BW GOLD LTD
a subsidiary company of Artemis Gold Inc

Blackwater Gold Project

Follow-up Programs for Condition 3.16 of the Blackwater Mine Project Decision Statement Issued under Section 54 of the Canadian Environmental Assessment Act, 2012

May 9 2023

Project No.: 2006501

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Blackwater Gold Project

Follow-up Programs for Condition 3.16 of the Blackwater Mine Project Decision Statement Issued under Section 54 of the Canadian Environmental Assessment Act, 2012

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ACRONYMS AND ABBREVIATIONS

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

AEMP	Aquatic Effect Monitoring Program
BC	British Columbia
BW Gold	BW Gold LTD.
CEA Agency	Canadian Environmental Assessment Agency
DS	Decision Statement
Ds	Secchi Depth
EA	Environmental Assessment
FWSS	Freshwater Supply System
FWR	Freshwater Reservoir
HSI	Habitat Suitability Index
IFN	Instream Flow Needs
New Gold	New Gold Inc.
POPC	Parameter of Potential Concern
Project	Blackwater Gold Project
RIC	Resources Information Committee
SEFA	System for Environmental Flow Analysis
UAV	Unmanned Aerial Vehicle
YOY	Young of Year
Z1%	Euphotic Depth

1. INTRODUCTION

The Blackwater Gold Project (Project) received a Decision Statement (DS) on April 15, 2019, under the Canadian Environmental Assessment Act, 2012 (CEA Agency 2019) and an Environmental Assessment Certificate #M19-01 on June 21, 2019, under the 2002 Environmental Assessment Act (EAO 2019).

Condition 3.16 of the DS requires the BW Gold Ltd.'s (BW Gold) to develop a Fish and Fish Habitat Follow-up Program as follows:

3.16 The Proponent shall develop, prior to construction and in consultation with Indigenous groups and relevant authorities, a follow-up program to verify the accuracy of the environmental assessment and determine the effectiveness of the mitigation measures as it pertains to fish habitat in Tatelkuz Lake and Chedakuz Creek. The Proponent shall implement the follow-up program from construction through decommissioning and shall apply conditions 2.9 and 2.10 when implementing the follow-up program.

Condition 2.9 of the DS requires follow-up programs to verify the accuracy of the environmental assessment (EA), determine whether modified or additional mitigation measures are required, and timely implementation if required.

Condition 2.10 of the DS requires consultation with Indigenous groups on the follow-up programs regarding opportunities for participation in their implementation.

1.1 Purpose and Objectives

The purpose of the Fish and Fish Habitat Follow-up Program described herein is to fulfill the condition 3.16 of the federal DS, including:

- Conduct, prior to the commissioning of the freshwater supply system (FWSS) as the main mitigation measure for loss of water in Davidson Creek, fish habitat quantity and quality surveys in the Tatelkuz Lake littoral zone. [Condition 3.16.1]
- Monitor the Tatelkuz Lake littoral zone from the commissioning of the freshwater supply system until decommissioning. [Condition 3.16.2]
- Monitor water flows in lower Chedakuz Creek between Tatelkuz Lake and the confluence with Davidson Creek during the open water season from Construction until Decommissioning. [Condition 3.16.3]

To achieve these objectives, the Fish and Fish Habitat Follow-up Program is designed to first determine baseline conditions for each of the indicators described above. These indicators will then be monitored during different phases of the Project to determine if variation from baseline conditions is occurring. Monitoring of instream flow needs (IFN) in Davidson Creek due to changes in flow from operation of the FWSS is part of the Aquatic Effects Monitoring Plan (AEMP) currently being developed. This plan will assess potential project-related changes to nutrient concentrations and water chemistry that may affect aquatic resources such as benthic invertebrates and periphyton communities.

As stated in Condition 2.9, an additional purpose of this program is to verify the accuracy of the environmental assessment. Verification will be accomplished by comparing monitoring results with original baseline results.

The follow-up programs for Condition 3.16 and Condition 2.9 described herein will evolve over time in response to the results of the monitoring, changing conditions or development at the Project, updates to methods, and through consultation with Indigenous groups, regulators, or other stakeholders. This process of continuous improvement with changing conditions and the potential implementation of mitigation is identified as adaptive management and will be developed as specified by Condition 2.5 and Condition 2.6 of the DS (See **Section 0**

Adaptive Management below).

1.2 Applicable Guidance

This plan for monitoring variation in baseline conditions and determining effectiveness of the mitigation measures has been prepared in accordance with DFO's guiding principles, as outlined in its *Measures to Protect Fish and Fish Habitat* (DFO 2019). It also aligns with provincial fisheries management objectives and prioritizes measures that address existing limitations on fisheries productivity within and beyond the Project area.

The following broad fisheries management objective was used to guide development of effectiveness monitoring of mitigation measures:

- Protect and increase freshwater fish lake and stream habitat.

The proposed mitigation measures focus on maintaining fish habitat in Tatelkuz Lake and lower Chedakuz Creek. This lake and stream system is a culturally important area to Indigenous groups.

1.3 Condition 3.16.1 – Tatelkuz Lake Littoral Zone Surveys Prior to Operations

The first follow-up program condition of the Decision Statement is 3.16.1 that requires BW Gold to:

> Conduct, prior to the commissioning of the freshwater supply system, fish habitat quantity and quality surveys in the Tatelkuz Lake littoral zone.

The Project will cause a reduction in water flow in Davidson Creek due to infrastructure overlaying portions of the upper watershed. This flow reduction will be mitigated in part via a FWSS that will pump water from Tatelkuz Lake to a freshwater storage reservoir adjacent to Reach 6 of Davidson Creek via a pipeline (**Figure 1-1**). The freshwater storage reservoir also will collect and store water from the upper portions of Davidson Creek, non-contact water, and mine contact water that is suitable for release. This water will be released into Davidson Creek from Year 1 of Operations onwards. Water will be pumped from Tatelkuz Lake starting in Year 6 of Operations.

One potential reason for this monitoring requirement in the Decision Statement is to determine whether the loss of water from Tatelkuz Lake will have any effects on fish habitat in the littoral zone (i.e., near shore area) of the lake. The Application/EIS determined potential littoral fish habitat loss to be not significant because and water level change would be low in magnitude and local in extent. This condition requires collection of baseline information on fish habitat quality and quantity for the Tatelkuz Lake littoral zone that can be monitored subsequently during Operations (**Section 1.4 Condition 3.16.2 - Tatelkuz Lake Littoral Zone Monitoring During Operations**).

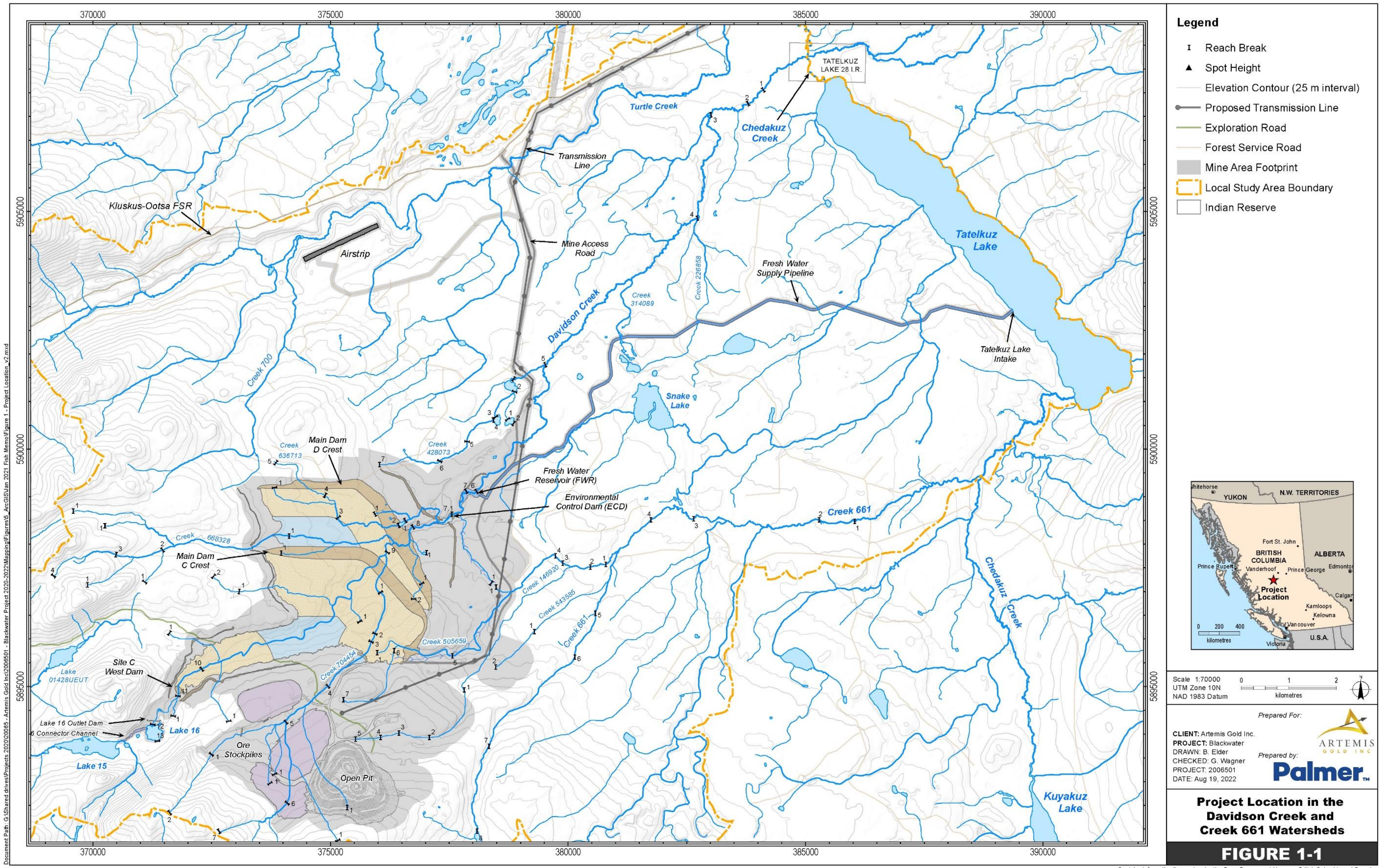

Figure 1-1. Project Location in the Davidson Creek and Creek 661 Watersheds

1.4 Condition 3.16.2 - Tatelkuz Lake Littoral Zone Monitoring During Operations

The second follow-up program condition of the Decision Statement is 3.16.2 that requires BW Gold to:

> Monitor the Tatelkuz Lake littoral zone from the commissioning of the freshwater supply system until decommissioning.

A potential reason for this monitoring requirements in the Decision Statement is to compare Tatelkuz Lake littoral zone fish habitat quality and quantity during active FWSS pumping with baseline levels measured previously (**Section 1.3 Condition 3.16.1 – Tatelkuz Lake Littoral Zone Surveys Prior to Operations**). Results from this comparison can be used to determine whether the loss of water from Year 6 of Operations onwards has any effects on littoral zone fish habitat quality and quantity in the lake. Fish habitat monitoring will be performed in conjunction with hydrological monitoring of lake levels during pumping. This hydrological monitoring is important to first determine if the surface level of the lake is being affected by FWSS pumping to a measurable degree above natural variation. The Application/EIS determined potential littoral fish habitat loss to be not significant because and water level change would be low in magnitude and local in extent. Water surface elevation of Tatelkuz Lake is determined by measuring the difference between the water level elevation and at least one of the four permanent benchmarks established around the lake (See **Section 2.2.1 Tatelkuz Lake Limnology**). Tatelkuz Lake water surface level will be monitored on an ongoing basis as part of the AEMP.

1.5 Condition 3.16.3 – Lower Chedakuz Creek Monitoring During All Project Phases

The third follow-up program condition of the Decision Statement is 3.16.3 that requires BW Gold to:

> Monitor water flows in Chedakuz Creek between Tatelkuz Lake and the confluence with Davidson Creek during the open water season from construction until decommissioning.

This condition refers to the section of lower Chedakuz Creek that flows from the outlet of Tatelkuz Lake, downstream to its confluence with Davidson Creek. One potential reason for this monitoring requirement in the Decision Statement is to determine whether the loss of water in the upper Creek 661 Watershed from Project Construction and Operations, and direct loss of water from Tatelkuz Lake during FWSS pumping (Year 6 onwards) will have any detectable effects on water levels downstream of the lake. The Application/EIS determined potential fish habitat loss in Chedakuz Creek to be not significant because water loss was predicted to not change significantly from natural variation. Any water loss in Tatelkuz Lake will have a potential affect on water levels, and may affect fish habitat, in this section of lower Chedakuz Creek. Baseline hydrological and fish habitat information obtained prior to Construction will be compared with water levels and habitat during Operations. Similar to Condition 3.16.2 (**Section 1.4 Condition 3.16.2 - Tatelkuz Lake Littoral Zone Monitoring During Operations),** this hydrological monitoring is important to determine if water level in the creek is being affected by the Project footprint and by FWSS pumping to a measurable degree above natural variation.

2. FOLLOW-UP PROGRAM 3.16.1: TATELKUZ LAKE LITTORAL ZONE SURVEYS PRIOR TO OPERATIONS

2.1 Background and Approach

A Tatelkuz Lake littoral zone study, initiated in 2021, satisfies Condition 3.16.1 of the Decision Statement. For this study, seasonal limnological measurements of the lake are taken along with fish habitat surveys along selected littoral areas. The purpose of these measurements is to characterize fish habitat quantity and quality in the littoral zone of Tatelkuz Lake.

Littoral areas were selected at eleven locations (**Figure 2-1**) distributed around the lake that correspond to baseline-identified littoral habitat classes. Sites are also located near lake inlets, the outlet to lower Chedakuz Creek, and the planned FWSS intake location. Some sites are co-located with historical capture locations of Brassy Minnow (*Hybognathus hankinsoni*) a littoral-dwelling fish species that will be used to monitor littoral habitat suitability. Brassy Minnow is targeted for the following reasons:

- Brassy Minnow is a BC listed species of conservation concern that uses littoral habitat in Tatelkuz Lake for its entire life history;
- Brassy Minnow have been captured in multiple areas of the lake, with the highest catch close to the proposed FWSS intake; and
- Brassy Minnow growth, survival, and recruitment are vulnerable to the effects of water level reductions and habitat drying (Falke et al. 2010).

The proposed littoral habitat monitoring program development will assess the extent and quantity of unique littoral habitat types in Tatelkuz Lake. The littoral habitat information will be used to assess habitat suitability for Brassy Minnow using the lacustrine Habitat Suitability Index (HSI) developed by Golder (2008) and area for each of eleven unique littoral habitat types identified by AMEC (2013). Habitat quantity and quality data will be compared to baseline habitat information from AMEC (2013) and will serve as the updated baseline littoral habitat information to be used for monitoring from the commissioning of the FWSS.

2.2 Study Design

General descriptions of the sampling locations and methods are provided in the following sub-sections. Sampling locations and methods are based on those used for the original baseline information that is presented in the Fish and Aquatic Resources 2011-2012 Baseline Report for Tatelkuz Lake fish habitat (AMEC 2013, Appendix 5.1.2.6A, Section 5.9.4).

2.2.1 Tatelkuz Lake Limnology

To support the Tatelkuz Lake littoral zone studies, seasonal (i.e., spring, summer, fall, winter) physical limnological surveys will be conducted at four sites on Tatelkuz Lake (**Figure 2-1**). Spring survey timing is planned to coincide with freshet, while summer and fall survey timing is planned to coincide with fish and fish habitat assessments. At each site, sampling includes:

- Vertical profiles at 1.0 m intervals for temperature (ºC), pH, conductivity (µS/cm), and dissolved oxygen (mg/L) at four established locations in Tatelkuz Lake (**Figure 2-1; Table 2-1**) identified by AMEC (2013);
    - Winter profiles are taken under ice, including measurement of ice thickness (m).

  - Winter *in situ* water quality is measured at the four fish and fish habitat sampling locations (**Figure 2-1**) to determine overwintering dissolved oxygen, a habitat suitability metric for Brassy Minnow.

- Collection of surface water samples for analysis of epilimnetic total phosphorus (mg/L) and total nitrogen (mg/L); and
- Secchi depths by lowering the Secchi disc over the shaded side of the boat recording the depth at which the disc disappears from sight and the depth at which it reappears.

Sampling frequency is described in **Section 2.4 Frequency and Duration**, with data collected in 2021 and early 2022 summarized in **Section 2.3.1 Tatelkuz Lake Limnology**. The Tatelkuz Lake limnology endpoints will include several physical water measurements and winter ice measurements (

Table 2-2).

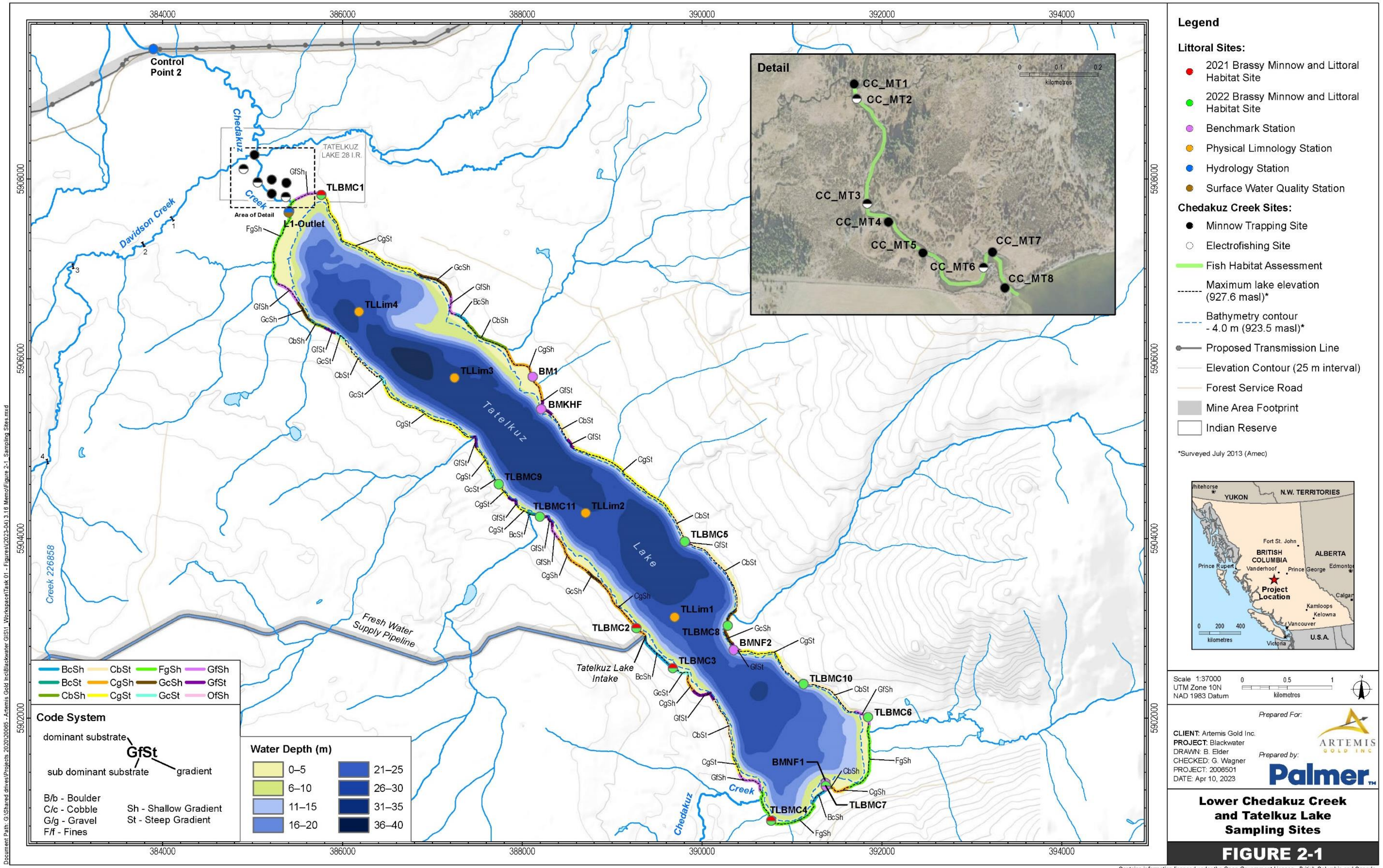

Figure 2-1. Lower Chedakuz Creek and Tatelkuz Lake Sampling Sites

Table 2-1. Tatelkuz Lake Littoral Habitat and Limnology Sampling Site Names, 2021-2022

Station Type	Station ID	Littoral Habitat Type[1]	Elevation (MASL)	UTM E	UTM N
Brassy Minnow/ Littoral Habitat	TLBMC1*	Cg-St	-	385764	5907822
Brassy Minnow/ Littoral Habitat	TLBMC2*	Cg-Sh	-	389268	5903003
Brassy Minnow/ Littoral Habitat	TLBMC3*	Bc-Sh	-	389674	5902558
Brassy Minnow/ Littoral Habitat	TLBMC4*	Fg-Sh	-	390766	5900859
Brassy Minnow/ Littoral Habitat	TLBMC5	Gf-St	-	389807	5903965
Brassy Minnow/ Littoral Habitat	TLBMC6	Gf-Sh	-	391845	5902013
Brassy Minnow/ Littoral Habitat	TLBMC7	Cb-Sh	-	391375	5901246
Brassy Minnow/ Littoral Habitat	TLBMC8	Gc-Sh	-	390285	5903031
Brassy Minnow/ Littoral Habitat	TLBMC9	Gc-St	-	387737	5904604
Brassy Minnow/ Littoral Habitat	TLBMC10	Cb-St	-	391128	5902380
Brassy Minnow/ Littoral Habitat	TLBMC11	Bc-St	-	388194	5904242
Benchmark Station	BMNF1	-	929.47	391372	5901279
Benchmark Station	BMNF2	-	928.381	390351	5902760
Benchmark Station	BMKHF	-	928.467	388209	5905440
Benchmark Station	BM1	-	928.633	388115	5905799
Benchmark Station	Control Point 2	-	926.295	383919	5909388
Physical Limnology	TLLim1	-	-	389694	5903124
Physical Limnology	TLLim2	-	-	388704	5904283
Physical Limnology	TLLim3	-	-	387247	5905786
Physical Limnology	TLLim4	-	-	386184	5906523

*Notes: * 2021 littoral habitat and brassy minnow stations; MASL = metres above sea level; UTM = Universal Transvers Mercator, NAD83 Datum, Zone 10U;*

[1] Gradient is qualified as Shallow (Sh) = <10%, or Steep (St) = >10%, 2 Littoral Habitat Type format: Dominant substrate/sub-dominant substrate-Shoreline gradient, Capital letter = dominant substrate, lower case letter = sub-dominant substrate (where g = gravel, f = fines, c = cobble, and b = boulder); Gradient (Sh or St), (-) = data not available

Table 2-2. Measurement and Assessment Endpoints for Tatelkuz Lake Limnology Prior to Operations

Measurement Endpoint	Assessment Endpoint	Baseline Ranges
Physical limnology	Temperature (ºC), pH, conductivity (µS/cm), dissolved oxygen (mg/L), phosphorous (mg/L), nitrogen (mg/L), Secchi Depth	Temperature: Mar.1.9-3.7ºC, Jun. 2.0-16.8ºC, Aug. 5.1-24.7ºC, Oct. 6.4-6.8ºC. pH: Mar. 6.3-7.2, Aug. 7.9-8.8 Conductivity: Mar. 118.3-126.3 µS/cm, Aug. 113.5-134.4 µS/cm Dissolved Oxygen: Mar. 4.23-10.65 mg/L, Jun. 6.52-12.10 mg/L, Aug. 2.49-12.59 mg/L, Oct. 5.17-8.99 mg/L Phosphorus: Jun. 0.0128-0.0158 mg/L, Sep. 0.0074-0.0091 mg/L, Nov. 0.0225-0.0290 mg/L Nitrogen: Sep. 0.331-0.353 mg/L, Nov. 0.346-0.375 mg/L. Secchi Depth: Jun. 2.6-3.3 m, Aug. 4.4-4.5 m, Oct. 3.5-3.8 m.
Winter ice conditions	Ice thickness (cm), littoral winter dissolved oxygen (mg/L)	Ice: 0.32-0.44 m Dissolved Oxygen: 8.52-12.10 mg/L at 1m

2.2.2 Littoral Fish and Fish Habitat

The summer littoral fish habitat assessments follow the baseline methods of AMEC (2013) which were completed using the ‘Standard Methods Guide for the Classification/Quantification of Lacustrine Habitat in Newfoundland and Labrador’ (Bradbury et al 2001). Planned limnological and littoral fish habitat studies will use the same methods:

- A total of 11 littoral sites will surveyed (**Figure 2-1; Table 2-1**) to compare to each of the eleven unique littoral habitat types identified by AMEC (2013), including;
  - Measurement of habitat characteristics at 1 m intervals along transects, from above the high-water mark to 3 m water depth (following AMEC [2013] methods), including:
    - Water depth measurement;
    - Distances from high water mark, toe of the bank and wetted edge;
    - Using a 0.5 x 0.5 m quadrat, characterization of:
      - Substrate (i.e., identification of dominant and subdominant substrate types along the transect); and
      - Littoral plant community (i.e., percent emergent, submerged, floating-leaved or free floating macrophytes) and identification of other key habitat features (e.g., woody debris, percent cover for fish).
  - In situ water quality measurement, including surface water temperature (ºC), pH, conductivity (µS/cm), and dissolved oxygen (mg/L) at each sampling location.
  - Capture of fish using beach seining, as per standardized methods for monitoring the distribution and relative abundance of a fish species related to Brassy Minnow (Macnaughton et al. 2019). To ensure that fish density and biomass estimates can be compared across sites and between years, sampling at each site will use consistent methodology:
    - One pass with a beach seine per site;

  - Sampling a minimum wetted area of 200 m^2;
  - Use of a standardized beach seine length and mesh size;
- Drone-based field survey and orthoimagery of Tatelkuz Lake shoreline at all habitat assessment locations; and
- Lake elevation level will be collected at the time of the littoral habitat assessments using either a benchmark survey or elevation information collected by the external consultant responsible for hydrological monitoring.

Fish sampling for the larval life-stage will occur in June during the expected spawning and hatching window and in August to capture other life-stages during summer stratification of the lake. Habitat sampling will be conducted during the August sampling period when littoral vegetation is expected to be at its maximum extent. Sampling frequency is described in **Section 2.4 Frequency and Duration**, with data collected in 2021 and early 2022 summarized in **Section 0**

Littoral Fish and Fish Habitat. The summer littoral fish and fish habitat survey measurement endpoints will include assessment of fish habitat conditions, habitat suitability, and fish abundance (**Table 2-3**).

In 2021, preliminary littoral fish habitat assessments included the sampling detailed above at only four sites (**Figure 2-1; Table 2-1**).Two Brassy Minnow sampling programs were completed in 2021. The first in June to capture the spawning and hatching time, and larval abundance of Brassy Minnow using larval light traps deployed at night and dipnets during the day to match the sampling methodology of Falke et al. (2010). The second sampling program occurred in late summer. This program included:

- Minnow trap sampling in September at the four established Brassy Minnow sampling and habitat assessment locations (**Figure 2-1**)
- Paired traps set at three depth strata (0.5 m, 1.0 m, and 3.0 m) at each of the four stations and soaked for approximately 24 hours. Beach seining sets of approximately 15 m were completed at each station.

Results from these preliminary programs were used to determine the optimal method for littoral fish sampling in Tatelkuz Lake is beach seining.

Table 2-3. Measurement and Assessment Endpoints for the Littoral Fish and Fish Habitat Assessment in Tatelkuz Lake

Measurement Endpoint	Assessment Endpoint	Baseline Ranges
Habitat conditions	Water temperature (ºC), pH, conductivity (µS/cm), dissolved oxygen (mg/L)	Temperature: variable for each site - see Table 2-6 pH: variable for each site - see Table 2-6 Conductivity: variable for each site - Table 2-6 Dissolved Oxygen: variable for each site - see Table 2-6
Habitat suitability	Water depth (cm), substrate type, plant community (percent emergent), habitat cover (percent cover), lake elevation	Water Depth: see Table 2-7 Substrate: see Table 2-7 Plant Community: see Table 2-7 Habitat Cover: see Table 2-7 Lake Elevation: 927.10 – 928.34 m above sea level

Fish abundance	Catch Per Unit Effort (CPUE) and fish density (fish/100 m^2) for each identified species	CPUE: variable for each site - see Table 2-8 Density: variable for each site - see Table 2-8

2.3 Data Analysis

Power analyses have been performed, as appropriate, to support a study design that will allow for between-year comparisons and longer-term trend analysis. Between-year comparison (i.e., paired comparison between two separate annual datasets) will be completed to identify statistically differences in mean values using Analysis of Variance (ANOVA), or if the data are not normally distributed the equivalent non-parametric statistical test (e.g., Wilcoxon Signed-Rank Test). All statistical analyses will be performed using the R statistical system (R Core Team 2011). The significance level (α) = 0.05 will be used for all statistical tests, except as noted in specific analyses. In addition, year over year change will be assessed qualitatively, by comparing with the baseline data.

For longer time scale (i.e., five years and onwards), non-parametric Mann-Kendall temporal trends testing will be used to determine if there are significant temporal trends in any given monitoring metric, and if so, the direction and statistical significance of temporal trend. The sensitivity of the Mann-Kendall trends test increases with an increasing number of time steps (i.e., consecutive years of data) and it is considered that somewhere between five- and ten-time steps are a minimum requirement. Therefore, trends analyses will begin following the fifth year of this monitoring program.

2.3.1 Tatelkuz Lake Limnology

Data from the four sites will be statistically compared for a 'site' effect using a single-factor Analysis of variance (ANOVA) and Tukey's post-hoc comparison if the data are normally distributed, or an equivalent non-parametric test if not.

Vertical lake profiles were collected seasonally in June, September, November 2021 and March 2022 to capture the seasonal lake turnover and mixing and the depth and water quality parameters during lake stratification. The parameters recorded were temperature (^{o}C), conductivity and specific conductance (µS/cm), dissolved oxygen (mg/L and %), pH, and secchi depth (i.e., water transparency). Epilimnetic water samples were collected to measure seasonal nutrient levels (i.e., total phosphorus and total nitrogen) to monitor the trophic state of Tatelkuz Lake.

For physical water quality parameters stratified in the lake, the mean value and range for each stratification zone (i.e., epilimnion, thermocline and hypolimnion) was calculated. If no stratification was present, the mean parameter for the full vertical profile was used. The average depth range of each stratification zone also was recorded. Vertical profile plots of temperature, dissolved oxygen and conductivity were produced for each sampling event. A vertical profile plot comparison of dissolved oxygen and temperature for the four 2021-2022 sampling events is presented in **Figure 2-2**. Mean, near-surface (i.e., epilimnetic), open-water period nutrient and 1% euphotic depth (using secchi depth) also will be calculated for comparison.

The data collected from the vertical profile water quality sampling will be compared spatially (between sites) and temporally using the appropriate hypothesis test for an analysis of variance (e.g., single-factor ANOVA) depending on the distribution and variance range of the data, followed by the appropriate post-hoc test (e.g., Tukey's HSD). If there is no evidence of significant spatial trends then future monitoring programs will use one site instead of four. Data will be compared seasonally and annually, and following 5 years of monitoring data. A non-parametric temporal trends analysis will be completed using a Mann-Kendall trends test.

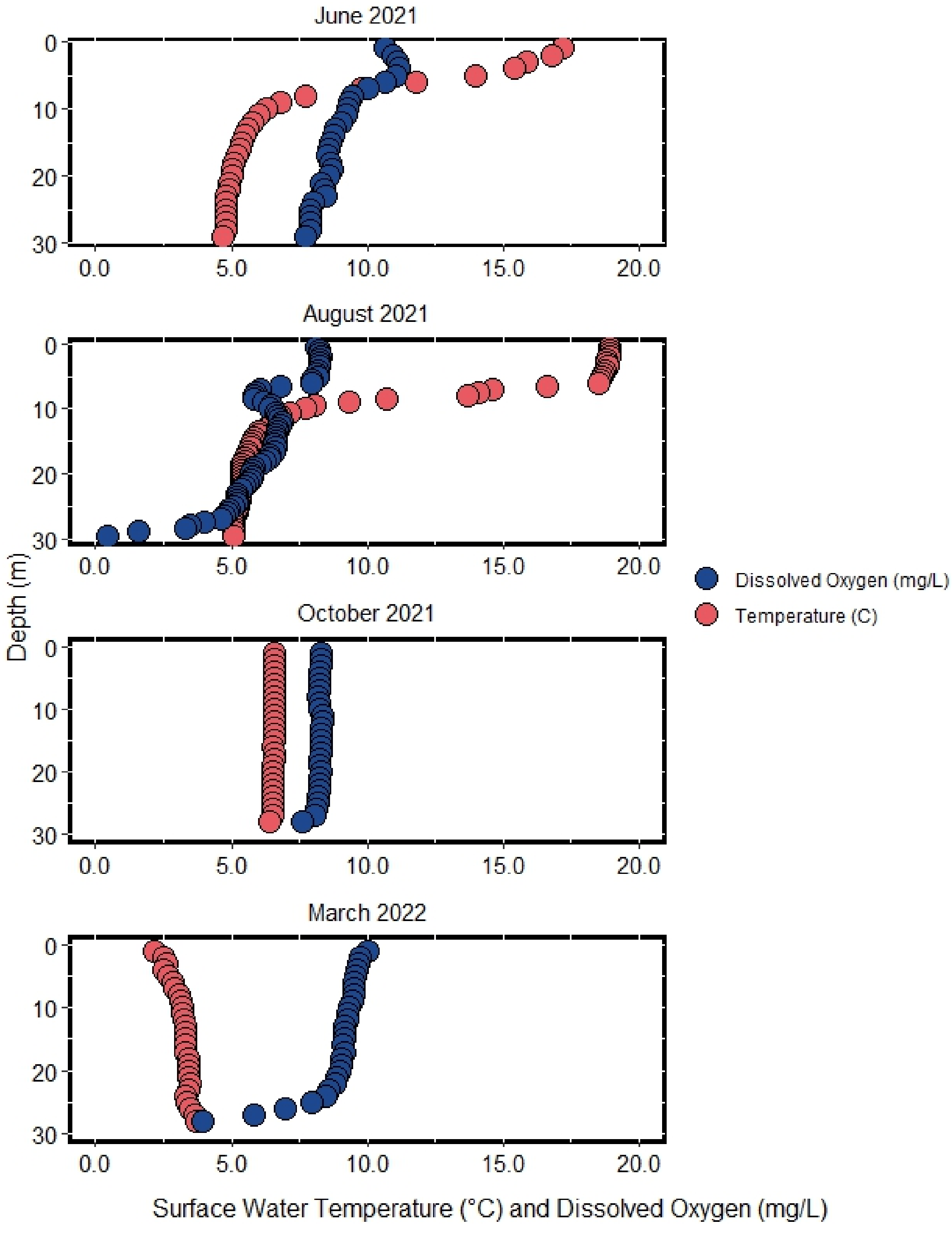

Figure 2-2. Tatelkuz Lake Water Temperature (°C) and Dissolved Oxygen (mg/L) at Different Depths for Site TL LIM 1 in June 2021, August 2021, October 2021, and March 2022.

Secchi depth, (D_s), is used to calculate the light extinction coefficient (k) for non-turbid water and 1% euphotic depth ($Z_{1\%}$) using the formula (Parsons et al. 1984):

$$k = \frac{1.7}{D_s}$$

$Z_{1\%}$, the depth to which 1% of surface light irradiance extends into the water column, is the point where gross photosynthetic production in the water column is equal to gross respiration and, therefore, is the maximum depth at which photosynthesis and net carbon fixation occurs. $Z_{1\%}$ was calculated according to the formula (Parsons et al., 1984):

$$Z_{1\%} = \frac{4.6}{k}$$

A summary of the results from the 2021 and winter 2022 physical limnology sampling in Tatelkuz Lake is presented in **Table 2-4**.

Table 2-4. 2021 and Winter 2022 Physical Limnology Results from Vertical Profile Sampling in Tatelkuz Lake

Date	Temp. Range (C)	DO Range (mg/L)	Conductivity Range	Specific Conductivity Range	pH Range	Secchi Depth (m)	1% Euphotic Depth ($Z_{1\%}$)	Thermo-cline Depth (m)
Jun 22, 2021	4.7 - 16.9	6.5 - 12.1	85.6 - 112.7	113.9 - 113.0	8.0 - 8.3	2.6 - 3.3	8.8	1 - 15
Aug 10, 2021	5.1 - 18.9	0.4 - 9.0	116.8 - 226.7	252.3 - 256.7	8.5 - 8.6	4.2 - 4.5	11.5	8 - 10
Oct 28, 2021	6.4 - 6.8	5.2 - 9.0	169.4 - 174.1	261.7 - 281.8	7.6 - 7.7	3.5 - 3.8	9.4	-
Mar 3, 2022	1.9 - 3.7	4.2 - 10.7	68.0 - 74.4	118.3 - 126.3	6.3 - 7.2	-	-	-

2.3.2 Littoral Fish and Fish Habitat

2.3.2.1 Drone Orthoimage Maps

Orthoimages of the littoral and riparian habitat at each of four littoral 2021 monitoring stations in Tatelkuz Lake (**Figure 2-1**) were collected using an unmanned aerial vehicle (UAV). These images were used to produce updated baseline aerial orthoimage maps of each site for comparison to on-the-ground habitat information from the 2021 baseline program and the original 2013 baseline information collected by AMEC (2013).

2.3.2.2 Tatelkuz Lake Littoral Habitat Assessment

Unique habitat types and recorded habitat characteristics collected during the shoreline transects will be used to determine the total area and abundance (%) of these habitat types to be used for long term monitoring. The habitat information will also be used to assess suitability of delineated habitat areas for Brassy Minnow using the lacustrine HSI for Brassy Minnow presented in **Table 2-5** (Golder 2008). Brassy Minnow HSI will be calculated using the following equation:

$$HSI_{BMC} = average(V_1 + V_2 + V_3 + V_4 + V_5 + V_6 + V_7)$$

where HSI_{BMC} is the Brassy Minnow habitat suitability index.

Table 2-5. Lacustrine Habitat Suitability Index of Brassy Minnow

Variable		Excellent (SI=1.0)	Above Average (SI=0.75)	Average (SI=0.5)	Below Average (SI=0.25)	None (SI=0.0)
V_1	substrate[1]	G, S & CS		C and R	Bd, Bo	
V_2	cover	submergent and emergent plants		woody debris, rock		
V_3	spawning	quiet, shallow, well vegetated areas	-	-	-	no suitable material
V_4	depth (m)	⩽10		>10		
V_5	% littoral zone cover	>50	>30 to 50	>20 to 30	>0 to 20	0
V_6	Late winter dissolved oxygen (mg/L)[2]	⩾2		<2		
V_7	pH	6 to 9		5.5 to <6		<5.5 or >9

[1] Bd = bedrock, Bo = boulder (> 256 mm), C = cobble (> 64 to 256 mm, rounded), R = rubble (> 64 to 256 mm, angular), G = gravel (> 2 to 64 mm), S = sand (> 0.06 to 2.0 mm) and CS = clay/silt (≤ 0.06 mm) includes detritus (Bradbury et al. 1999). The distinction between cobble and rubble is that cobble material has a smooth rounded shape while rubble is material in the same size range, but with sharp angular corners.

[2] Late winter dissolved oxygen (DO) criteria are based on the assumption that if measured late winter DO is greater than the indicated concentration, DO is not limiting at any time of the year, and if measured late winter DO is less than the indicated concentration, DO may be limiting in winter but not during the open-water period. In addition, since DO is not measured in all areas within a watercourse or waterbody, there may exist some local areas where late winter DO is greater than the measured concentration.

The habitat features, extent and area will be compared with the littoral habitat information in the baseline study completed by AMEC (2013) in order to provide an updated baseline dataset from which long-term monitoring plans, triggers and adaptive management can be based. Changes in habitat type, area and suitability will be assessed using field-based methods supported by a post-hoc GIS-based analysis. Quantitative analysis between years using a suitable parametric or non-parametric statistical test (e.g., single-factor or two-factor ANOVA with Tukey's HSD post-hoc test) will be used to compare habitat types by area and Brassy Minnow Habitat suitability unique habitat type between years. Once the minimum sample size of 5 years is satisfied, changes will be monitored using a non-parametric Mann-Kendall trends analysis. Habitat and environmental metrics will be related to Brassy Minnow abundance data using a suitable hypothesis test or mixed effect modeling approach (e.g., generalized linear mixed effect model).

Water quality variables were measured at the 11 littoral transect sites between August 24 and 29, 2022, at a depth of 0.5 and 1 m (**Table 2-6**). At 0.5 m, temperature across the lake ranged from 17.9 to 26.1ºC, pH ranged from 7.91 to 8.8, conductivity ranged from 113.6 to 133.6 µS/cm, specific conductivity ranged from 131.5 to 134.2 µS/cm, and dissolved oxygen ranged from 6.66 to 11.4 mg/L. At 1 m, temperature across the lake ranged from 17.7 to 24.7ºC, pH ranged from 7.89 to 8.79, conductivity ranged from 113.5 to 133.6

µS/cm, specific conductivity ranged from 130.9 to 134.4 µS/cm, and dissolved oxygen ranged from 7.33 to 12.59 mg/L.

Table 2-6. In-Situ Water Quality Data in Tatelkuz Lake, August 2022

Site	Date	Depth (m)	Temperature (ºC)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)
TLLit1	24-Aug-2022	0.5	24.4	8.60	131.4	132.6	11.40	nm
	24-Aug-2022	1	22.8	8.79	125.5	130.9	12.59	nm
TLLit2	29-Aug-2022	0.5	18.7	8.01	116.4	132.3	7.66	82.0
	29-Aug-2022	1	18.4	7.99	115.8	132.1	7.63	81.4
TLLit3	29-Aug-2022	0.5	17.9	7.91	113.6	131.5	7.53	79.8
	29-Aug-2022	1	17.7	7.89	113.5	131.5	7.45	79.2
TLLit4	25-Aug-2022	0.5	26.1	8.80	133.6	133.8	9.19	113.3
	25-Aug-2022	1	24.7	8.46	133.6	133.8	9.13	110.4
TLLit5	29-Aug-2022	0.5	19.6	8.29	118.3	132.4	7.77	83.5
	29-Aug-2022	1	19.0	8.24	117.6	132.5	7.64	82.6
TLLit6	28-Aug-2022	0.5	19.4	8.23	119.4	133.6	7.59	83.0
	28-Aug-2022	1	19.4	8.13	119.5	133.9	7.33	79.7
TLLit7	27-Aug-2022	0.5	nm	nm	nm	nm	nm	nm
	27-Aug-2022	1	nm	nm	nm	nm	nm	nm
TLLit8	27-Aug-2022	0.5	nm	nm	nm	nm	nm	nm
	27-Aug-2022	1	nm	nm	nm	nm	nm	nm
TLLit9	29-Aug-2022	0.5	23.9	7.93	131.5	134.2	8.79	nm

Site	Date	Depth (m)	Temperature (ºC)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)
	29-Aug-2022	1	23.9	7.94	131.7	134.4	8.82	nm
TLLit10	28-Aug-2022	0.5	19.4	8.23	119.4	133.6	7.59	83.0
	28-Aug-2022	1	19.4	8.13	119.5	133.9	7.33	79.7
TLLit11	29-Aug-2022	0.5	18.0	7.92	114.1	132.0	6.66	69.5
	29-Aug-2022	1	17.9	7.92	114.1	132.0	6.60	69.3

Notes: nm = not monitored due equipment malfunction

At the same 11 littoral sites in Tatelkuz Lake, littoral habitat characteristics were defined over a range of depths (**Table 2-7**).

Table 2-7. Littoral Habitat Transect Data, Tatelkuz Lake, August 2022

Site	Depth (m)	Substrate and Gradient Classes				Cover			
		Dominant Substrate	Sub-dominant Substrate	Shoreline Gradient (%)[1]	Littoral Habitat Type[2]	Total	Emergent Vegetation (0.5 x 0.5 m)	Submergent Vegetation	WD
TLLit1	0-0.5	gravel	fines	12	Gf-St	✓	✓	✓	✗
	0.5-1	fines	gravel	1	Fg-Sh	✓	✗	✓	✗
	1-2	fines	gravel	2	Fg-Sh	✓	✗	✓	✗
	2-3	fines	gravel	6	Fg-Sh	✓	✗	✓	✗
TLLit2	0-0.5	gravel	fines	12	Gf-St	✗	✗	✗	✗
	0.5-1	boulder/ cobble	cobble	15	Bc-St	✗	✗	✗	✓
	1-2	gravel/ cobble	cobble	10	Gc-St	✗	✗	✗	✓
	2-3	gravel/ cobble/ boulder	cobble	19	Gc-St	✗	✗	✗	✓
TLLit3	0-0.5	boulder	cobble	18	Bc-St	✗	✗	✗	✓
	0.5-1	boulder	gravel	15	Bg-St	✗	✗	✗	✗
	1-2	cobble	fines	13	Cf-St	✗	✗	✓	✗
	2-3	cobble / fines	cobble / fines	8	Cf-Sh	✗	✗	✗	✗

Site	Depth (m)	Substrate and Gradient Classes				Cover			
		Dominant Substrate	Sub-dominant Substrate	Shoreline Gradient (%)[1]	Littoral Habitat Type[2]	Total	Emergent Vegetation (0.5 x 0.5 m)	Submergent Vegetation	WD
TLLit4	0-0.5	fines	gravel	1	Fg-Sh	✓	✓	✓	×
	0.5-1	fines	gravel	3	Fg-Sh	✓	×	✓	×
	1-2	gravel	fines	20	Gf-St	✓	×	✓	×
	2-3	gravel	fines	19	Gf-St	✓	×	✓	×
TLLit5	0-0.5	gravel	fines	15	Gf-St	×	×	×	×
	0.5-1	fines	gravel	23	Fg-St	×	×	✓	×
	1-2	fines	gravel	38	Fg-St	×	×	✓	×
	2-3	fines	gravel	28	Fg-St	×	×	×	×
TLLit6	0-0.5	fines	gravel	1	Fg-Sh	×	✓	×	×
	0.5-1	fines	gravel	8	Fg-Sh	×	✓	×	×
	1-2	fines	gravel	12	Fg-St	×	✓	×	×
	2-3	fines	gravel	34	Fg-St	×	✓	×	×
TLLit7	0-0.5	boulder	cobble	21	Bc-St	×	✓	×	×
	0.5-1	-	-	-	-	-	-	-	-
	1-2	fines / gravel	gravel / fines	4	Fg-Sh	×	✓	×	×
	2-3	gravel	fines	11	Gf-St	×	✓	×	×
TLLit8	0-0.5	cobble	fines	10	Cf-St	×	×	×	×
	0.5-1	fines	gravel	15	Fg-St	×	×	×	×
	1-2	fines	gravel	18	Fg-St	×	×	×	×
	2-3	fines	gravel	30	Fg-St	×	×	×	×
TLLit9	0-0.5	fines	gravel	12	Fg-St	✓	×	×	×
	0.5-1	fines	gravel	16	Fg-St	✓	×	×	×
	1-2	fines	cobble	31	Fc-St	✓	×	✓	×
	2-3	fines	cobble	45	Fc-St	✓	×	×	×
TLLit10	0-0.5	gravel	fines	14	Gf-St	✓	×	×	×
	0.5-1	fines	gravel	18	Fg-St	✓	×	×	×
	1-2	fines	gravel	37	Fg-St	✓	×	×	×
	2-3	fines	cobble	47	Fc-St	✓	×	×	×
TLLit11	0-0.5	gravel	fines	11	Gf-St	×	×	×	×
	0.5-1	gravel	fines	14	Gf-St	✓	×	×	×
	1-2	gravel / fines	fines / gravel	26	Gf-St	✓	×	×	✓
	2-3	fines	gravel	40	Fg-St	×	×	×	×

Notes: [1] Gradient is qualified as Shallow (Sh) = <10%, or Steep (St) = >10%, [2] Littoral Habitat Type format: Dominant substrate/sub-dominant substrate-Shoreline gradient, Capital letter = dominant substrate, lower case letter = sub-dominant substrate (where g = gravel, f = fines, c = cobble, and b = boulder); Gradient (Sh or St), ✓ = present, ✗ = absent, (-) = data not available, WD = woody debris

2.3.2.3 Tatelkuz Lake Littoral Fish Assessment

Littoral Community Composition

Littoral fish captured at four sites in Tatelkuz Lake in 2021 are presented in **Table 2-6**. Four fish species were captured using beach seines and minnow traps at the four locations surveyed in 2021, with Brassy Minnow (36 total) and Northern Pikeminnow (33 total) being the most prevalent. Fish density calculations for each site are possible only for beach seine results, and this standardized method will be used for long-term monitoring (see **Section 2.2.2 Littoral Fish and Fish Habitat**).

Site Selection Power Analysis

A power analysis was completed using Brassy Minnow CPUE data from the 2021 the beach seine survey and beach seine CPUE data for the related Western Silvery Minnow (*Hybognathus argyritis*) from standardized field sampling methods for the Western Silvery Minnow (Macnaughton et al. 2019). The sample size calculation was completed using the 'Counts per Unit' sample size tool in JMP® statistical software (2021) using the mean baseline CPUE pooled between both datasets (0.095 fish/m^2), alpha = 0.05, power = 0.8 and effect size of 30%. This power analysis produced a minimum sample size of n=11. Therefore, 11 littoral habitat monitoring stations will be monitored in 2022 (**Figure 2-1**), which matches the 11 unique habitat types identified by AMEC (2013). At each habitat monitoring station, Brassy Minnow sampling using beach seining will be completed twice per year, June for larval fish and August-September for adult fish.

Table 2-8. Littoral Fish Species Captured in Tatelkuz Lake, 2021 and 2022

Year	Method		Fish Species							CPUE fish/m²	Density (fish/100 m²)
		Site*	BMC	MW	NSC	RB	Sculpin	Sucker	Total		
2021	BS	TLBMC1	5	0	0	0	0	0	5	0.07	6.7
	BS	TLBMC2	3	0	1	0	0	0	4	0.05	5.3
	BS	TLBMC3	12	0	20	0	1	10	43	0.57	57.3
	BS	TLBMC4	5	0	2	0	9	5	21	0.28	28.0
										CPUE fish/24 hr/trap	
	MT	TLBMC1	0	0	1	0	1	1	3	0.54	
	MT	TLBMC2	3	0	5	0	5	4	17	3.20	
	MT	TLBMC3	8	0	3	0	1	1	13	2.67	
	MT	TLBMC4	0	0	1	0	1	5	7	1.47	
2022										**CPUE fish/m²**	**Density (fish/100 m²)**
	BS	TLBMC1	6	1	36	1	4	90	138	0.74	73.5
	BS	TLBMC2	1	0	0	2	12	0	15	0.08	7.5
	BS	TLBMC3	0	0	0	0	3	0	3	0.02	1.5
	BS	TLBMC4	1	0	5	0	9	333	348	1.74	174.0
	BS	TLBMC5	19	0	0	2	42	2	65	0.33	32.5
	BS	TLBMC6	1	0	0	0	0	17	18	0.09	9.0
	BS	TLBMC7	1	0	0	0	1	6	8	0.04	4.0
	BS	TLBMC8	0	1	0	0	0	0	1	0.01	0.5
	BS	TLBMC9	0	0	1	1	0	5	7	0.04	3.5
	BS	TLBMC10	7	0	0	0	20	18	45	0.23	22.5
	BS	TLBMC11	0	0	0	0	35	0	35	0.18	17.5

Note: Site locations presented in Figure 2-1
BMC = Brassy Minnow
BS = beach seine
CPUE = Catch-per-unit-effort
MT = minnow trap
MW = Mountain Whitefish
NSC = Northern Pike Minnow
RB = Rainbow Trout

2.4 Frequency and Duration

The monitoring programs for Tatelkuz Lake littoral fish and fish habitat conditions and habitat suitability prior to Operations will continue to establish updated baseline conditions from which to compare future monitoring efforts related to EA Condition 3.16.2 (**Section 3 Follow-up Program 3.16.2: Tatelkuz Lake Littoral Zone Monitoring During Operations**). The baseline conditions program will allow the comparison of conditions prior to pumping water from Tatelkuz Lake by the FWSS to ensure no changes to baseline conditions occur during Operations pumping. Baseline monitoring will occur up to the start of FWSS operations in Year 6.

Monitoring frequency of the Tatelkuz Lake littoral fish and fish habitat conditions and habitat suitability after Year 6 of Operations (i.e., after the start of FWSS pumping) is described in **Section 3.4 Frequency and Duration** that applies to EA Condition 3.16.2. Under the EA Condition 3.16.2 Follow-up Program. Littoral fish habitat will be monitored once annually in late summer (July or August) until the start of, and during the Construction phase. Annual monitoring will provide updated baseline littoral habitat information.

3. FOLLOW-UP PROGRAM 3.16.2: TATELKUZ LAKE LITTORAL ZONE MONITORING DURING OPERATIONS

The Tatelkuz Lake Littoral Zone Monitoring Program during Operations will match the field and data analysis methods described in **Section 1.3 Condition 3.16.1 – Tatelkuz Lake Littoral Zone Surveys Prior to Operations**. Following the review of the 2021-2022 data by key stakeholders adjustments to the monitoring methodology, frequency and locations can be made to the Operational monitoring plans.

3.1 Background and Approach

The monitoring programs planned for Operations will be based on those started in 2021 and refined in 2022. The Operations monitoring programs will be designed in order to satisfy Condition 3.16.2 of the EA Certificate. This monitoring will include seasonal limnological measurements of the lake as well as fish and fish habitat surveys in littoral areas previously selected. Spring survey timing is planned to coincide with freshet, while summer and fall survey timing is planned to coincide with fish and fish habitat assessments. Original baseline information is presented in the Fish and Aquatic Resources 2011-2012 Baseline Report for Tatelkuz Lake fish habitat (AMEC 2013, Appendix 5.1.2.6A, Section 5.9.4).

3.2 Study Design

3.2.1 Tatelkuz Lake Limnology

The following seasonal limnological measurements will be taken for comparison with baseline water property information from deeper parts of the lake that will influence littoral zone fish habitats:

- Vertical profiles up and down at 1.0 m intervals for temperature (ºC), pH, conductivity (µS/cm), and dissolved oxygen (mg/L) at four established locations in Tatelkuz Lake (**Figure 2-1; Table 2-1**) identified by AMEC (2013).
  - 2022 Winter profiles to be taken under ice, including measurement of ice thickness (m).
  - Additional Winter *in situ* water quality to be taken at the four fish and fish habitat sampling locations to determine overwintering dissolved oxygen, a habitat suitability metric for Brassy Minnow.
- Collection of surface water samples for analysis of epilimnetic total phosphorus (mg/L) and total nitrogen (mg/L); and
- Secchi depths by lowering the Secchi disc over the shaded side of the boat recording the depth at which the disc disappears from site and the depth at which it reappears from site.

Sampling frequency is described in **Section 3.4 Frequency and Duration**. The Tatelkuz Lake limnology endpoints will include several physical water measurements and winter ice measurements (**Table 3-1**).

Table 3-1. Measurement and Assessment Endpoints for Tatelkuz Lake Limnology During Operations

Measurement Endpoint	Assessment Endpoint	Baseline Ranges
Physical limnology	Temperature (ºC), pH, conductivity (µS/cm), dissolved oxygen (mg/L), phosphorous (mg/L), nitrogen (mg/L), Secchi Depth	Temperature: Mar.1.9-3.7ºC, Jun. 2.0-16.8ºC, Aug. 5.1-24.7ºC, Oct. 6.4-6.8ºC. pH: Mar. 6.3-7.2, Aug. 7.9-8.8 Conductivity: Mar. 118.3-126.3 µS/cm, Aug. 113.5-134.4 µS/cm Dissolved Oxygen: Mar. 4.23-10.65 mg/L, Jun. 6.52-12.10 mg/L, Aug. 2.49-12.59 mg/L, Oct. 5.17-8.99 mg/L Phosphorus: Jun. 0.0128-0.0158 mg/L, Sep. 0.0074-0.0091 mg/L, Nov. 0.0225-0.0290 mg/L Nitrogen: Sep. 0.331-0.353 mg/L, Nov. 0.346-0.375 mg/L. Secchi Depth: Jun. 2.6-3.3 m, Aug. 4.4-4.5 m, Oct. 3.5-3.8 m.
Winter ice conditions	Ice thickness (cm), littoral winter dissolved oxygen (mg/L)	Ice: 0.32-0.44 m Dissolved Oxygen: 8.52-12.10 mg/L at 1m

3.2.2 Littoral Fish and Fish Habitat

Summer and fall littoral fish habitat assessments will include the following measurements for comparison with baseline information:

- Drone-based field survey and orthoimagery of Tatelkuz Lake shoreline at the four established Brassy Minnow sampling and habitat assessment locations (**Figure 2-1; Table 2-1**) representative of the unique littoral habitat types identified by AMEC (2013). Ground surveys will verify the littoral habitat description completed in 2013.
- Measurement of habitat characteristics at 1 m intervals along transects, from shore to 3 m water depth (following AMEC [2013] methods), including:
  - Water depth measurement and elevation using a benchmark survey;
  - Distances from high water mark, toe of the bank and wetted edge;
  - Using a 0.5 x 0.5 m quadrat:
    - Substrate characterization (i.e., identification of dominant and subdominant substrate types along the transect); and
    - Littoral plant community characterization (i.e., percent emergent, submerged, floating-leaved or free floating macrophytes) and identification of other key habitat features (e.g., woody debris, percent cover for fish).
- In situ water quality measurement, including surface water temperature (ºC), pH, conductivity (µS/cm), and dissolved oxygen (mg/L) at each sampling location.
- Beach seine sets of approximately 200 m^2 will be completed at each station, with captured fish identified to species and a subset measured.

Fish and fish habitat sampling will occur in June (i.e., larval life-stage) and August (i.e., other life-stages), during summer stratification of the lake. Littoral vegetation is expected to be at its maximum extend during this period. Sampling frequency is described in **Section 3.4 Frequency and Duration**. The summer littoral fish habitat survey measurement endpoints will include assessment of fish habitat suitability (**Table 3-2**).

Table 3-2. Measurement and Assessment Endpoints for the Littoral Fish Habitat Assessment in Tatelkuz Lake

Measurement Endpoint	Assessment Endpoint	Baseline Ranges
Habitat conditions	Water temperature (ºC), pH, conductivity (µS/cm), dissolved oxygen (mg/L)	Temperature: variable for each site - see Table 2-6 pH: variable for each site - see Table 2-6 Conductivity: variable for each site - see Table 2-6 Dissolved Oxygen: variable for each site - see Table 2-6
Habitat suitability	Water depth (cm), substrate type, plant community (percent emergent), habitat cover (percent cover),	Water Depth: see Table 2-7 Substrate: see Table 2-7 Plant Community: see Table 2-7 Habitat Cover: see Table 2-7 Lake Elevation: 927.10 – 928.34 m above sea level
Fish abundance	Catch Per Unit Effort (CPUE) and fish density (fish/100 m^2) for each identified species	CPUE: variable for each site - see Table 2-8 Density: variable for each site - see Table 2-8

3.3 Data Analysis

Data analysis methodologies for littoral habitat monitoring during operations will match or be based on the methods described in **Section 2.2.2 Littoral Fish and Fish Habitat**.

3.4 Frequency and Duration

The monitoring programs for Tatelkuz Lake littoral fish and fish habitat conditions and habitat suitability will start in Year 6 of Operations at the start of water withdrawal from Tatelkuz Lake. The monitoring will continue for all remaining phases of the Project following Year 6 of Operations. Starting from Year 6 of Operations, monitoring for Condition 3.16.2 will be conducted annually for the duration of Operations. Monitoring frequency of all Condition 3.16.2 components for Closure and Post-Closure phases will be determined near the end of the Operations phase and will depend on monitoring results during that phase.

4. FOLLOW-UP PROGRAM 3.16.3 – LOWER CHEDAKUZ CREEK MONITORING DURING ALL PROJECT PHASES

4.1 Background and Approach

Water flows in lower Chedakuz Creek have been monitored by Knight Piésold Consulting since 2012 (Knight Piésold 2021). Data from this monitoring program will be used to satisfy Condition 3.16.3 of the Decision Statement requiring monitoring of flows in lower Chedakuz Creek. In addition, fish and fish habitat has been assessed in lower Chedakuz Creek to validate the EA conclusions (Condition 3.16).

Original baseline information is presented in the Fish and Aquatic Resources 2011-2012 Baseline Report for lower Chedakuz Creek temperatures (AMEC 2013, Appendix 5.1.2.6A, Section 5.1) and fish habitat (AMEC 2013, Appendix 5.1.2.6A, Section 5.8.1). Stream flows for lower Chedakuz Creek were not measured for the EA. ERM (2017) estimated streamflow in Chedakuz Creek would decrease from baseline conditions during Construction (52 L/s decrease from baseline; 2% reduction relative to baseline), early Operations (316 L/s decrease from baseline; 13% reduction relative to baseline), late Operations (182 L/s decrease from baseline; 7% reduction relative to baseline), Closure (317 L/s decrease from baseline; 13% reduction relative to baseline), and Post-Closure (37 L/s decrease from baseline; 1% reduction relative to baseline).

4.2 Study Design

4.2.1 Lower Chedakuz Creek Discharge

A water flow monitoring station has been in place in lower Chedakuz Creek near the outlet of Tatelkuz Lake since 2012. This station measures discharge stage, with discharge measurements compared against a data logger station located downstream of the confluence with Davidson Creek. These flow measurements encompass the section of lower Chedakuz Creek described in Condition 3.16.3. The location of the hydrology station (L1-Outlet) is presented in **Figure 2-1**.

Standard techniques are employed at the hydrometric station to manually measure streamflow (RISC 2018). A minimum of five stage-discharge measurements are collected annually at different flow conditions in order to validate developed empirical relationships (i.e., rating curves) between water level and streamflow. Discharge measurements are collected during the winter months at monitoring stations where site conditions allow, typically late October to early April. For each station, the rating curves are used to convert continuous stage data into continuous streamflow and, from this information, specific hydrologic parameters such as runoff and unit yield are calculated.

Hydrometric data will be provided in a consistent, industry-standard manner so that it can be easily integrated into common analytical workflows using R or other similar tools, including the fasstr package. This standardization will facilitate analysis for the Nations through standardized tools and allow incorporation into larger datasets to help understand hydrological processes in the Project are and enable management decisions related to the mine in the context of ongoing climate change.

Sampling frequency is described in **Section 4.4 Frequency and Duration**. The lower Chedakuz Creek discharge endpoints will include stream depth and flow velocity to develop rating curves (**Table 4-1**).

Table 4-1. Measurement and Assessment Endpoints for Lower Chedakuz Creek (H5) Discharge

Measurement Endpoint	Assessment Endpoint	Baseline Ranges*
Discharge	Stream depth (m) and discharge (m^3/s)	Depth, Discharge: January: 0.60 m, 1.4 m^3/s February: 0.55-0.64 m, 1.0-1.8 m^3/s March: 0.48-0.60 m, 0.9-1.3 m^3/s April: 0.56-0.78 m, 1.2-3.7 m^3/s May: 1.04-1.99 m, 7.7-21.0 m^3/s June: 0.88-1.43 m, 4.8-19.2 m^3/s July: 0.61-0.99 m, 1.4-7.0 m^3/s August: 0.61-0.77 m, 1.4-3.3 m^3/s September: 0.54-0.64 m, 0.6-1.7 m^3/s October: 0.47-0.79 m, 0.3-3.5 m^3/s November: 0.53-0.57 m, 0.8-1.1 m^3/s December: 0.55-0.72 m, 0.9-2.7 m^3/s

*Notes: * depths and discharge rates from Blackwater Gold Project 2020 Hydrology and Water Temperature Baseline Report (Knight Piésold 2021)*

4.2.2 Lower Chedakuz Creek Water Quality

Sampling will be conducted quarterly at the hydrology station site (**Figure 2-1**). Additionally, 5-in-30-day sampling will be performed during spring freshet. Water sampling will be completed to align with biological sampling. Sampling methods will follow best practices as outlined in *British Columbia Field Sampling Manual* (BC MWLAP 2013). Samplers will always practice clean sampling techniques including wearing clean vinyl gloves while handling samples at each station.

For stream sampling, water samples will be collected in areas of laminar flow, if present and when it is safe to do so, to minimize suspended particulates. Stream samples will be collected by facing upstream and submerging the laboratory-certified, clean general parameter sample bottle below the surface until filled. The general parameter bottle will then be used to fill the other sample bottles by decanting the collected water.

All samples will be field filtered and/or preserved in the field according to the analytical laboratories protocols. Samples will be stored in coolers on ice and/or refrigerated until shipped to an accredited analytical laboratory for sample analysis. Collected water quality samples will be analysed for general physical/ion parameters, nutrients and organics, cyanide, and total and dissolved metals at a Canadian Association for Laboratory Accreditation (CALA)-accredited laboratory. The lower Chedakuz Creek water quality endpoints will include these parameters (**Table 4-2**).

Table 4-2. Measurement and Assessment Endpoints for Lower Chedakuz Creek Water Quality

Measurement Endpoint	Assessment Endpoint	Baseline Ranges
Water quality	Physical/ion parameters (e.g., temperature, dissolved oxygen), nutrients and organics (e.g., nitrates, phosphorus), cyanide, and total and dissolved metals (e.g., arsenic , iron, mercury)	Temperature: Aug. 16-8-17.2 °C; Sept. 14.8-18.1 °C Dissolved Oxygen: Aug. 8.8-9.3 mg/L; Sept. 8.4-9.2 mg/L pH: Aug. 8.1-8.2; Sept. 8.0-10.2 Conductivity: 111.8-112.3 µS/cm Nutrients/Cyanide/Metals: monitored as part of AEMP

4.2.3 Lower Chedakuz Creek Fish and Fish Habitat

4.2.3.1 Field Methods - Overview

A fish and fish habitat inventory will be conducted in lower Chedakuz Creek to update the baseline information from the EA. This set of surveys will include the following tasks:

- Measuring mean monthly discharge for the hydrology station (L1-Outlet) located at the outlet of Tatelkuz Lake into lower Chedakuz Creek (**Figure 2-1**), to produce a hydrograph showing the annual mean monthly discharge.
- Water quality measurements in lower Chedakuz Creek as part of the AEMP Plan (ERM 2022) for comparison with results from the original environmental assessment.
- A Fish Habitat Assessment Procedures (FHAP; Johnston and Slaney, 1996) Level 1 survey will be completed in the portion of lower Chedakuz Creek between the outlet of Tatelkuz Lake and the confluence with Davidson Creek (**Figure 2-1**), including measurement of channel dimensions, substrate percent composition, channel disturbance, and instream cover for fish.
- Drone-based orthoimagery is to be collected for the reach of lower Chedakuz Creek between the outlet of Tatelkuz Lake and the confluence with Davidson Creek to establish high-level baseline habitat conditions. This drone imagery will be compared to previous imagery to assess whether the channel morphology of lower Chedakuz Creek has changed significantly and whether the hydraulic relationships contained within the System for Environmental Flow Analysis (SEFA) model remain valid. FHAP data will be used to verify the habitat description completed in 2013 by AMEC (2013).
- Fish sampling will be completed using minnow traps to estimate distribution and abundance of immature and small-bodied fish species at eight sites (**Figure 2-1)**, matching the original locations assessed by AMEC (2013)**.**
- Closed-site backpack electrofishing with block nets at the three locations to estimate relative abundance (**Figure 2-1).**
- A winter habitat assessment will be conducted in early-February to early-March. Depending on the conditions at the selected monitoring locations in lower Chedakuz Creek the following information will be recorded:
  - Water depth (m)
  - Ice depth (m)
  - Measurement of temperature (ºC), pH, conductivity (µS/cm), and dissolved oxygen (mg/L) at selected locations within lower Chedakuz Creek;
- Bank walk kokanee spawner surveys will be repeated to determine abundance of spawners in the section of lower Chedakuz Creek between the Tatelkuz Lake outlet and the confluence with Davidson, as well as locations and habitat characteristics of sections of high spawning activity.

4.2.3.2 Field Methods – Summer Fish and Fish Habitat

Electrofishing surveys will be conducted at the three sites in lower Chedakuz Creek, as shown in **Figure 2-1.** At each site, sampling will include:

- Three-pass depletion electrofishing of stream sections 100 m in length, isolated with block nets;
- Identification of species and collection of length, weight, and body condition data for all fish captured;

- Measurement of channel dimensions and calculation of mean values of bankfull width, wetted width, water depth, and gradient, based on the FHAP survey; and,
- In-situ water quality measurements (i.e., temperature, dissolved oxygen, pH, and conductivity).

Sampling will occur during in late July, during the period after Rainbow Trout Young of Year (YOY) emergence and before the arrival of spawning kokanee adults. At each site, sampling effort, electrofisher specifications, and catches will be recorded. Catch per unit effort (CPUE), relative abundance (number of fish per unit effort) and density metrics (number of fish per m^2) will be calculated and analyzed.

FHAP fish habitat surveys will be completed on lower Chedakuz Creek (**Figure 2-1**) and will include delineation of mesohabitat units (e.g., riffle, run, pool) and measurement of key habitat components such as channel dimensions, stream morphology, cover, vegetation, substrate composition and riparian habitat information.

The summer fish inventory measurement endpoints will include an inventory of the fish community and fish health (**Table 4-3**).

Table 4-3. Measurement and Assessment Endpoints for the Lower Chedakuz Creek Summer Fish Assessment

Measurement Endpoint	Assessment Endpoint	Baseline Ranges
Fish inventory	Catch Per Unit Effort (CPUE), fish density (fish/100 m^2), and biomass (total kg) for each identified species, and population structure	CPUE: minnow trap 0.0-0.74 fish/trap-hr; electrofishing 1.33-4.51 fish/100s effort Density: 1.58-6.66 fish/100m^2 Biomass: to be included starting 2023 Population: kokanee, Northern Pike Minnow, Prickly Sculpin, Rainbow Trout, sucker species
Fish health	Length, weight, condition	Length: kokanee 165-194 mm; Rainbow Trout 175-190 mm Weight: kokanee 37.0-72.7 g; Rainbow Trout 61.2-69.0 g Condition: kokanee 0.8-1.0; Rainbow Trout 1.0-1.1
Fish habitat	Mesohabitat unit boundaries, channel dimensions, stream morphology, cover, vegetation, substrate composition, riparian habitat	Mesohabitat: to be included starting 2023 Channel: see Table 4-6 Cover: see Table 4-6 Substrate: see Table 4-6

4.2.3.3 Field Methods - Kokanee Spawner Survey

Kokanee and redds will be counted weekly over a four-week period by a two-person crew hiking upstream between the confluence of Davidson Creek and lower Chedakuz Creek and the outlet of Tatelkuz Lake. By walking upstream, the crew will reduce the startle response of fish, which are usually oriented head-first into the flowing water. This method increases the probability of accurately counting fish.

Both live and dead kokanee will be counted in separate categories. Live fish will be classified as migrating/holding, spawning, or spent, depending on their behaviour. Migrating fish are those swimming steadily, usually upstream. Holding fish are those paired and occupying a station. Spawning fish are those paired and engaged in courtship behaviour with one or more mates, or actively digging or guarding a redd. Spent fish are those observed in pools and backwaters or drifting downstream along the stream margins with clear damage to body and fins.

Fish in each of the four classes will be counted individually by each crew member and then the two sets of counts compared at the end of a survey section. The set with the larger numbers will be selected as the best representative of the number of fish in that reach. Dead fish will be measured for post-orbital hypural and fork length (mm) and internally inspected to determine spawning success.

Information will be recorded for the start and end location of the survey as measured by GPS, water temperature (ºC), dissolved oxygen (mg/L), pH, conductivity (µS/cm), creek width (m), redd habitat type (glide, riffle, or pool) based on FHAP (Johnston and Slaney 1996), and dominant and subdominant substrate in redds based on RIC standards (BC FISB 2001).

Concurrent with the visual survey, a drone-based survey also will be completed. This survey will provide a permanent record of spawning activity. Drone-based and visual surveys will be performed once each week over the four-week peak spawning period for comparison of the two survey methods' accuracy for estimating spawner numbers and redds.

Kokanee spawner counts, redd counts, and length measurements will be used to evaluate the relative abundance and density of spawners and redds, and size at maturity. The kokanee bank walk visual assessment measurement endpoints will include assessment of fish and redd abundance and size at maturity (**Table 4-4**).

Table 4-4. Measurement and Assessment Endpoints for Kokanee Spawning Bank Walk in Lower Chedakuz Creek

Measurement Endpoint	Assessment Endpoint	Baseline Ranges
Fish abundance	Relative number of adult spawners and their density observed in each survey reach	Number: 0-4 spawners Density: 0.006-0.147 fish/m
Redd abundance	Relative number of redds and their density observed in each survey reach	Number: Zero Density: Zero
Fish size at 100% maturity	Length and age at 100% maturity of kokanee returning to Davidson Creek	Length: to be included starting 2023 Age: to be included starting 2023

4.3 Data Analysis

Several of the fish and fish habitat surveys described in **Section 4.2 Study Design** were conducted in lower Chedakuz Creek in 2021. A summary of results for these surveys are presented in the following sections.

4.3.1 Lower Chedakuz Creek Discharge

The mean monthly discharge for each year of record between 2011-2020 was calculated for the hydrology station (L1-Outlet) located at the outlet of Tatelkuz Lake into lower Chedakuz Creek (**Figure 2-1**), to produce a hydrograph showing the annual mean monthly discharge (**Figure 4-1**, Knight Piésold 2021). Freshet in lower Chedakuz Creek typically starts in late March and peaks in late May or mid June. Low flows occur from late summer through to March each year.

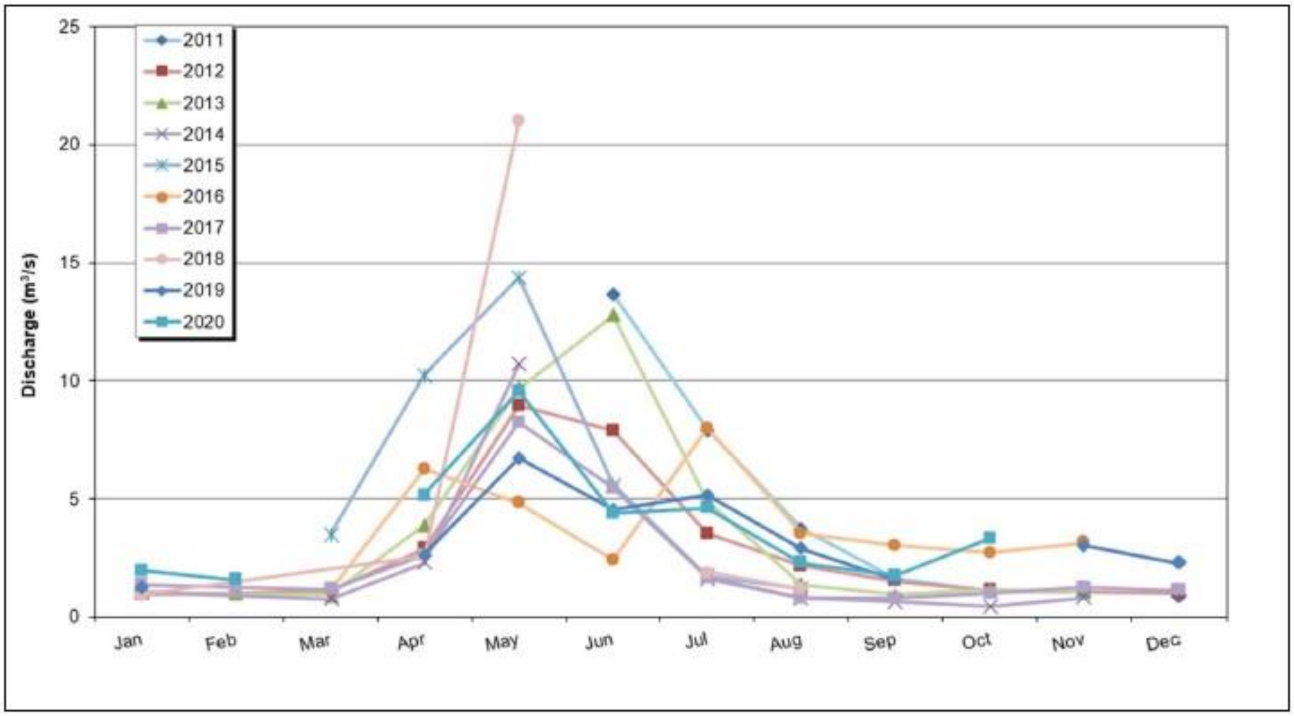

Figure 4-1. Mean Monthly Discharge for the Tatelkuz Lake Outlet to Lower Chedakuz Creek, 2012-2020, from Knight Piésold (2021)

The discharge hydrographs for the Tatelkuz Lake outlet to lower Chedakuz Creek were converted to daily unit runoff to allow for the comparison of unit runoff and peaks between years within a catchment. This metric will be used at the lake outlet hydrology station to monitor flows in lower Chedakuz Creek prior to and during operation of the FWSS (see **Section 2.4 Frequency and Duration**).

4.3.2 Lower Chedakuz Creek Water Quality

Water quality measurements in lower Chedakuz Creek will be compared with results from the original environmental assessment. Each water quality metric will be monitored to determine if significant changes occur in lower Chedakuz Creek compared to AEMP reference sites or over time (ERM 2022).

4.3.3 Lower Chedakuz Creek Fish and Fish Habitat

In 2021 and 2022 minnow trapping effort at eight sites and ten sites, respectively (**Figure 2-1**) in the section of lower Chedakuz Creek between the Tatelkuz Lake outlet and Davidson Creek confluence caught totals of 98 to 130 fish with a CPUE ranging from an average low of 0.17 fish-per-trap-hour to an average high of 0.48 fish-per-trap-hour. In 2010 three-pass electrofishing was performed at two of three sites lower Chedakuz Creek (**Figure 2-1**). A third electrofishing site was not accessible due to spawning kokanee. . A total of 91 fish were captured at the two sites, with CPUE averages of 4.51 and 1.33, respectively. A summary of catch by site is presented in **Table 4-5**.

Table 4-5. Catch-per-unit-effort from Fishing Effort using Minnow Traps and Electrofishing in Lower Chedakuz Creek in 2021 and 2022

Site	Year	Species	Catch (# of fish)	CPUE (# of fish per trap-hour)	CPUE (# of fish per 100s electrofishing effort)
CCMT1	2021-2022	Sculpin sp.	1 - 36	0.03 - 0.67	--
CCMT2	2021-2022	Sucker sp.	15 - 28	0.45 - 0.53	--
CCMT3	2021-2022	RB	1 - 6	0.03 - 0.16	--
CCMT4	2021-2022	Sucker sp.	1 - 6	0.03 - 0.16	--
CCMT5	2021-2022	-	0 - 10	0 - 0.27	--
CCMT6	2021-2022	BMC, RB, Sculpin sp.	7 - 8	0.19 - 0.22	--
CCMT7	2021-2022	Sculpin sp. Sucker sp. Dace sp.	0 - 48	0.00 - 1.29	--
CCMT8	2021-2022	Sculpin sp. Dace sp.	4 - 24	0.11 - 0.62	--
CCMT9	2022	NPM Sucker sp.	5	0.13	--
CCMT10	2022	Sucker sp.	28	0.74	--
CC_EF2 pass 1	2022	kokanee MWH, NPM, RB Sculpin sp. Sucker sp.	40	--	6.66
CC_EF2 pass 2	2022	kokanee NPM Sculpin sp. Sucker sp.	20	--	4.18
CC_EF2 pass 3	2022	kokanee NPM Sculpin sp. Sucker sp.	13	--	2.68
CC_EF3 pass 1	2022	NPM Sculpin sp.	8	--	1.58
CC_EF3 pass 2	2022	NPM, RB Sculpin sp.	5	--	1.18
CC_EF3 pass 3	2022	NPM, RB Sculpin sp.	5	--	1.23

Sculpin sp.=unidentified sculpin species, sucker sp.=unidentified suck species, dace sp.=unidentified dace spaces, BMC = Brassy Minnow, MWH=Mountain Whitefish, NPM=Northern Pikeminnow, RB=Rainbow Trout.

4.3.3.1 Population Structure

Length frequency results for the 2021 fish sampling in lower Chedakuz Creek have not yet been processed and analyzed. Population structures of fish will be assessed using length frequency distributions and length-age regressions. The length frequency distributions between control and impact sites will be compared using a two-level Kolmogorov-Smirnov Test to determine whether the distribution was the same across the two groups being compared. A minimum of 30 individual length measurements will be considered the minimum required to provide the statistical power required for the Kolmogorov-Smirnov Test. Length and length-at-age will be monitored to determine if significant reduction occurs in lower Chedakuz Creek compared to AEMP reference sites (ERM 2022).Fish Condition

The length/weight data from reference sites and from historical data (Appendix 2-O, Fish and Aquatic Resources 2011 – 2012 Baseline Report; Appendix 2-P, Fish and Aquatic Resources 2013 Baseline Report) will be combined and a normal reference range will be calculated using specific length increments and the associated average weight data.

The relative condition (K_n) will be used as the metric for condition and will be calculated by comparing the measured weight to the expected weight from the measured length as:

$$K_n = \frac{W}{W_E}$$

where W = measured fish weight (g) and W_E = expected fish weight (g).

Relative condition will be statistically compared between reference and impact sites (ERM 2022). Significance will be assumed when $p < 0.05$. Fish condition will be monitored to determine if significant reduction occurs in lower Chedakuz Creek compared to AEMP reference sites (ERM 2022).

4.3.3.2 Fish Habitat

The main focus of this program regarding is on flows in Chedakuz Creek, which directly affect fish habitat. Continuous hydrometric gauges are operated on Chedakuz Creek immediately downstream of the outflow of Tatelkuz Lake and below its confluence with Davidson Creek. This streamflow record will be used in conjunction with existing SEFA models for the reach of Chedakuz Creek between Tatelkuz Lake and the confluence with Davidson Creek to estimate the reductions in physical fish habitat caused by the operations of the FWSS. For each relevant stanza, a timeseries of daily habitat will be generated by coupling the existing SEFA models to the observed streamflow record. This timeseries will be compared to a secondary timeseries of estimated habitat that would have occurred, had the FWSS not been operational.The relevant timeseries of habitat values for each stanza will be compared to a long-term baseline record to quantify reductions using a percentile-based approach. Additional work will be conducted to assess the validity of the SEFA model for Chedakuz Creek.

Fish habitat data gathered from FHAP surveys and past Reconnaissance (1:20,000) Fish and Fish Habitat Site Card (RIC 2001) surveys will be compared each year. Assessments will include comparison of channel dimensions, overall mesohabitat composition, start and end points of individual mesohabitat units, channel substrate composition, riparian woody debris presence, cover abundance and composition, disturbance indicators, and riparian vegetation condition.

In 2021 only some key habitat characteristics were measured at the three lower Chedakuz Creek fish habitat sites (**Figure 2-1**). A summary of the habitat metrics collected in 2021 is presented in **Table 4-6**. Lower Chedakuz Creek at the three sites has a large channel averaging a 15.6 m channel width and 13.8 m wetted width, dominated by fines with some gravel substrate. The stream banks at two of the three sites have been disturbed by cattle.

4.3.3.3 Fish and Fish Habitat Change Monitoring

A System for Environmental Flow Analysis (SEFA) model was used to estimate the amount of stream habitat loss in lower Chedakuz Creek due to water loss due to planned FWSS pumping (Palmer 2021). This same SEFA model will be used in conjunction with ongoing lower Chedakuz Creek streamflow monitoring data to quantify actual changes in physical habitat compared to baseline conditions. Development of follow-up program trigger responses (**Section 6.1 Follow-Up Program Trigger Response**) during Construction and Operations will be based on variation observed from baseline conditions during pre-Operations monitoring.

Table 4-6. Summary Table of 2021 Lower Chedakuz Creek Fish Habitat Information

Site ID	Sampling Date	Morphology	B_fW (m)	WW (m)	Res. Pool (m)	Bed Materials	Stream Cover (%)	WD (%)	Undercut Bank (%)	Disturbance	Instream Vegetation
CCMT6	29/07/22	LC	18.5	13.20	0.24	Fg	M	D	T	Beaver Trampled banks	N
CCMT2	29/07/22	LC	12.1	12.1	0.87	Fg	T	T	T		V
CCMT3	29/07/22	LC	16.2	16.2	0.27	Fg	T	T	T	Trampled banks	

LC=large channel morphology, BfW= channel width measured at the top of bank, WW=wetted width of the channel, Res. Pool = residual pool depth, WD= woody debris, Fg=fines dominant and gravel subdominant substrate classes using the specifications of RIC (2001)

4.3.4 Kokanee Spawner Surveys

Kokanee spawner surveys for the section of lower Chedakuz Creek between the outlet of Tatelkuz Lake and the confluence with Davidson Creek were completed in fall 2021 and fall 2022 using weekly bank-walk and UAV-based surveys. Lower Chedakuz Creek has a large channel morphology with shallow depth, low cover and complexity, low gradient and short riparian vegetation. These habitat features are suitable for UAV-based spawner surveys, that were completed each week. No kokanee spawners were observed during bank-walk and UAV surveys in this section of lower Chedakuz Creek in fall 2021 despite the timing matching that of AMEC (2013) when spawners and redds were observed within this reach.

In 2022 the kokanee spawner counts for this section of lower Chedakuz Creek observed one spent and four dead kokanee, indicating some spawning had taken place (**Table 4-7)**. Peak kokanee spawner counts may not be possible for determining density by linear stream length (# of fish/linear m) and by stream area (# of fish/m^2) to match the baseline methods of AMEC (2013) in this section of lower Chedakuz Creek due to low to no spawning activity.

Table 4-7. Kokanee Visual Spawner Survey in Lower Chedakuz Creek, August to September 2022

Date	Holding/ Migrating	Spawning	Spent	Dead	Observer Efficiency (%)	Linear Density (fish/m)	Redds Observed
26-Aug-2022	140	0	0	0	85	0.147	No
11-Sep-2022	6	0	0	0	50	0.006	No
18-Sep-2022	47	0	1	4	50	0.049	No

Notes: % = percentage, m = metre

4.4 Frequency and Duration

The monitoring programs for potential impacts lower Chedakuz Creek fish abundance, fish health, fish habitat and kokanee spawner populations will start in Year 6 of Operations at the start of water withdrawal from Tatelkuz Lake. Prior to Year 6, pre-Construction and pre-pumping surveys will be completed to establish a recent baseline dataset to enable comparison. The monitoring will continue for all remaining phases of the Project following Year 6 of Operations.

Starting from Year 6 of Operations the frequency of Condition 3.16.3 monitoring will be annual for all sampling components.

Monitoring frequency of all Condition 3.16.3 components for Closure and Post-Closure phases will be determined near the end of the Operations phase and will depend on monitoring results during that phase.

5. IMPLEMENTATION SCHEDULE

Follow-up Programs 3.16.1 (Tatelkuz Lake littoral habitat before Operations), 3.16.2 (Tatelkuz Lake littoral habitat during Operations), and 3.16.3 (lower Chedakuz Creek monitoring during all project phases) were initiated in 2021-2022 through field programs to select sites, refine field sampling methods, and collect baseline data prior the start of Construction and will continue until the start of FWSS operations in Year 6.

One year of monitoring will occur for follow-up program 3.16.1 to provide updated baseline conditions prior to water withdrawal from Tatelkuz Lake. The Tatelkuz Lake littoral fish and fish habitat monitoring program (Condition 3.16.2) will be ongoing throughout the life of the Project starting from Year 6 of Operations. The surface water quality and flow monitoring in lower Chedakuz Creek (Condition 3.16.3) will occur during all project phases, with the exception of the 5-in-30 sampling.

6. ADAPTIVE MANAGEMENT

The follow-up programs for Condition 3.16 described herein will evolve over time in response to the results of the monitoring, changing conditions or development at the Project, updates to methods, and through consultation with Indigenous groups, regulators, or other stakeholders. This process of continuous improvement with changing conditions is referred to as adaptive management.

Conditions 2.5 and 2.6 in the federal DS identify requirements for follow-up programs:

"2.5 The Proponent shall, where a follow-up program is a requirement of a condition set out in this Decision Statement, have a Qualified Professional, where such a qualification exists for the subject matter of the follow-up program, determine, as part of the development of each follow-up program and in consultation with the party or parties being consulted during the development, the following information:

2.5.1 the follow-up activities that must be undertaken by a qualified individual;

2.5.2 the methodology, location, frequency, timing and duration of monitoring associated with the follow-up program;

2.5.3 the scope, content, format and frequency of reporting of the results of the follow-up program;

2.5.4 the levels of environmental change relative to baseline conditions that would require the Proponent to implement modified or additional mitigation measure(s), including instances where the Proponent may require Designated Project activities to be stopped; and

2.5.5 the technically and economically feasible mitigation measures to be implemented by the Proponent if monitoring conducted as part of the follow-up program shows that the levels of environmental change referred to in condition 2.5.4 have been reached or exceeded.

2.6 The Proponent shall update and maintain the follow-up and adaptive management information referred to in condition 2.5 during the implementation of each follow-up program in consultation with the party or parties being consulted during the development of each follow-up program."

Thus, an adaptive management framework has been incorporated into the follow-up programs. **Figure 6-1** identifies the components of the adaptive management framework.

Figure 6-1. Adaptive Management Framework

Plan: In collaboration with the Indigenous groups, further refine and plan Follow up Programs 3.16.1, 3.16.2 and 3.16.3.

Do: Implement Follow-up Programs 3.16.1, 3.16.2 and 3.16.3.

Monitor: BW Gold will review and update the follow up programs over the life of the Project. This will include:

- Review of the programs in terms of effectiveness in detecting changes with the monitoring program;
- Recommendations provided by qualified individual and Indigenous groups on the monitoring plan; and
- Engagement tracking to record input from Indigenous groups.

Adjust: BW Gold will adjust the follow-up programs (e.g., study design, field methods, data analysis methods, and reporting) based on program findings, as well as input and feedback from Indigenous groups.

An example of potential adaptive measures is for changing withdrawal amounts from the Tatelkuz Lake due to pumping having an affect on littoral fish habitat. The adaptive management framework is as follows:

1. Negative adverse effects to littoral fish habitat observed that deviate from the predictions of the EA.
2. Reduce the volume of water being withdrawn from Tatelkuz Lake to augment flows in Davidson Creek via the FWR/FWSS
3. Monitor Tatelkuz Lake surface level and investigate alternative water management strategies and supplies (e.g., groundwater wells)
4. If level increases, maintain current pumping rate. If level continues to decrease, further reduce or stop pumping from the lake.
5. If IFN cannot be maintained in Davidson Creek with decreased or halted pumping from the lake, alternative water management strategies or sources will be used. Mine operations will be reduced or halted until IFS can be maintained.

6.1 Follow-Up Program Trigger Response

To determine ‘the levels of environmental change relative to baseline conditions that would require the Proponent to implement modified or additional mitigation measure(s)’ (DS Condition 2.5.4) entails establishing levels (i.e., triggers), that when reached, trigger a response action.

Changes in the monitoring metrics for fish populations (e.g., fish abundance and spawner escapement), may reflect natural variability and it is challenging to pinpoint whether a significant change is attributable to mine activities (namely, water withdrawal by the from Tatelkuz Lake). Establishing triggers provides an early-warning system, allowing sufficient time to investigate root causes, increase monitoring, and take preventative action (i.e., implement modified or additional mitigation measure(s)).

Statistical analyses will be used to evaluate changes over time. Analyses will allow for between-year comparisons and longer-term trend analysis. Between-year comparison (i.e., paired comparison between two separate annual datasets) will be completed to identify statistical differences in mean values. In addition, year over year change will be assessed qualitatively, by comparing with the baseline data.

For longer time scale (i.e., five years and onwards), non-parametric Mann-Kendall temporal trends testing will be used to determine if there are significant temporal trends in any given monitoring metric, and if so, the direction and statistical significance of temporal trend. The sensitivity of the MK trends test increases with an increasing number of time steps (i.e., consecutive years of data) and it is considered that somewhere between five-and-ten-time steps are a minimum requirement. For the first four years of monitoring, temporal trends analysis will not be possible, however a Trigger Action Response Plan for fish habitat endpoints has been established that is based on triggers for flow and temperature. This is outlined in the AEMP for the Project.

Table 6-1 identifies triggers and responses for adaptive management related to fish population monitoring as part of follow-up programs 3.16.2 and 3.16.3. There are no triggers proposed for follow-up program 3.16.1, as the study will be completed prior to Construction and Operations.

Table 6-1. Adaptive Management Triggers and Responses

Trigger	Response
No trend in monitoring metric (i.e., stable over time) or upward trend (e.g., increase in fish habitat suitability)	Inform Indigenous groups No change to mitigation measures Consider reduction in the frequency of monitoring
Downward trend monitoring metric (e.g., decrease in fish habitat suitability)	Inform Indigenous groups Identify potential causes and additional studies to test hypotheses Implement modified or additional mitigation measures Monitor post-implementation of the modified or additional mitigation measures and communicate results Evaluate if new mitigation or fish offsetting measures are required

In the case of negative adverse effects to littoral fish habitat that deviate from the predictions of the EA, there are limited additional mitigation measures available. Flow augmentation from the FWR/FWSS can be controlled to reduce the volume of water being withdrawn from Tatelkuz Lake. However, if agreed upon adaptive measures in response to triggers related to the monitoring metrics outlined in this follow-up program prove insufficient, new mitigation or fish offsetting measures might be required.

7. REPORTING

DS Conditions 2.11, 2.12 and 2.13 set out annual reporting requirements related to the implementation of conditions in the DS. Condition 2.14 sets out information sharing requirements related to the annual reports. Reporting will commence when BW Gold begins to implement the conditions set out in the DS. Requirements in DS Conditions 2.11 – 2.14 are presented below.

DS Condition 2.11 requires:

> *"The Proponent [BW Gold] shall, commencing in the reporting year during which the Proponent begins the implementation of the conditions set out in this Decision Statement, prepare an annual report that sets out:*
>
> *2.11.1 the activities undertaken by the Proponent in the reporting year to comply with each of the conditions set out in this Decision Statement;*
>
> *2.11.2 how the Proponent complied with condition 2.1;*
>
> *2.11.3 for conditions set out in this Decision Statement for which consultation is a requirement, how the Proponent considered any views and information that the Proponent received during or as a result of the consultation, including a rationale for how the views have, or have not, been integrated;*
>
> *2.11.4 the information referred to in conditions 2.5 and 2.6 for each follow-up program;*
>
> *2.11.5 the results of the follow-up program requirements identified in conditions 3.14, 3.15, 3.16, 4.5, 5.5, 6.11, 6.12, 6.13, 6.14, 8.18.6, 8.20.5, 8.21, and 8.22 if required;*
>
> *2.11.6 any update made to any follow-up program in the reporting year;*
>
> *2.11.7 any modified or additional mitigation measures implemented or proposed to be implemented by the Proponent, as determined under condition 2.9 and rationale for why mitigation measures were selected pursuant to condition 2.5.4; and*
>
> *2.11.8 any change(s) to the Designated Project in the reporting year."*

DS Condition 2.12 requires: *"The Proponent [BW Gold} will provide the draft annual report to Indigenous groups, no later than June 30 following the reporting year to which the annual report applies. BW Gold will consult Indigenous groups on the content and findings in the draft annual report."*

DS Condition 2.13 requires: *"The Proponent [BW Gold], in consideration of any comments received from Indigenous groups pursuant to condition 2.12 shall revise and submit to the Agency [Impact Assessment Agency of Canada] and Indigenous groups a final annual report, including an executive summary in both official languages, no later than September 30 following the reporting year to which the annual report applies."*

DS Condition 2.14 requires: "The Proponent [BW Gold] shall publish on the Internet, or any medium which is publicly available, the annual reports and the executive summaries referred to in conditions 2.11 and 2.13.

The Proponent shall keep these documents publicly available for 25 years following the end of decommissioning of the Designated Project. The Proponent shall notify the Agency and Indigenous groups of the availability of these documents within 48 hours of their publication."

DS Condition 2.15 requires: "*When the development of any plan is a requirement of a condition set out in this Decision Statement, the Proponent [BW Gold] shall submit the plan to the Agency and to Indigenous groups prior to construction, unless otherwise required through the condition.*"

The Proponent shall keep these documents publicly available for 25 years following the end of decommissioning of the Designated Project. The Proponent shall notify the Agency and Indigenous groups of the availability of these documents within 48 hours of their publication."

Reporting in compliance with these conditions will commence when BW Gold begins to implement the follow-up programs. BW Gold will implement the follow up programs during all phases of the Project, as stipulated in the DS.

BW Gold is also committed to developing a data sharing agreement such that monitoring data can be accessed by Indigenous groups and regulators. This data sharing agreement will include both raw and interpreted data such preliminary field memos and data packages in the fall/winter following each field season. Starting in 2023, field forms connected to a database will be used to record most monitoring field data. An example of these field forms is presented in **Figure 7-1**. Monitoring data for all Condition 3.14 studies will be presented to the Nations, as requested, in an annual report and saved to a Project file sharing site.

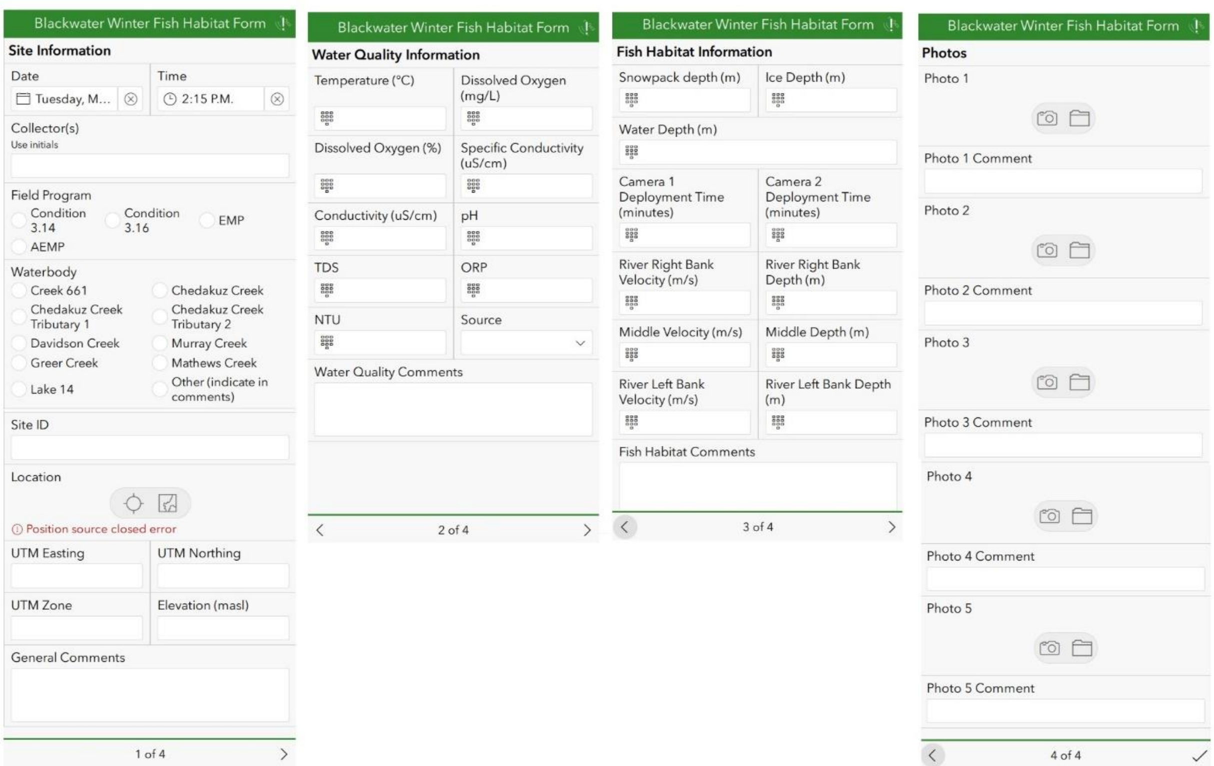

Figure 7-1. Screenshot of the Field Form Interface for Recording Monitoring Data.

8. SUMMARY

The follow up programs herein have been developed to fulfill DS condition 3.16. This condition pertains to monitoring littoral fish habitat in Tatelkuz Lake before Operations, monitoring littoral fish habitat tin Tatelkuz Lake during Operations, and monitoring lower Chedakuz Creek during all Project Phases. The follow up programs cover data collection during pre-Construction (2021-2022), through to decommissioning.

Information from these programs will be used for comparison during long-term monitoring over the life of the Project to determine the accuracy and effectiveness of mitigation measures, as set out in Condition 2.9. Depending on the long-term monitoring results compared with threshold values for the monitoring metrics used, modified or additional mitigation measures may be required in conjunction with subsequent monitoring.

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