth, length/width, side channels, inflow/outflow channels, and any relevant wildlife observed), and *in-situ* water quality. Details on the fish habitat and aquatic health sampling completed in wetlands are provided in the following subsections.

Table 12.4-6: Summary of Lentic Survey Locations within the Fish and Fish Habitat LSA

Site Code	Easting	Northing
WL4	664742	5509372
WL5.1	664626	5510566
WL6	664264	5514861
WL11.1	655465	5524177
WL17	653864	5520896
WL21	666530	5509502

Fish Presence/Absence

In addition to the visual assessments completed within each wetland, a subset of wetlands was surveyed for fish presence/absence via the use of electrofishing techniques and/or the deployment of minnow traps. The minnow traps were set and left overnight in the proper conditions (e.g., sufficient water depth).