OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

SECTION 7.9: FRESHWATER FISH

October 2022

OSISKO DEVELOPMENT

Cariboo Gold Project

PO Box 250
3700 Ski Hill Road
Wells, BC V0K 2R0

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ABBREVIATIONS

Terminology used in this document has been defined where it is first used, while the following list has been presented to assist readers that choose to review only portions of the document.

Abbreviation	Description
%	percent
µg	microgram
µg/cm^2	micrograms per square centimetre
µg/L	micrograms per litre
AEMP	Aquatic Effects Monitoring Program
AIR	Application Information Requirements
BC	British Columbia
BGM	Barkerville Gold Mines Ltd.
BL	Bonanza Ledge Site
BMP	Best Management Practice
CABIN	Canadian Aquatic Biomonitoring Network
CCME	Canadian Council for Ministers of the Environment
CDC	Conservation Data Centre
CFIA	Canadian Food Inspection Agency
COPC	Constituents of Potential Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Fisheries and Oceans Canada
dw	Dry weight
EA	Environmental Assessment
EAO	Environmental Assessment Office (BC)
ECCC	Environment and Climate Change Canada
EFU	End of fish use
EMA	*Environmental Management Act*
ENV	Ministry of Environment and Climate Change Strategy (British Columbia) – formerly Ministry of Environment
EPT	Ephemeroptera, Plecoptera, and Trichoptera
ESC	Erosion and Sediment Control
FHAP	Fish Habitat Assessment Procedures
FIDQ	Fish Inventories Data Queries

Abbreviation	Description
FLNRORD	Ministry of Forests, Lands, Natural Resources Operations and Rural Development (BC)
FSTSF	Filtered Stack Tailings Storage Facility
FWA	Freshwater Atlas
g	grams
Golder	Golder Associates Ltd.
ha	hectare
Hatfield	Hatfield Consultants
LiDAR	Light detection and radiation
km	kilometre
km^2	square kilometre
KP	Knight Piésold Ltd.
L	litre
LAA	Local Assessment Area
LSA	Local Study Area
Ltd	Limited
LWD	Large woody debris
m	metre
m^2	square metre
m^3/s	cubic metre per second
masl	metres above sea level
MDMER	Metal and Diamond Mining Effluent Regulation
mg/kg	milligrams per kilogram
mg/m^3	milligrams per cubic metre
mL	millilitre
mm	millimetre
MWLAP	Ministry of Water, Land and Air Protection (BC)
ODV	Osisko Development Corp.
org/L	organisms per litre
PAHs	Polycyclic aromatic hydrocarbons
Project	Cariboo Gold Project (proposed)
QR Mill	Quesnel River Mill
RAA	Regional Assessment Area
RCA	Reference Condition Approach

Abbreviation	Description
RISC	Resources Information Standards Committee
RSA	Regional Study Area
ROW	Right of way
SARA	*Species at Risk Act*
SWD	Small woody debris
TSF	Tailings storage facility
TSS	Total Suspended Solids
VC	Valued Component
WQG	Water Quality Guideline
WRSF	Waste rock storage facility
WTP	Water Treatment Plant
ww	Wet weight
yr	year

7.9 Freshwater Fish

This section presents the effects assessment for the Freshwater Fish Valued Component (VC) for the Cariboo Gold Project (the Project) as proposed by Osisko Development Corp. (ODV). The purpose of this assessment is to evaluate the potential changes to Freshwater Fish that may result from the Project.

The Freshwater Fish VC has three subcomponents: fish habitat, aquatic resources, and fish. Each of these subcomponents are interlinked. Fish habitat and its quality are closely linked to aquatic resources, such as benthic macroinvertebrates, which fish rely on for food. All subcomponents will be discussed where information is available, but some subcomponents can be considered as a surrogate for others. For example, fish habitat can be used as a surrogate for fish, especially where information on fish is absent or lacking. In addition, within the fish subcomponent, all fish species within the Local Assessment Area (LAA) will be discussed, but the presence of Rainbow Trout, *Oncorhynchus mykiss*, (spring spawners) and Bull Trout, *Salvelinus confluentus*, (fall spawners) can represent other fish species within the LAA where other species information may be missing.

The Freshwater Fish VC is linked to the following VCs or chapters of the assessment: Surface Water (Section 7.4), Wildlife (Section 7.8), Land and Resource Use (Section 7.11), Human Health (Section 7.13), Culture (Section 7.15), Lhtako Dené Nation (Chapter 11.0), Williams Lake First Nation (Chapter 12.0), Xatśūll First Nation (Chapter 13.0), and Summary of Biophysical Factors that Support Ecosystem Function (Chapter 16.0).

7.9.1 Relevant Statutes, Policies, and Frameworks

The Application Information Requirements (AIR) for the Project, issued by the British Columbia (BC) Environmental Assessment Office (EAO) in April 2021, outlines the requirements of the Freshwater Fish effects assessment to meet the requirements under the *BC Environmental Assessment Act* (2018).

Federal and provincial regulations, legislations, policies, or guidelines that protect Freshwater Fish during the Project development process are summarized in Table 7.9-1.

Guidelines for water and sediment quality include both federal and provincial guidelines (See Section 7.4.1). In general, the BC guidelines are used where the BC and the Canadian Council of Ministers of Environment (CCME) guidelines differ, as the provincial guidelines are more specific to BC waters.

Table 7.9-1 Summary of Applicable Legislation, Policies, and Guidelines for Freshwater Fish

Government Level	Relevant Legislation, Policy, Framework, or Guideline	Regulator or Governing Body	Summary
Federal	*Fisheries Act*	Fisheries and Oceans Canada (DFO)	The *Fisheries Act* is the legislation that protects fish and fish habitat and was amended in 2019. The *Fisheries Act* prohibits anyone from carrying on work, undertaking, or activity other than fishing that results in the death of fish or results in the harmful alteration, disruption, or destruction of fish habitat.
Federal	*Species at Risk Act* (SARA)	DFO for aquatic species as listed in Schedule 1	The SARA prohibits killing, harming, capturing, or harassing species listed in Schedule 1 of the Act which are endangered, threatened, or extirpated. Those listed species are also afforded protection for their habitat. Species are designated at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Approval is required from DFO if any activity affects an aquatic species or fish in a way that is prohibited by SARA. An aquatic species is defined as a fish, shellfish, crustacean, marine animal, or marine plant.
Federal	Fish and Fish Habitat Protection Policy	DFO	The Fish and Fish Habitat Protection Program enacts the Policy by ensuring compliance with the relevant provisions under the *Fisheries Act* and SARA.
Provincial	*Environmental Management Act* (EMA)	BC Ministry of Environment and Climate Change Strategy (ENV)	The EMA regulates industrial and municipal waste discharge, pollution, hazardous waste, and contaminated site remediation. The EMA provides the authority for introducing wastes into the environment while protecting public health and the environment. Guidelines and objectives for water quality are developed under the EMA. The Waste Discharge Regulation defines what industries, activities, and operations require authorization to discharge or release waste into the air, water, and land under the EMA.
Federal	Metal and Diamond Mining Effluent Regulations (MDMER)	DFO	The MDMER are administered under the *Fisheries Act* and were amended in 2018 and authorize the deposit of effluent into fish-frequented waters. All effluent must meet the concentration-based limits for arsenic, copper, cyanide, lead, nickel, zinc, suspended solids, and radium 226. The effluent must have a pH that is between a minimum and maximum level and must not be acutely lethal. The MDMER also specifies various requirements such as carrying out effluent sampling, reporting, and Environmental Effects Monitoring.
Provincial	*Riparian Areas Protection Act*	ENV	The *Riparian Areas Protection Act* protects and enhances riparian areas. Under the *Riparian Areas Protection Act,* local governments are called upon to protect riparian areas during residential, commercial, and industrial development. The *Riparian Areas Protection Act* protects the many and varied features, functions, and conditions that are vital for maintaining stream health and productivity.

Government Level	Relevant Legislation, Policy, Framework, or Guideline	Regulator or Governing Body	Summary
Provincial	*Forest and Ranges Practices Act*	BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development (FLNRORD)	The *Forest and Ranges Practices Act* outlines how all forest and range practices and resource-based activities are to be conducted on Crown Land in BC, while ensuring protection to everything in and on them, such as plants, animals, and ecosystems.
Provincial	*Water Sustainability Act*	FLNRORD	The *Water Sustainability Act* regulates the diversion and use of water and work in and around water. Changes in and about a stream means: • Any modification to the nature of a stream, including any modification to the land, vegetation, and natural environment of a stream or the flow of water in a stream; or • Any activity or construction within a stream channel that has or may have an impact on a stream or a stream channel.
Federal	Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada	DFO	This framework provides guidance on science-based tools for assessing the impacts of flow alteration on fisheries.
Provincial	*Wildlife Act*	ENV, Environmental Stewardship Division	The *Wildlife Act* was designed to help protect and manage wildlife species in BC. It gives the minister responsible the authority to designate a species as endangered or threatened if the species is in danger of imminent extinction or endangerment throughout all or a significant portion of its range in BC because of the actions of humans. Under the BC *Wildlife Act,* it is prohibited to alter, destroy, or damage wildlife habitat, or deposit on land or water, a substance or manufactured product or by-product in a manner that is harmful to wildlife or wildlife habitat. *The Wildlife Act* protects certain ecological communities, such as riparian ecosystems on Crown land, as wildlife habitat.
Provincial	BC Environmental Flow Needs Policy (ENV, 2016c)	ENV	The environmental flow needs of a stream are defined as the volume and timing of water flow required for the proper functioning of the aquatic ecosystem. The Environmental Flow Needs Policy has been developed to guide the review of applications under the *Water Sustainability Act* in their consideration of environmental flow needs.
Provincial	Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators (ENV, 2016a)	ENV	This guidance document is designed to outline and define the baseline study requirements and information considerations necessary to propose a mineral development project in BC. Information requirements are provided for water quality (physical and chemical parameters, aquatic sediments, tissue residues, and aquatic life) and fish and fish habitat.

Government Level	Relevant Legislation, Policy, Framework, or Guideline	Regulator or Governing Body	Summary
Federal	Canadian Water Quality Guidelines (WQG) for the Protection of Aquatic Life (CCME, 2001)	Canadian Council for Ministers of the Environment (CCME)	Canadian WQG provides protection of freshwater life from anthropogenic stressors. Guideline values are meant to protect all forms of aquatic life and all aspects of aquatic life cycles, including the most sensitive life stage of the most sensitive species over the long term.
Provincial	Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture: Working Water Quality Guidelines (ENV, 2021a) Approved Water Quality Guidelines (ENV, 2019c)	ENV	Represents BC safe levels of substances that protect different water uses, including aquatic life. These guidelines also include sediment quality values. Exceeding a WQG does not imply that unacceptable risks exist but that a potential adverse effect may be increased. Working WQGs are the best guidance provided for substances without approved WQGs. The working WQGs may be based on historic information or different derivation protocols, and different jurisdictions or published scientific literature.
Federal	Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CCME, 1999)	CCME	Sediment quality guidelines provide scientific benchmarks, or reference points, for evaluating the potential for observing adverse biological effects in aquatic systems.

Notes: CCME = Canadian Council for Ministers of the Environment, COSEWIC = Committee on the Status of Endangered Wildlife in Canada, DFO = Fisheries and Oceans Canada, EMA = *Environmental Management Act*, ENV = BC Ministry of Environment and Climate Change Strategy, FLNRORD = BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development, SARA = *Species at Risk Act*, WQG = Water Quality Guidelines.

7.9.2 Assessment Boundaries

7.9.2.1 Spatial Boundaries

The spatial boundaries for assessment of the Freshwater Fish VC consist of the Local Assessment Area (LAA) and the Regional Assessment Area (RAA) associated with each of the Project components. Table 7.9-2 and Figure 7.9-1 identify the spatial boundaries for Freshwater Fish. The LAA includes the zone of influence of the Project or the area where all or most potential Project effects are expected to occur. The RAA is a larger area and provides context for the assessment of potential effects, including potential cumulative effects.

The LAA and RAA are divided into the main Project components (Table 7.9-2), which include the Mine Site, the Quesnel River Mill (QR Mill), the Transmission Line and associated access roads. The Transportation Routes were excluded from the assessment as there are no new roads planned as part of the Transportation Routes and the assumption that there are no anticipated interactions during the operation of the Transportation Routes and Freshwater Fish as a result of the Project.

Table 7.9-2 Spatial Assessment Boundaries – Freshwater Fish

Boundary	Component	Extent
LAA	Mine Site	Same as Surface Water LAA. Willow River Watershed and Slough Creek upstream of their confluence.
	QR Mill	Same as Surface Water LAA. Includes Rudy Creek Watershed and tributaries south of the QR Mill that drain into the Quesnel River.
	Transmission Line	100 m area upstream and 500 m downstream extended from the Transmission Line corridor, and 50 m upstream and downstream from upgraded access roads.
	Transportation Route	Not applicable
RAA	Mine Site	Same as surface water RAA. Willow River Watershed upstream of the confluence with Stephanie Creek.
	QR Mill	Same as surface water RAA. Includes Maud Creek Watershed and its confluence to the Quesnel River and the Quesnel River upstream from its confluence with Beaver Creek.
	Transmission Line	1 km area upstream and downstream extended from the Transmission Line corridor.
	Transportation Route	Not applicable

Notes: m = metres; km = kilometre; LAA = local assessment area; RAA = regional assessment area; QR Mill = Quesnel River Mill

7.9.2.1.1 Local Assessment Area

The LAA for the Mine Site is approximately 142 km^2 and includes the Willow River and Slough Creek Watersheds (Figure 7.9-1 and Figure 7.9-2). The Willow River is further divided into sub-watersheds of Williams Creek, Lowhee Creek, Jack of Clubs Lake, and Jack of Clubs Creek (Table 7.9-3, Figure 7.9-3). The Mine Site LAA watersheds were delineated starting from the most downstream point where the Willow River and Slough Creek cross the Mine Site LAA boundary. The ground elevation within the LAA varies between 1,156 and 1,979 metres above sea level (masl; 823 altitude differential), with a mean ground elevation of 1,460 masl.

The LAA for the QR Mill is approximately 12 km^2 and includes the Maud Creek Watershed, which drains into the Quesnel River (Figure 7.9-1 and Figure 7.9-2). The sub-watersheds for the QR Mill include Rudy Creek, a sub-watershed of the Maud Creek Watershed, and Creek #2, Creek #2.5, and Creek #3 drainages that flow directly into the Quesnel River (Table 7.9-3, Figure 7.9-4). The QR Mill LAA ground elevation varies between 622 and 1,243 masl (621 m altitude differential), with a mean ground elevation of approximately 933 masl.

The Transmission Line LAA includes all watercourses and waterbodies crossed by, and 100 m upstream and 500 m downstream from the watercourses extended from, the corridor of the Transmission Line (Table 7.9-2, Table 7.9-3, Figure 7.9-1 and Figure 7.9-2). The LAA also includes all watercourses that will be crossed by the upgraded access roads. The LAA extends 50 m upstream and downstream from the access road crossing.

Major watersheds crossed by the Transmission Line include the Cottonwood River Watershed, the Willow River Watershed, and the Quesnel River Watershed (Figure 7.9-2).

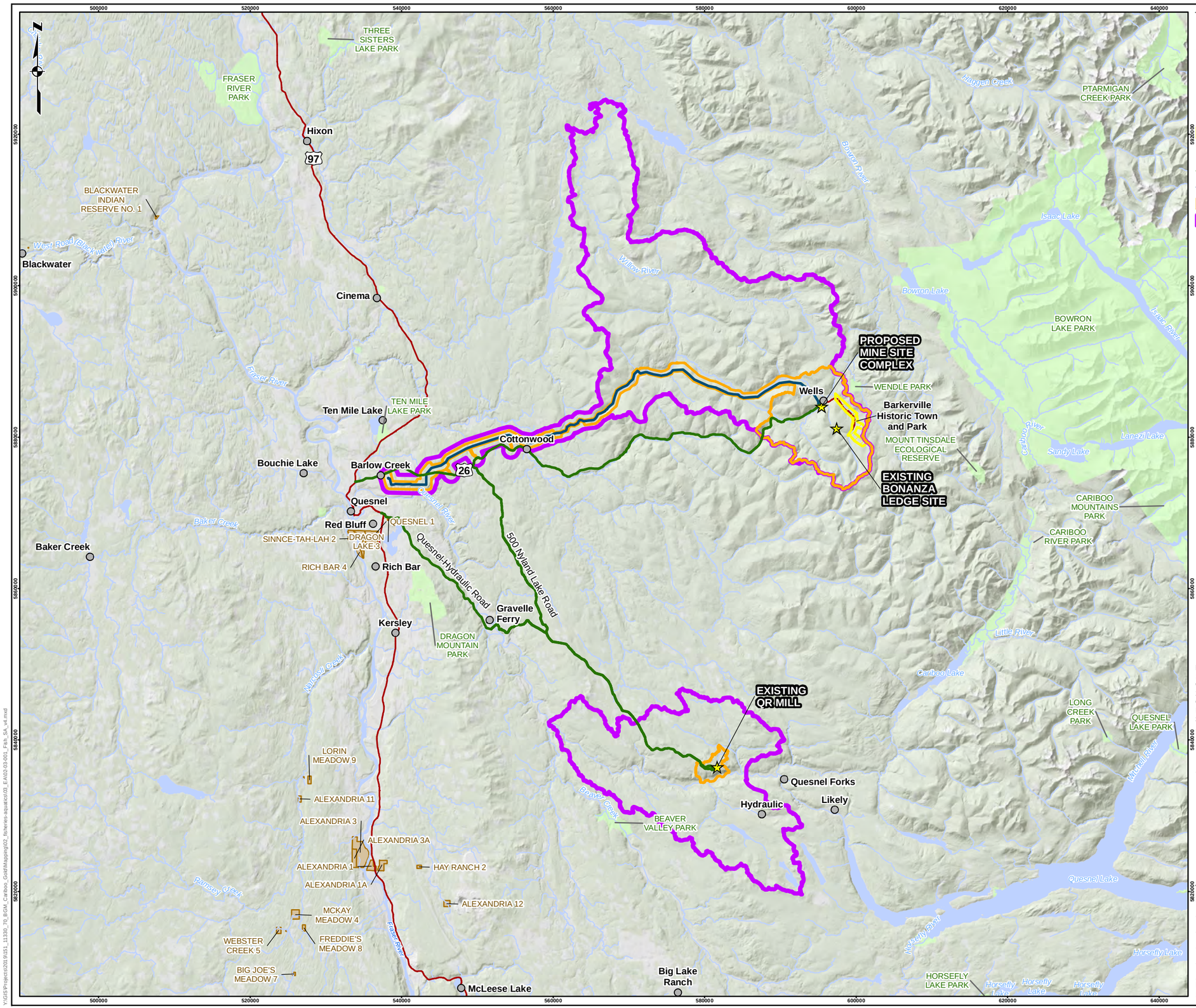
Table 7.9-3 Local Assessment Area Watersheds and Named Tributaries

Mine Component	Watershed	Key Named Tributaries	Flows to
Mine Site	Willow River	Jack of Clubs Lake, Jack of Clubs Creek, Lowhee Creek, Williams Creek, Mosquito Creek, Red Gulch, Peeps O' Day Creek, and Slough Creek	Fraser River
	Jack of Clubs Lake	Jack of Clubs Creek, ILP11, ILP16, ILP17, and ILP18	Willow River
	Jack of Clubs Creek	ILP12, ILP19, ILP20, Victoire Creek, and Stoney Creek	Jack of Clubs Lake
	Slough Creek	Slough Creek and Promise Creek	Willow River
	Williams Creek	McArthur Gulch, Conklin Gulch, Stouts Gulch, Emory Gulch, Walker Gulch, ILP21, ILP22, ILP23, and ILP24	Willow River
	Lowhee Creek	Watson Gulch, Core Shack 2 Tributary, F Road 0.1 Culvert	Willow River
QR Mill	Quesnel River	Maud Creek	Quesnel River
		Sandy Lake	Rudy Creek
		Rudy Creek	Maud Creek
		Creek #2, Creek #2.5, and Creek #3	Quesnel River
Transmission Line	Quesnel River	Unnamed tributaries to Quesnel River	Fraser River
	Cottonwood River	Cottonwood River, Alice Creek, John Boyd Creek, and Frye Creek	Fraser River
	Willow River	Willow River, Hyde Creek, Tregillus Creek, Julius Creek, Albrecht Creek, Dragon Creek, Montgomery Creek, New Creek, Slough Creek, Martins Creek, Mosquito Creek, and Lowhee Creek	Fraser River

Note: ILP = Interim Locational Point Site number

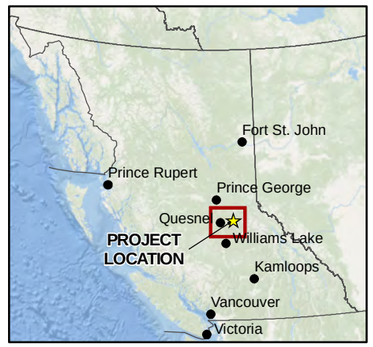
7.9.2.1.2 Regional Assessment Area

The RAA for the Mine Site is an approximately 875 km^2 drainage area of the Willow River at the point immediately upstream of its confluence with Stephanie Creek (Figure 7.9-1 and Figure 7.9-2). The RAA for the QR Mill is a 459 km^2 drainage area of the Quesnel River, upstream of its confluence with Beaver Creek. The Transmission Line RAA is a 1 km area both upstream and downstream extended from the Transmission Line Corridor (Table 7.9-1).



LEGEND

- POPULATED COMMUNITY
- HIGHWAY
- ROAD
- WATERCOURSE
- WATERBODY
- FIRST NATION RESERVE
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED PROJECT INFRASTRUCTURE LOCATION
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA



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NAD83 CSRS
UTM Zone 10N

0 10 20 30
1:500,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

FRESHWATER FISH VC
SPATIAL ASSESSMENT BOUNDARIES

REV.	DESCRIPTION	DATE	INITIALS
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PROJECT NO.	PHASE	REV.	FIGURE
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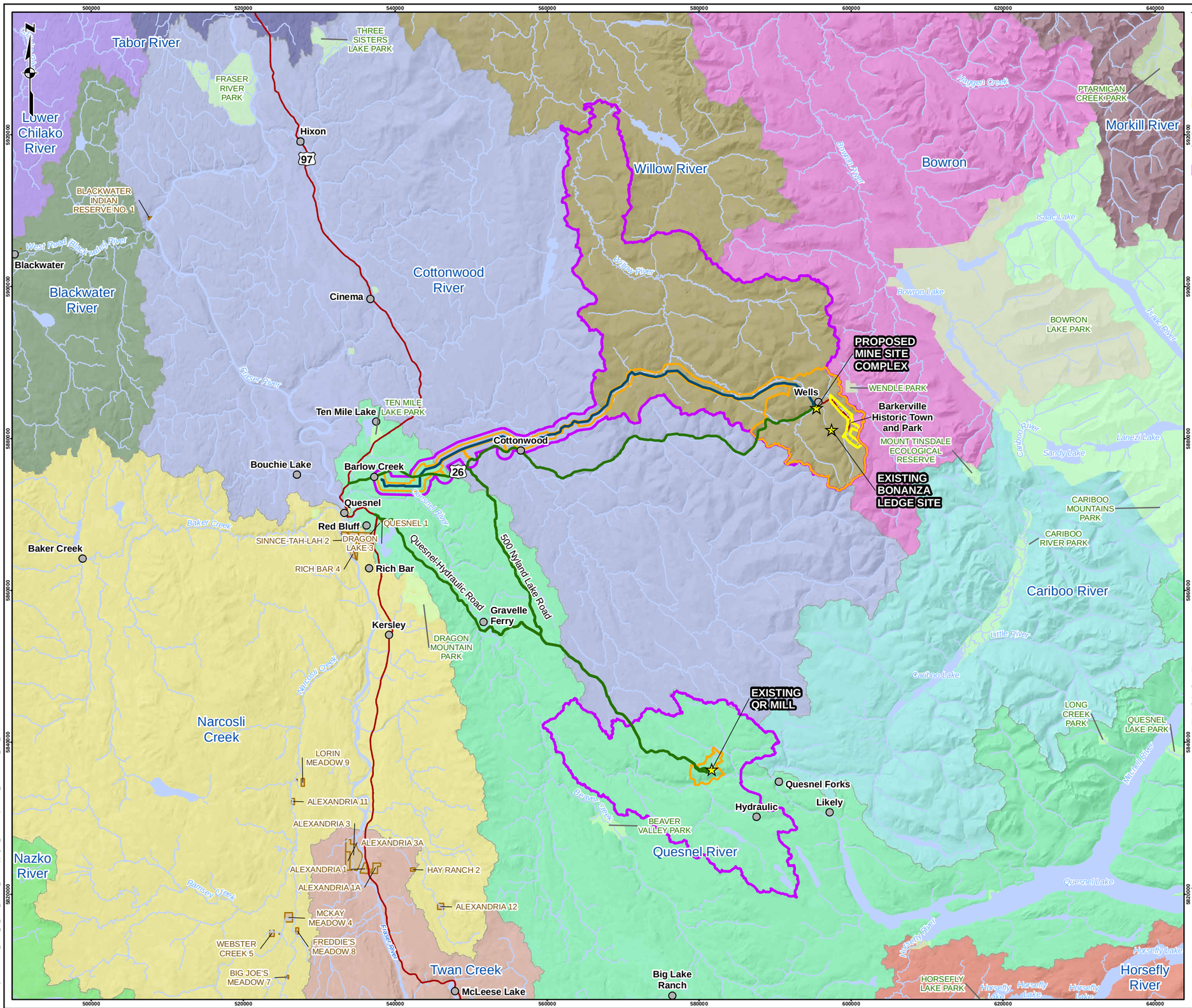
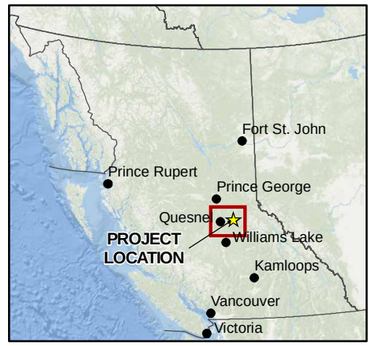


LEGEND

- POPULATED COMMUNITY
- HIGHWAY
- ROAD
- WATERCOURSE
- WATERBODY
- FIRST NATION RESERVE
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED PROJECT INFRASTRUCTURE LOCATION
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA

WATERSHED GROUPS

- BLACKWATER RIVER
- BOWRON
- CARIBOO RIVER
- COTTONWOOD RIVER
- HORSEFLY RIVER
- LOWER CHILAKO RIVER
- MORKILL RIVER
- NARCOSLI CREEK
- NAZKO RIVER
- QUESNEL RIVER
- TABOR RIVER
- TWAN CREEK
- WILLOW RIVER



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NAD83 CSRS
UTM Zone 10N

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OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

SPATIAL BOUNDARIES AND WATERSHEDS

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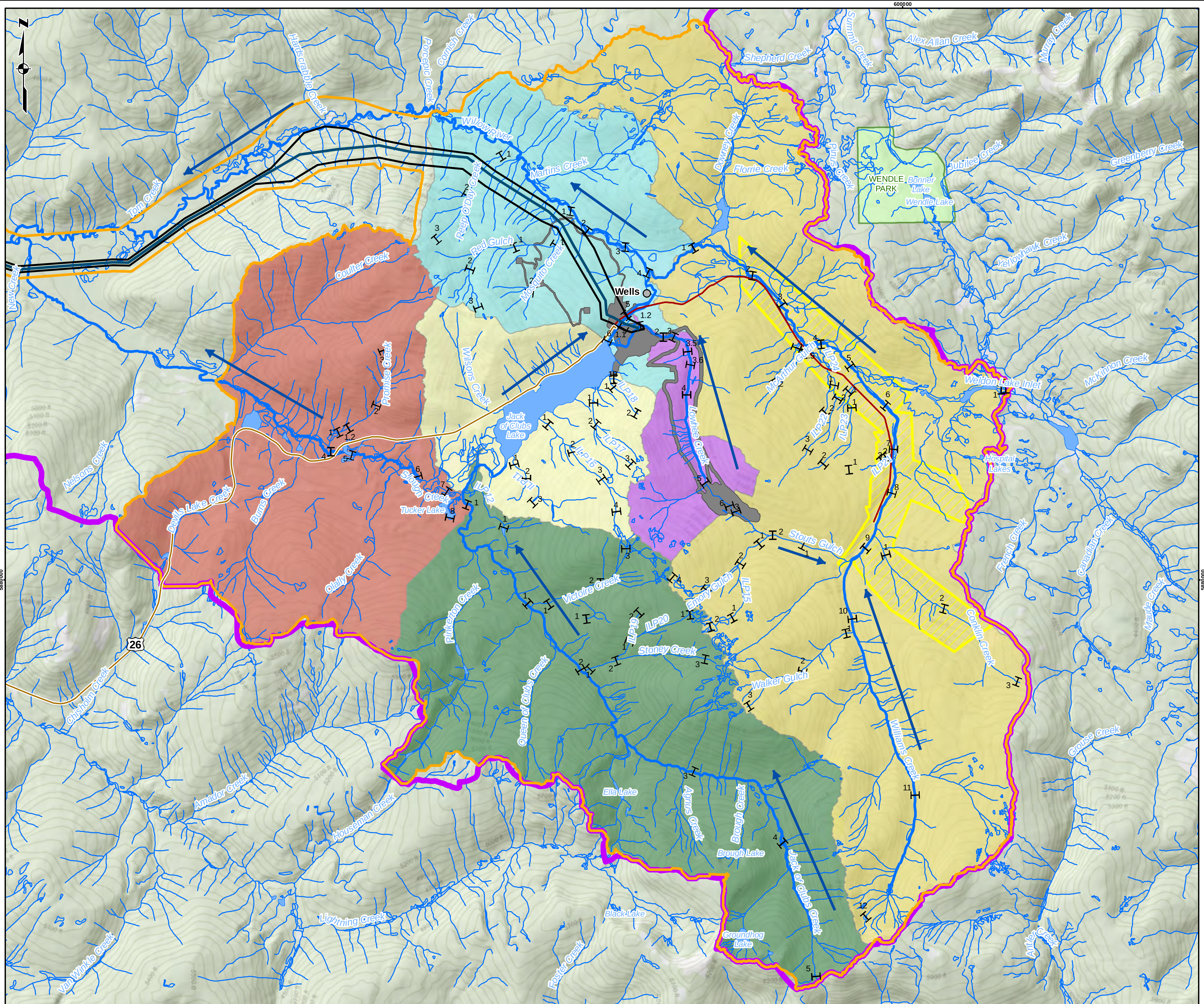
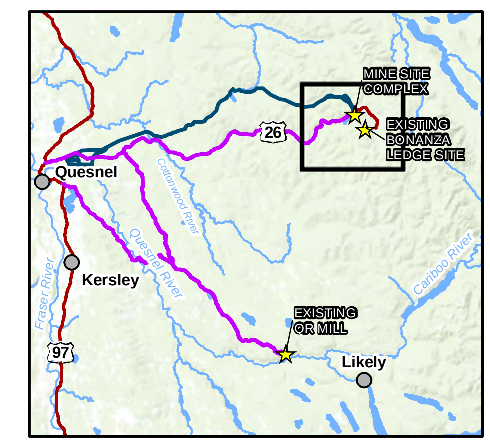


LEGEND

- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



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NAD83 CSRS
UTM Zone 10N

0 1 2 3
1:65,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

MINE SITE AREA WATERSHEDS

REV.	DESCRIPTION	DATE	INITIALS
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PROJECT NO.	PHASE	REV.	FIGURE
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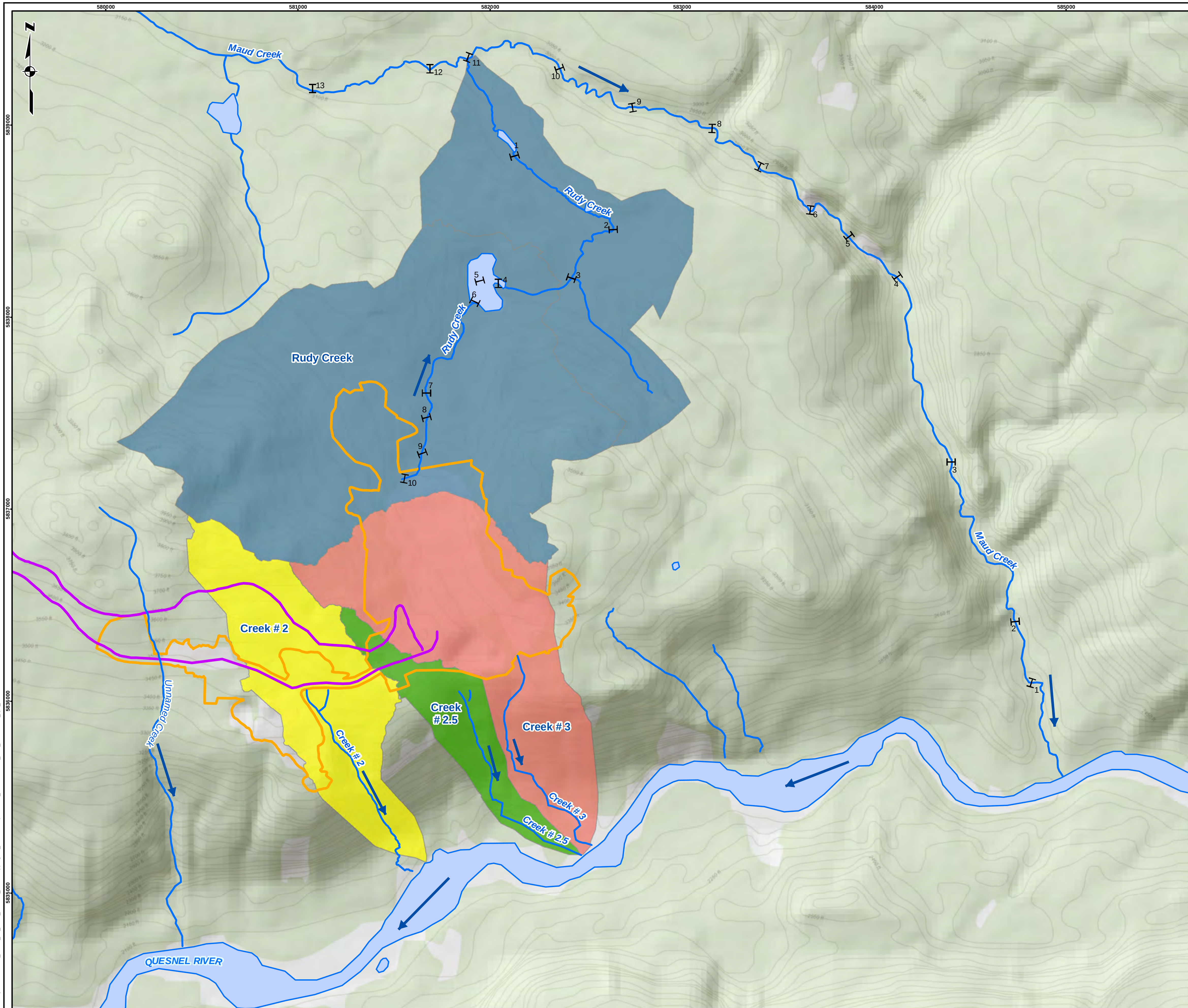
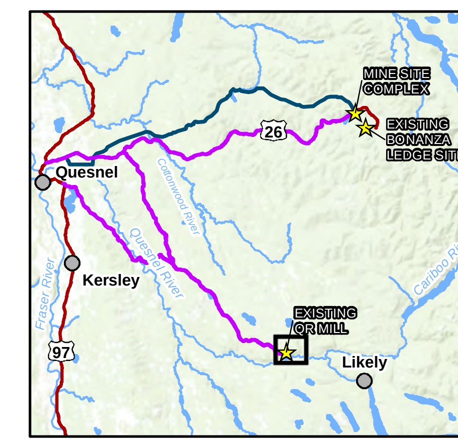


LEGEND

- REACH BREAKS
- WATERCOURSE
- FLOW DIRECTION
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED PROJECT FOOTPRINT
- PROPOSED NEW INFRASTRUCTURE

QR MILL WATERSHED

- RUDY CREEK
- CREEK # 2
- CREEK # 2.5
- CREEK # 3



REFERENCE(S)

1. TRAILS, WATER FEATURES, ROADS, MUNICIPAL BOUNDARY, PARK/PROTECTED AREAS, BARKERVILLE HISTORIC TOWN/PARK, CITIES (INSET), PROVINCIAL BORDERS (INSET) OBTAINED FROM THE B.C. MINISTRY OF FORESTS, LANDS, NATURAL RESOURCE OPERATIONS AND RURAL DEVELOPMENT.
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3. BASE DATA SOURCE: ESRI, GEOBASE, NRCAN, AND THE GIS USER COMMUNITY.
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NAD83 CSRS
UTM ZONE 10N

0 0.5 1
1:20,000 METRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

QR MILL SUB-WATERSHEDS

REV.	DESCRIPTION	DATE	INITIALS
B		4/11/2022	M.Y

PROJECT NO.	PHASE	REV.	FIGURE
151-11330-70	00	B	7.9-4

A Broad Scale Cumulative Impact Assessment has been conducted by FLNRORD for the Cariboo – Chilcotin (FLNRORD, 2015), which includes hydrological stability assessments at the sub-basin scale. The cumulative effects framework (CEF) is a systematic approach used to describe the cumulative risks for broad-scale assessments. The CEF was designed as an initial assessment to outline engagement requirements and the determination of impacts and mitigations. The risk description approach was designed to be easily understood and efficiently applied to multiple areas. The overall environmental conditions are described relative to the valued ecosystem components (VECs) of the region. The VEC risk assessment includes three risk components:

- Ecological Importance;
- Hazard to the VEC; and
- Current Mitigations in Place.

To complete the CEF assessment, the identified VECs that best represent the key component of the environment are evaluated and rated (Very Low, Low, Medium, High, Very High). One of the VECs identified in the CEF is hydrological stability, which assesses the inherent sensitivity of a watershed and the impact of current development. Hydrological assessments are reported at the watershed, basin, and sub-basin scale and include the Jack of Clubs Basin, the Williams Creek Basin, the Willow River Watershed, the Quesnel River Watershed, and the Maud Creek Sub-basin, each of which is included in the RAA. Ratings for each of these are meant to flag potential issues requiring management attention where additional consideration is required. The hydrological risk assessment information is best used as a screening device to identify units that may require an additional, more detailed hydrological assessment. Section 7.4 provides a more detailed hydrological assessment, which has been used to determine if there are any effects in the RAA for Freshwater Fish.

7.9.2.2 Temporal Boundaries

The temporal boundaries for Freshwater Fish cover each phase of the Project, starting with Construction through to Post-Closure (Table 7.9-4). These boundaries capture the time periods within which reasonable expectation of interaction with components of Freshwater Fish with the Project can be predicted.

Table 7.9-4 Temporal Boundaries for the Effects Assessment of Freshwater Fish

Project Phase	Duration	Project Activities
Construction	1 year	Site preparation and construction of surface and underground infrastructure including Maintenance Shop, Service Building, Camp, Portals, ventilation shafts, Waste Rock Storage Facility (WRSF) site preparation, Transmission Line, Water Treatment Plant (WTP), water wells, and water and effluent supply pipelines. Construction of firewater pumping station on Jack of Clubs Lake and firewater distribution piping system at the Mine Site. Prior to construction, the existing tailings pond at the QR Mill will be dewatered (approximately 800,000 m^3) to expose the Filtered Stack Tailings Storage Facility (FSTSF) foundation with the water directed to the WTP. Other activities include grading, soil salvage, construction / upgrading of main and ancillary facilities, water diversion/ collection/ treatment upgrades, management of construction wastes, and construction of the workforce accommodation. Construction of the Willow River bridge and bypass. Construction of culverts at roads crossings of channels or streams at the Mine Site.

Project Phase	Duration	Project Activities
Operations	16 years	Project operation and ongoing mining. Transportation of development waste rock to the Mine Site to develop the Bulk Fill Area. Transmission line operation and maintenance. Transportation of waste rock to the WRSF (starting in the second half of Year 1). Water Intake/collection, management, diversion, and treatment systems. Operation of Water Management System, including sediment ponds at the Mine Site and Bonanza Ledge and water diversion system. Operation of water management system at QR Mill. Treated effluent discharge at the QR Mill to Rudy Creek. Treated effluent discharge at the Mine Site into Jack of Clubs Lake and the Willow River. Disposal of water treatment waste byproduct at Mine Site and QR Mill.
Closure	2 years	Construction of Spillway closure and portal plugs. Decommissioning of roads not in use, surface explosive storage, underground infrastructure, mill, FSTSF, transmission line, and ancillary structures not in use, Bonanza Ledge WRSF, Mine Office, Maintenance Shop, Warehouse, and paste backfill Plant. Recontouring and revegetation of roads and FSTSF closure cover completion. Reclamation monitoring. Flooding the underground mine and treating and discharging water from the WTP and water pipeline.
Post-Closure	10 years or until post-monitoring objectives have been met	Ongoing water treatment (active care period) and monitoring (active and passive care periods). Decommissioning and dismantling of the WTP.

Notes: WRSF = waste rock storage facility; WTP = water treatment plant; m^3 = metres cubed; FSTSF = filtered stack tailings storage facility; QR Mill = Quesnel River Mill

7.9.2.3 Administrative and Technical Boundaries

Administrative boundaries refer to the limitations imposed on an Environmental Assessment (EA) by political, economic, or social constraints. The Project falls within the FLNRORD Cariboo Region. The Mine Site and Transmission Line LAAs are within the Quesnel Regional District. The LAA of the QR Mill is within the Quesnel Regional District, but south of the Quesnel River is the Central Cariboo Regional District, and part of the RAA falls within this district.

Technical boundaries refer to the constraints imposed on an EA by limitations in the ability to predict the potential effects of a project. Technical boundaries for the assessment of Freshwater Fish include:

- Limitations imposed by the constraints of the data collection methods, study design, data collected, and extent of analysis of the existing conditions data;
- Limitations imposed by the existing conditions information available at the time of assessment;
- Site accessibility to collect existing conditions information; and
- The available information provided by Indigenous nations at the time of assessment.

7.9.3 Existing Conditions

7.9.3.1 Information Sources

Existing conditions associated with Freshwater Fish are summarized in: the Aquatic Health Existing Conditions Report (Appendix 7.9-1), the Fish and Fish Habitat Existing Conditions Report (Appendix 7.9-2), the Transmission Line Fish and Fish Habitat Existing Conditions Report (Appendix 7.9-3), the Fish and Fish Habitat Assessment of Jack of Clubs Lake Report (Appendix 7.9-4), the 2021 Jack of Clubs Lake Plankton Baseline Program Report (Appendix 7.9-5), the 2021 Jack of Clubs Lake Surface Water and Sediment Baseline Program Report (Appendix 7.9-6), and the Results of Soil, Vegetation, Soil Invertebrate, and Fish Tissue Analysis (Appendix 7.13-1). Information gathered during engagement activities, as well as information from the Technical Advisory Committee, was incorporated.

The characterization of existing conditions for Freshwater Fish within the Project area, as detailed in the above-mentioned reports, is summarized in Section 7.9.3.4. The following information sources were reviewed as part of the existing conditions reporting:

- Available grey literature and peer-reviewed scientific publications;
- Government and non-government reports and environmental resources databases, including the BC government's Ecological Reports Catalogue (EcoCat) and Habitat Wizard, and the BC Ministry of Environment and Climate Change Strategy (ENV) Fish Inventories Data Queries (FIDQ) search function;
- Previous investigations and research programs, environmental resource surveys, and environmental reports for Lowhee Creek, Willow River, Williams Creek, Jack of Clubs Creek, and Rudy Creek;
- A review of Species at Risk Registry and Committee on the Status of Endangered Wildlife (COSEWIC) databases and reports to identify species at risk and locations of critical habitat; and
- Historical data available from regional monitoring programs and previous environmental assessments done in the area.

Complete references are provided in the relevant existing conditions reports.

Non-confidential traditional knowledge and land use information was provided for use in the characterization of existing conditions by Lhtako Dené Nation, provided by DM Cultural Services Ltd (2019), and by Williams Lake First Nation and Xatśūll First Nation, provided by Landmark Resource Management (2021).

7.9.3.2 Regional Overview and Historical Activities

7.9.3.2.1 Regional Overview

The Project is located in the Quesnel Highlands, which is west of the Cariboo Mountains and east of the Fraser Plateau. The highlands extend from Bowron Lake on the north to Mahood Lake on the south, encompassing an area of approximately 8,100 km^2. Within the Quesnel Highlands, there are upland areas that are remnants of a highly dissected plateau of moderate relief. These remnants rise gradually from approximately 1,500 masl on the west to over 1,900 masl on the east and become progressively more dissected.

The watercourses documented in the LAA are situated within the Engelmann Spruce Subalpine Fir wet cool and wet cold subzones and within the Sub-Boreal Spruce wet cool subzone (Government of BC, 2019e). The landscape is characterized by moderate to steeply rolling hills ranging in elevation from 1,200 to 1,500 masl, with a few higher mountains up to 2,000 masl. The main valleys are wide, with slopes less than 2% (Government of BC, 2019e). Annual peak monthly mean flows occur in spring, between April and June, and during or soon after snowmelt.

7.9.3.2.2 Historical Activities

Indigenous people moved seasonally to harvest fish which were dried and stored to be consumed during the winter. Camping and gathering sites were found at Willow Creek, Lowhee Creek, and Jack of Clubs Lake. Ice-fishing was also conducted in Jack of Clubs Lake.

The District of Wells has a history of mining and anthropogenic disturbance dating back to the 1860s. Large scale lode gold exploration began in the 1930s. The Project area contains several historical mines, including Cariboo Gold Quartz, Aurum, and Mosquito Creek.

The Cariboo Gold Quartz Mine in Wells went into production in 1933. There has been substantial work completed over the last 90 years on the overall claim holdings, with work programs having been completed by various companies. The historic Cariboo Gold Quartz portal location for the 1,500 level is located immediately adjacent to the Valley Portal location for the Project at the Mine Site. Project underground development and ore extraction will take place adjacent to the extensive historical underground developments associated with these mining operations. During the operation of the Cariboo Gold Quartz Mine, approximately 2.65 million tonnes of flotation mill tailings were deposited into the northeastern end of Jack of Clubs Lake near its outlet into the Willow River, filling approximately 30 hectares of the original lake area (SNC Lavalin Group Inc, 2011). The Willow River watershed has experienced extensive timber harvesting over the past 35 years (Beaudry and DeLong, 1996; Berry, 1997).

In addition to the mill tailings, hydraulic placer mining operations in Lowhee Creek also deposited an unknown quantity of placer outwash to the northeastern end of Jack of Clubs Lake. Historical waste rock associated with the 1,500 level adit is also located on the northeast end of Jack of Clubs Lake, adjacent to the proposed Mine Site portal. The Cariboo Gold Quartz Mine closed on August 31, 1959. The Cariboo Gold Quartz Mill continued operating using feed from the Aurum Mine until March 1967.

Milling at the Aurum Mine, located on the north side of Jack of Clubs Lake, across from the Cariboo Gold Quartz Mine, commenced in 1934 by Newmont Mining Corporation. After 1945, no further exploration or development was carried out west of the Aurum Fault, and in 1952 the Aurum mine suspended active exploration and development. The Cariboo Gold Quartz Mine and Island Mountain Mine do not connect below Jack of Clubs Lake.

Historical activities have altered the landscape within the district, and the existing conditions studies do not necessarily represent fish and aquatic habitats prior to mining and other anthropogenic disturbance.

7.9.3.3 Project-Specific Existing Conditions Studies

Existing conditions studies were completed for Freshwater Fish within areas described as a Local Study Area (LSA) and a Regional Study Area (RSA). During Project scoping for the Freshwater Fish effects assessment, assessment areas (LAA and RAA) were refined based on the anticipated extent that potential effects to the Freshwater Fish VC can be reasonably expected (See Section 7.9.2.1). The results of the existing conditions studies for the Freshwater VC have been described for the LAA and RAA only.

7.9.3.3.1 Design of Field Surveys

Fish and fish habitat surveys were conducted in the spring, summer, and fall of 2016, the spring and summer of 2018, the spring of 2019, and the summer of 2021 by Golder Associates Ltd (Golder; Table 7.9-5), as described in Appendix 7.9-2 for the Mine Site and QR Mill and Appendix 7.9-4 for Jack of Clubs Lake. Avery Creek Services Ltd was commissioned by ODV to conduct spawning surveys in both the spring and fall of 2018 at the Mine Site (Table 7.9-5). Fish and fish habitat surveys for the Transmission Line were conducted in the summer of 2020 and summer of 2021 by Golder (Table 7.9-5) as described in Appendix 7.9-3. The type of sampling conducted for each survey is presented in Table 7.9-5 and further described in the following sections.

Willow River Reaches 2, 3, and 4 are located northeast of the town of Wells, BC and were not sampled as they are not proposed to be physically disturbed by the Project. Additional sites were added as the design of the Project changed, including the addition of the Transmission Line. Field surveys were conducted to confirm older historical surveys conducted in the study area and address data gaps on fish presence/absence and distribution of fish species in some smaller tributaries where historical information was not available. Some surveys were repeated in the following years in some reaches to confirm fish presence/absence or to collect information that was missed in the previous survey.

7.9.3.3.2 Field Sampling Methods and Locations

7.9.3.3.2.1 Guidelines, Standards, and Protocols

Methods and guidance documents used for the fish, fish habitat, and aquatic health existing conditions surveys included:

- Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Lake Survey Form Field Guide, Version 2.0 (Resources Information Standards Committee [RISC], 2008);
- Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures, Version 2.0 (RISC, 2001);
- Fish Habitat Assessment Procedures (FHAP) (Johnston and Slaney, 1996);
- Fish Collection Methods and Standards, Version 4.0 (RISC, 1997);
- The Salmonid Field Protocol Handbook Techniques for Assessing Status and Trends in Salmon and Trout Populations (Johnson et al., 2007);
- Fish-stream Crossing Guidebook (FLNRORD, 2012);
- Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators (ENV, 2016a); and
- Canadian Aquatic Biomonitoring Network (CABIN) sampling protocols (Environment and Climate Change Canada [ECCC], 2012).

Table 7.9-5 Summary of Existing Conditions Fish and Fish Habitat Surveys

Dates	Spawning Survey	Species Focus of Spawning Survey	Reconnaissance (presence/absence)	RISC Site Cards	Fish Community	FHAP	EFU
May 26 to 31, 2016	✓	Rainbow Trout	✓	-	-	-	-
July 19 to 28, 2016	-	-	✓	✓	-	-	-
August 17 to 24, 2016	-	-	-	-	✓	✓	-
September 11 to 15, 2016	✓	Bull Trout	-	-	-	-	-
April 24 to June 25, 2018	✓+	Rainbow Trout, Sucker (General)	-	-	-	-	-
June 12 to 23, 2018	-	-	-	✓	✓		✓
September 21 to October 15, 2018	✓+	Mountain Whitefish, Bull Trout	-	-	-	-	-
August 14 to 25, 2018	-	-	✓	✓	✓	✓	✓
June 11 to 15, 2019	-	-	✓	✓	✓	✓	-
July 7 to 13, 2020[1]	-	-	✓	✓	-	-	-
July 1 to 8, 2021[1]	-	-	✓	✓	-	-	-
July 2 to 5, 2021[2]	-	-	-	✓	✓	-	-

Notes: RISC = Resources Information Standards Committee; FHAP = Fish Habitat Assessment Procedures; EFU = End of fish use;
+ = survey completed by Avery Creek Services Ltd, - = indicates no survey.
[1] Transmission Line Surveys only.
[2] Jack of Clubs Lake fish sampling and hydroacoustic survey.
Aquatic health surveys were conducted in the fall of 2016 and 2018 by Golder at the Mine Site and by Hatfield Consultants in August 2019 at the QR Mill. Aquatic health surveys included habitat assessment, benthic taxonomy and tissue chemistry, periphyton taxonomy, periphyton biomass, periphyton chemistry, phytoplankton taxonomy, and zooplankton taxonomy.

7.9.3.3.2.2 Summary of Surveys

At the Mine Site, Golder conducted fish and fish habitat surveys in 2016 (Figure 7.9-5). This included 14 sites in the Willow River Watershed, 11 sites in the Jack of Clubs Lake Watershed, 14 sites in the Jack of Clubs Creek Watershed, 9 sites in the Slough Creek Watershed, 30 sites in the Williams Creek Watershed, and 3 sites in the Lowhee Creek Watershed (Table 7.9-6, Figure 7.9-6).

Golder and Avery Creek Ltd (spawning surveys only) conducted fish and fish habitat surveys in 2018, including at new locations and some repeat locations. The surveys included fish abundance and FHAP surveys or repeat surveys (RISC site cards, fish presence-absence) if the 2016 surveys were inconclusive concerning fish presence. New locations were added based on changes in design of the Mine Site. Sampling was conducted at 9 sites in the Willow River Watershed (8 repeat locations), 6 sites in Jack of Clubs Watershed (3 repeat locations), 2 sites in Slough Creek Watershed (1 repeat site), 36 sites in Williams Creek Watershed (14 repeat locations), and 11 sites in Lowhee Creek Watershed (3 repeat locations). Golder did not conduct sampling in Lowhee Creek in 2018, but Avery Creek Services Ltd did conduct spawning surveys in Lowhee Creek.

Golder conducted fish and fish habitat surveys in 2019 at the QR Mill and one location along the Transmission Line (Cottonwood River).

Fish and fish habitat surveys were conducted in 2021 due to changes in the Transmission Line route, including on five of the identified access roads that will require upgrades that were identified in May 2021. Fish and fish habitat surveys conducted in 2020 and 2021 included Reconnaissance 1:20,000 fish and fish habitat surveys at watercourse crossings on the transmission line corridor (Table 7.9-6, Figure 7.9-7, Appendix 7.9-3). There were 63 identified watercourse crossings, but seven were not surveyed as they were either located on private property or were not accessible due to challenging topography. Four of the locations were previously surveyed as they are located within the Mine Site LAA. These included one crossing on Peeps O'Day Creek, one crossing on the Willow River, one crossing on Mosquito Creek, and one crossing on Lowhee Creek.

Fish sampling and a hydroacoustic survey were also undertaken in 2021 at Jack of Clubs Lake. In addition, the hydroacoustic data was used to evaluate the substrate composition of Jack of Clubs Lake.

7.9.3.3.2.3 Fish Habitat Assessments

Fish habitat surveys in the Mine Site and QR Mill LAA included Reconnaissance-level Fish and Fish Habitat Assessment using RISC cards and/or FHAP surveys that were reach-based. Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures (RISC, 2001) were used to assess stream habitat. Lake habitat was assessed using methods consistent with Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Lake Survey (RISC, 2008). In addition, substrate was classified in Jack of Clubs Lake using the hydroacoustic data collected and verified with the lake sediment sampling detailed in Appendix 7.9-6.

Golder conducted FHAP surveys at the same locations as fish community sampling at both the Mine Site and QR Mill LAA sites; FHAP surveys followed the Fish Habitat Assessment Procedures (Johnston and Slaney, 1996). Fish Habitat Assessment Procedure surveys provided detailed information for each habitat unit (pool, riffle, glide, and cascade) along the length of the sampling site.

Golder assessed those accessible watercourse crossings along the Transmission Line for fish habitat. Surveys extended approximately 50 m upstream and 50 m downstream from the proposed Transmission Line watercourse crossing location. Upgrades to access roads as part of the Transmission Line have not yet been finalized. All streams that will be crossed as part of the access road system to the transmission line will be assessed, and best practices will be applied based on the Fish Stream Crossing Guidebook (BC MFLNRO, 2012). Preliminary information on some of these access roads is available in Appendix 7.9-3.

7.9.3.3.2.4 Fish Assessments

Fish sampling surveys included spring and fall spawning surveys, reconnaissance presence/absence surveys, fish community surveys, and EFU surveys. Fish assessments used backpack electrofishing, minnow trapping, or gill-netting as appropriate for the site conditions. All fish or a subset of fish captured were measured to fork length and weighed.

Golder conducted reconnaissance presence/absence surveys in 2016 and 2018 at the Mine Site and in 2019 at the QR Mill to understand fish distribution throughout each stream. Golder also conducted reconnaissance presence/absence surveys in 2020 and 2021 for the Transmission Line watercourse crossings. Electrofishing was conducted at most sites, but at lotic sites, backpack electrofishing and visual observation were used to determine the presence of fish. Baited minnow traps were used at lentic sites and at lotic sites where conditions were unsuitable for electrofishing (water was too deep) or electrofishing was not allowed due to permit conditions.

Golder conducted fish abundance surveys at the Mine Site and QR Mill using electrofishing at lotic sites using standard multiple-pass removal techniques using the Salmonid Field Protocol Handbook Technique for Assessing Status and Trends in Salmon and Trout Populations (Johnson et al., 2007) and RISC standards (RISC, 1997).

Golder completed mark-recapture studies for lentic site fish community assessments by completing two capture events over 48 hours. All fish captured using minnow traps were marked on the adipose or caudal fin and released. Approximately 24 hours later, a second capture event occurred and marked and unmarked fish were noted.

Avery Creek Services Ltd. conducted spawning surveys in the spring or fall on those streams where known distribution of Rainbow Trout and Bull Trout were known to occur at the Mine Site. A two-person crew conducted the surveys in an upstream direction to the suspected upstream limit of distribution. In addition, snorkelers conducted surveys at the Mine Site in the spring and fall to determine the location, duration, and timing of the spring and fall spawning events.

Table 7.9.6 Number of Fish and Fish Habitat Sampling Sites by Watershed, Cariboo Gold Mine Project, 2016 to 2021

Field Component	Unit	Project Component/Watershed									
		Wells Mine Site						QR Mill	Transmission Line*		
		Willow River	Jack of Clubs Lake	Jack of Clubs Creek	Slough Creek	Williams Creek	Lowhee Creek	Quesnel tributaries	Quesnel	Cottonwood	Willow River
Spawning Surveys by Golder	Sites	7	0	5	1	16	3	0	0	0	0
Spawning Survey by Avery	Reaches	4	1	6	5	11	0	0	0	0	0
Reconnaissance (presence/absence)	Sites	11	11	14	8	33	0	5	0	18	27
RISC Site Cards	Sites	10	11	14	8	36	11	9	0	20	38
Fish Community	Sites	7	46	4	5	28	9	4	0	0	0
FHAP	Sites	5	0	4	5	14	3	4	0	0	0
EFU	Sites	2	3	0	0	9	4	0	0	0	0
Fish Tissue	Sites	0	1[1]	0	2	0	0	0	0	0	0
Total Sites	Sites	15	57[2]	14	10	52	11	9[3]	0	20	38
Not sampled	Sites	-	-	-	-	-	-	-	5	2	0
Years Sampled	Year	2016, 2018	2016, 2018, 2021	2016	2016, 2018	2016, 2018	2016, 2018	2019	Not sampled	2020, 2021	2020, 2021[4]

Notes: RISC = Resources Information Standards Committee, FHAP = Fish Habitat Assessment Procedures, EFU = End of fish use; QR Mill – Quesnel River Mill

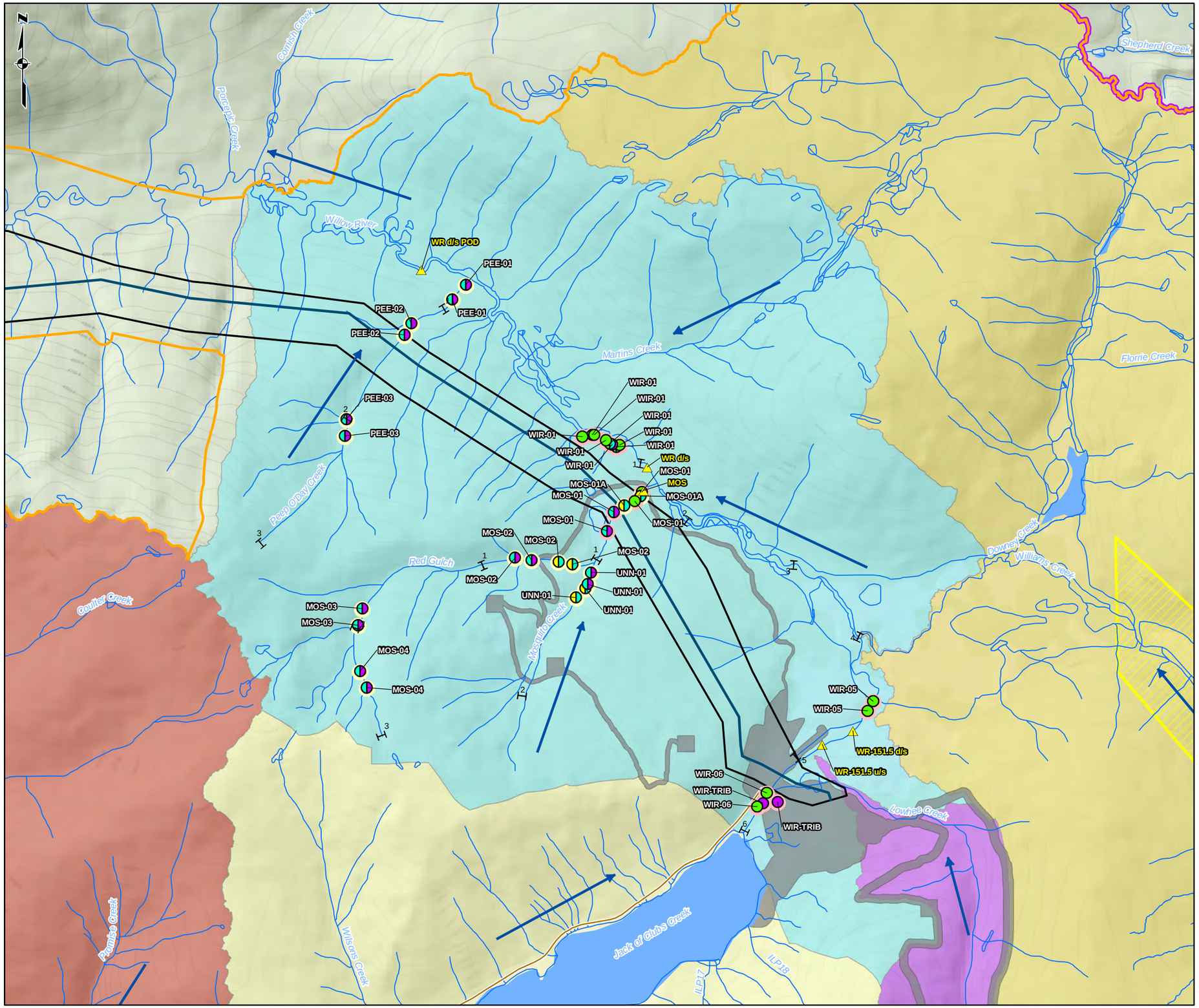
* = based on the 2020 route alignment, does not include changes to the route alignment or access roads.

[1] Sampling was done at 11 locations within Jack of Clubs Lake.

[2] 45 sites are located within Jack of Clubs Lake.

[3] Two sites were done within the same reach in Creek #2.5 and Creek #3.

[4] Includes 4 sites assessed previously in 2016 or 2018 years as part of the Mine Site assessments.



LEGEND

- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT
- HEALTH SAMPLE STATIONS

FISH SURVEY TYPE

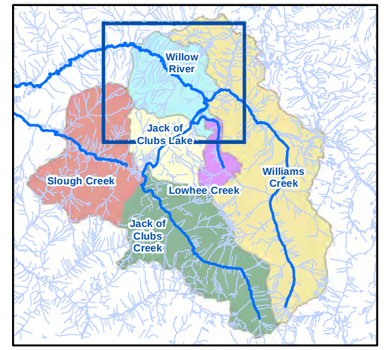
- RECCI
- RISC
- ABND
- FISH TISSUE
- EFU
- GILLNET

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



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NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:23,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

MINE SITE EXISTING CONDITIONS SAMPLING SITES FOR FRESHWATER FISH

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE: 1 of 7 | FIGURE 7.9-5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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600000

9880000

Burns Creek

Prom53

Slough Creek

ILP17

ILP16

ILP11

ILP12

ILP22

ILP23

ILP21

Lowhee Creek

Stouts Gulch

Conklin Creek

Olally Creek

Pluketon Creek

Victoire Creek

Ethoxy Gulch

ILP15

ILP19

ILP20

Stoney Creek

Walker Gulch

Queen of Clubs Creek

Amador Creek

Houseman Creek

Lightning Creek

Foster Creek

Agnes Creek

Agnus Creek

Brough Creek

Jack of Clubs Creek

Williams Creek

JCC d/s

JCC u/s

VC

SO

12-01

JAC-01

JAC-02

JAC-03

JAC-04

VIC-01

VIC-02

VIC-03

10-01

19-01

19-02

20-01

STO-01

STO-02

STO-03

1

2

3

4

5

600000

9880000

LEGEND

- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT
- HEALTH SAMPLE STATIONS

FISH SURVEY TYPE

- RECCI
- RISC
- ABND
- FISH TISSUE
- EFU
- GILLNET

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

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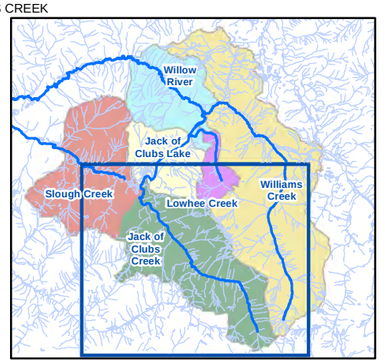
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



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NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:37,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

MINE SITE EXISTING CONDITIONS SAMPLING SITES FOR FRESHWATER FISH

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE: 2 of 7 | FIGURE 7.9-5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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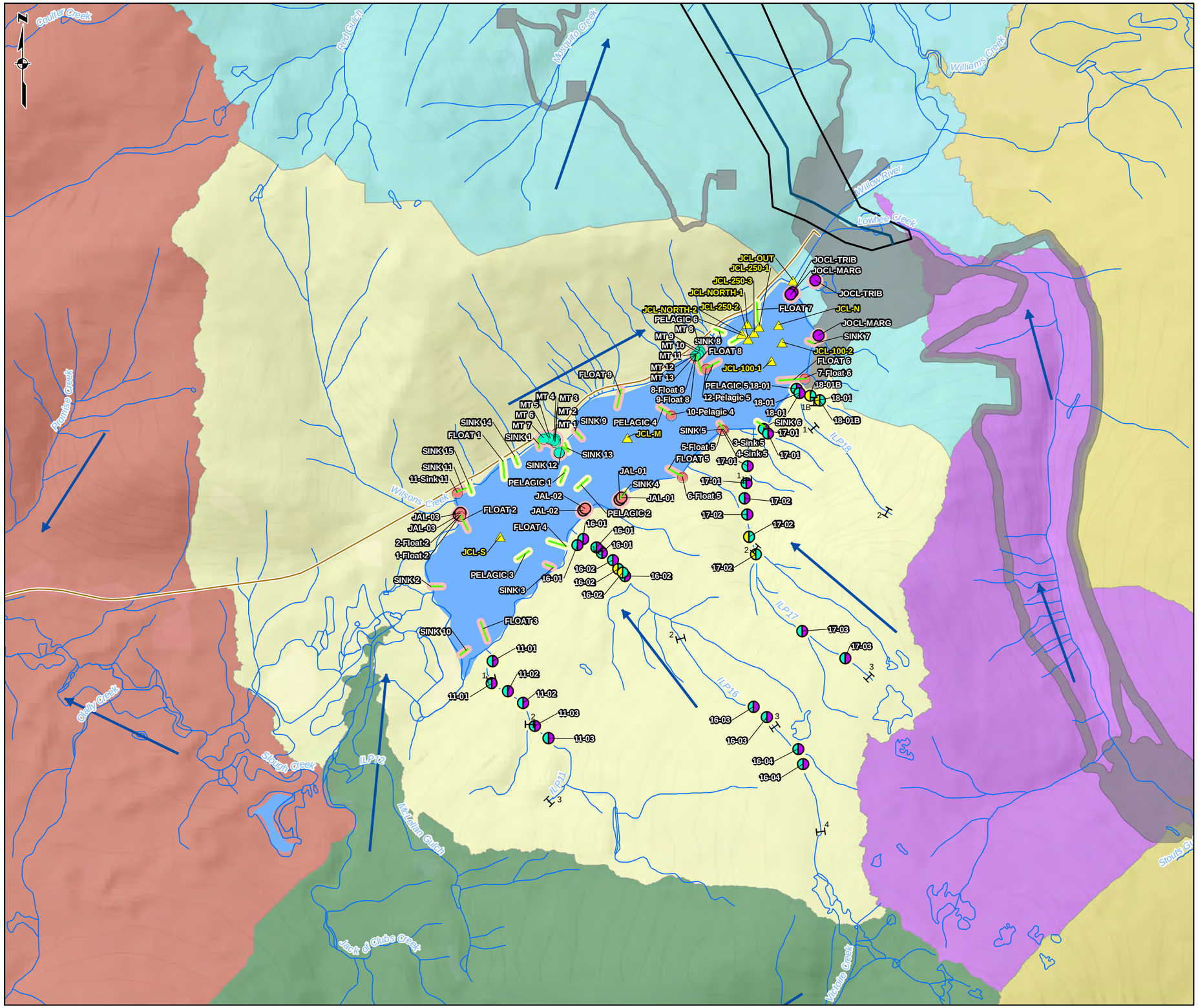

LEGEND

- REACH BREAKS
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- JACK OF CLUBS LAKE
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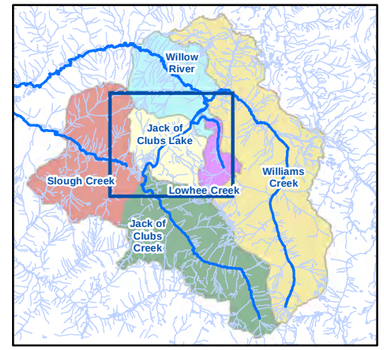
- SLOUGH CREEK
- WILLIAMS CREEK



REFERENCE(S)

1.WATER FEATURES, TRANSPORTATION FEATURES OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. CITIES/TOWNS, INDIAN RESERVES, FEDERAL LANDS AND PARK/PROTECTED AREAS OBTAINED FROM BC MINISTRY OF FORESTS, LANDS NATURAL RESOURCE OPERATIONS AND RURAL DEVELOPMENT.

NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:20,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

MINE SITE EXISTING CONDITIONS SAMPLING SITES FOR FRESHWATER FISH

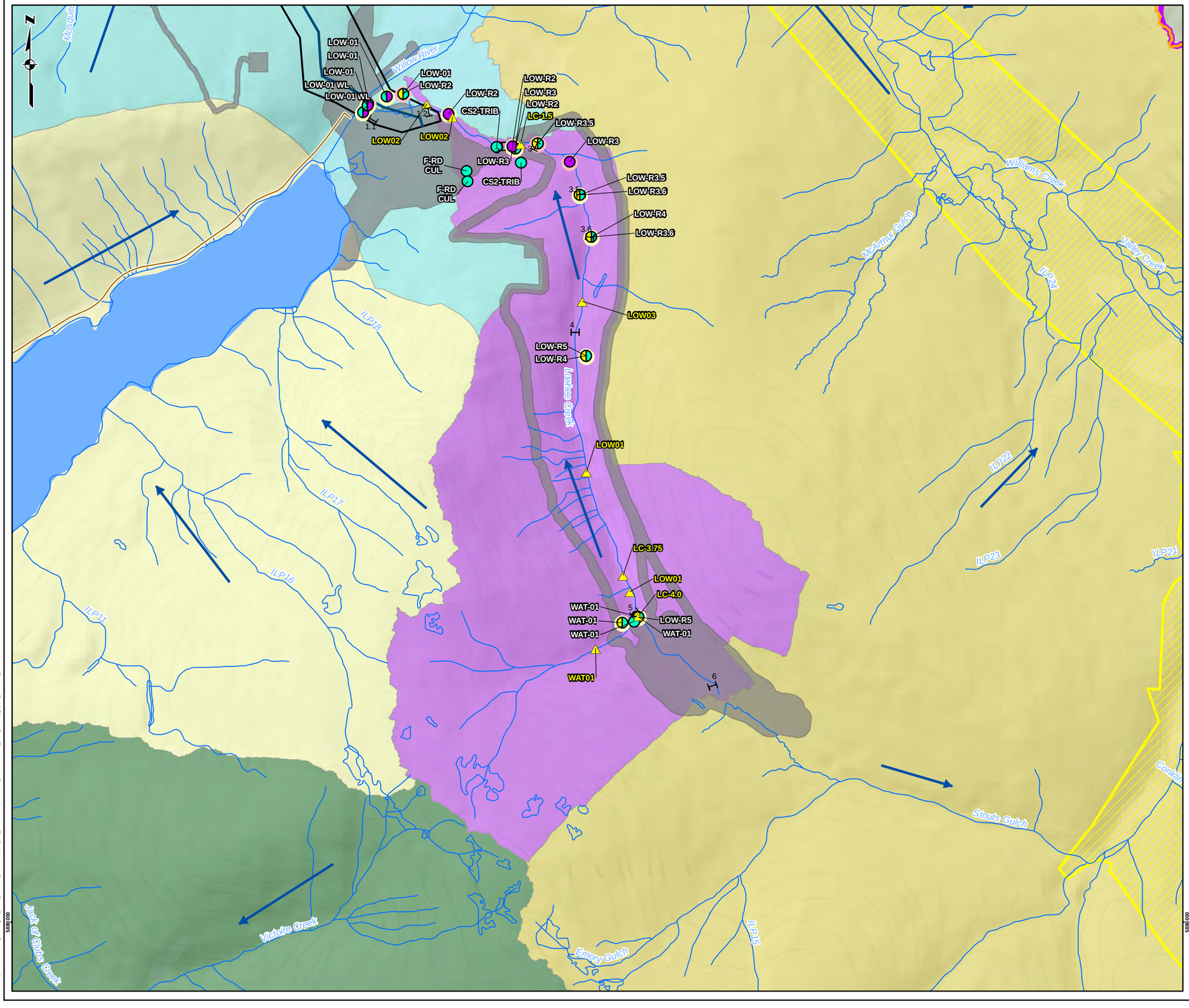
REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE: 3 of 7 | FIGURE 7.9-5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

Y:\G\SP\Projects\2019\151_11330_70_BGM_Cariboo_Gold\Mapping\gl\02_fisheries-aquatics\03_EA\02-03-001-6_Fish_Survey_Type_Minnette_v2.mxd



LEGEND

- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT
- HEALTH SAMPLE STATIONS

FISH SURVEY TYPE

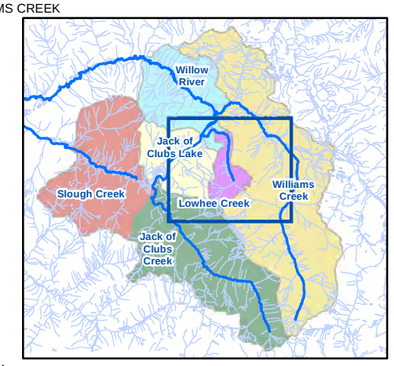
- RECCI
- RISC
- ABND
- FISH TISSUE
- EFU
- GILLNET

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



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NAD83 CSRS
UTM Zone 10N

0 0.5 1

1:20,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

MINE SITE EXISTING CONDITIONS SAMPLING SITES FOR FRESHWATER FISH

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO.	PHASE	PAGE:	FIGURE
151-11330-70	00	4 of 7	7.9-5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

0 25mm

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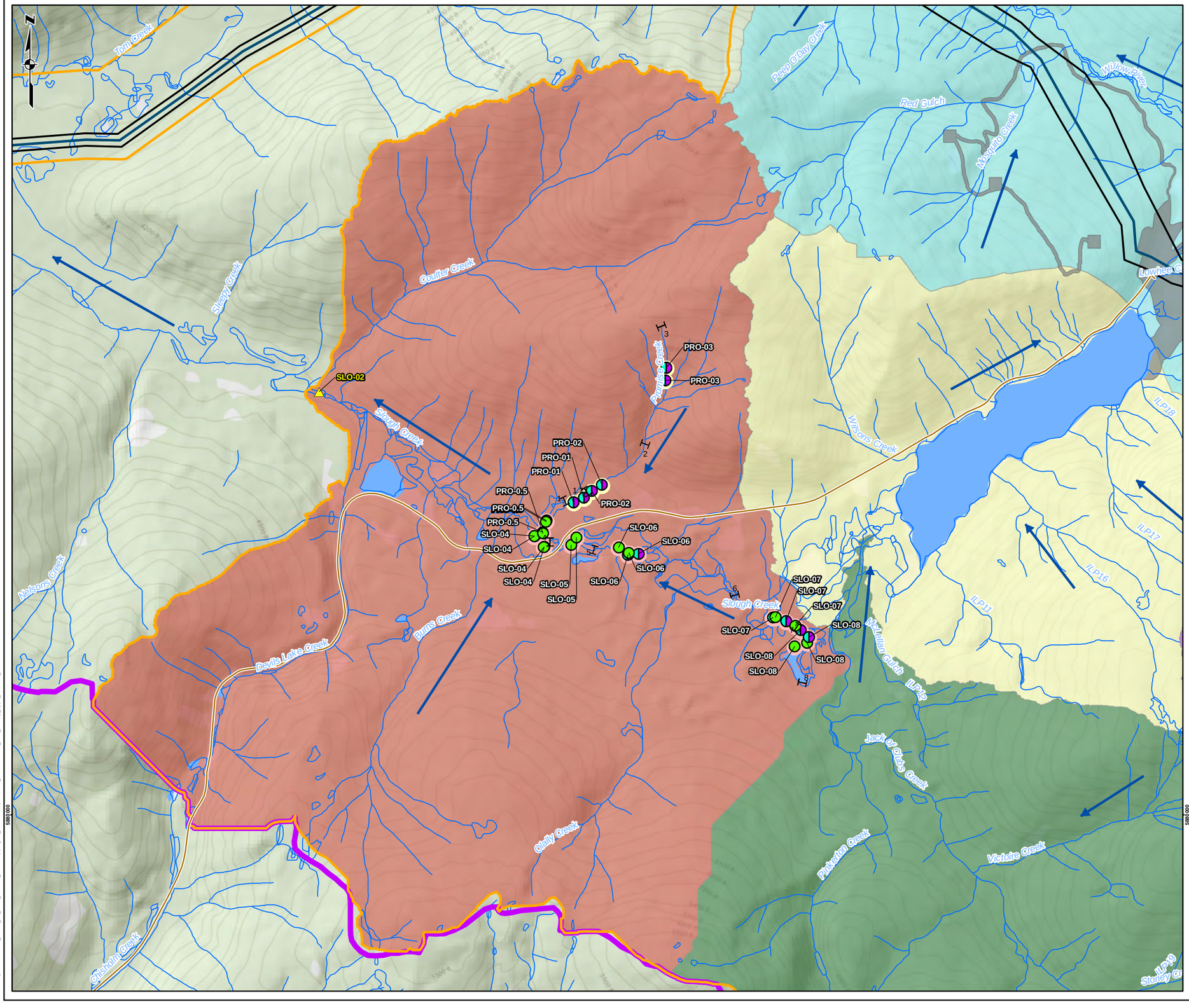


LEGEND

- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT
- HEALTH SAMPLE STATIONS

FISH SURVEY TYPE

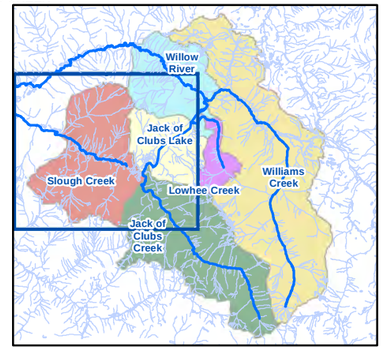
- RECCI
- RISC
- ABND
- FISH TISSUE
- EFU
- GILLNET

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



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NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:30,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

MINE SITE EXISTING CONDITIONS SAMPLING SITES FOR FRESHWATER FISH

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70
PHASE 00
PAGE: 5 of 7
FIGURE 7.9-5

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

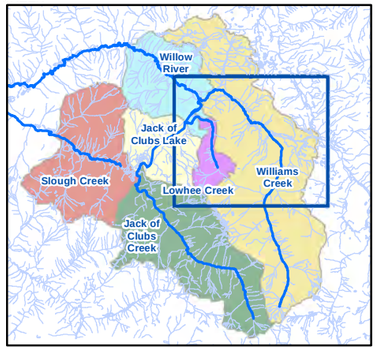
25mm
0

600000

5880000

Willow River
Downey Creek
Williams Creek
Pinus Creek
Jubilee Creek
Mailleue Creek
Yellowhawk Creek
Pleasant Valley Creek
Jack of Clubs Creek
Lowhee Creek
Slough Creek
ILP18
ILP17
ILP16
ILP22
ILP23
ILP24
ILP21
ILP15
Emory Gulch
Victoria Creek
Stouts Gulch
Conklin Creek
French Creek
Weldon Lake Inlet

WIC-01
WIC-0.25
WLM-03
WIC-02
WIC-04
MCA-01
MCA-02
MCA-01B
WIC-05
WIC-06
24-01
24-02
22-02
22-01
24-DITCH
23-01
23-02
22-03
WC-Trib1
Wetland-N
Wetland-S
WEL-M
WELOUT
WELIN-01
WELIN-02
WIC-08
P3
P1-DS-DITCH
P2
P1
UC
HOS-01
P1-DS-01
P1-DS-02
21-01A
21-01
21-01B
WIC-07/08A
WIC-07/08B
P1-US-01
P1A
P1B
HOS-02
STO-03
STO-04
STO-02
EMO-01
EMO-02
SG-1.35
STO01
STO03
SG-0.25
STO02
WLM03
WC-8.0
CG
CON-01
CON-02
WIC-10



LEGEND

- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT
- HEALTH SAMPLE STATIONS

FISH SURVEY TYPE

- RECCI
- RISC
- ABND
- FISH TISSUE
- EFU
- GILLNET

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK

REFERENCE(S)

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NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:25,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

MINE SITE EXISTING CONDITIONS SAMPLING SITES FOR FRESHWATER FISH

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70
PHASE 00
PAGE: 6 of 7
FIGURE 7.9-5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

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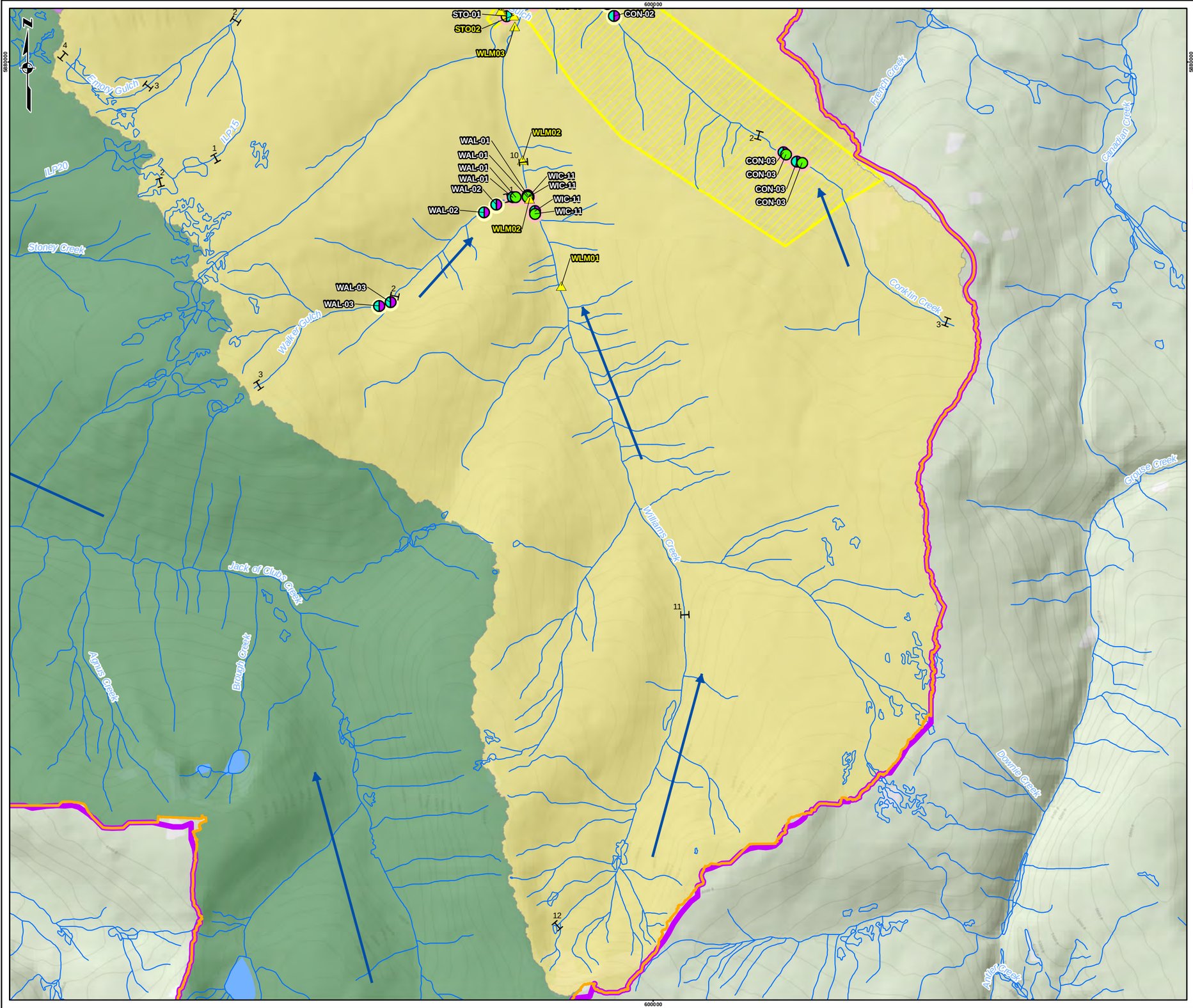


LEGEND

- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT
- HEALTH SAMPLE STATIONS

FISH SURVEY TYPE

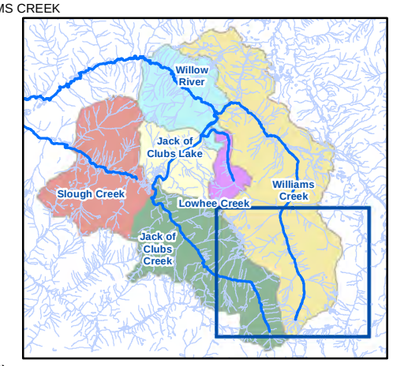
- RECCI
- RISC
- ABND
- FISH TISSUE
- EFU
- GILLNET

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



REFERENCE(S)

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NAD83 CSRS
UTM Zone 10N

0 0.5 1

1:25,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

MINE SITE EXISTING CONDITIONS SAMPLING SITES FOR FRESHWATER FISH

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE: 7 of 7 | FIGURE 7.9-5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

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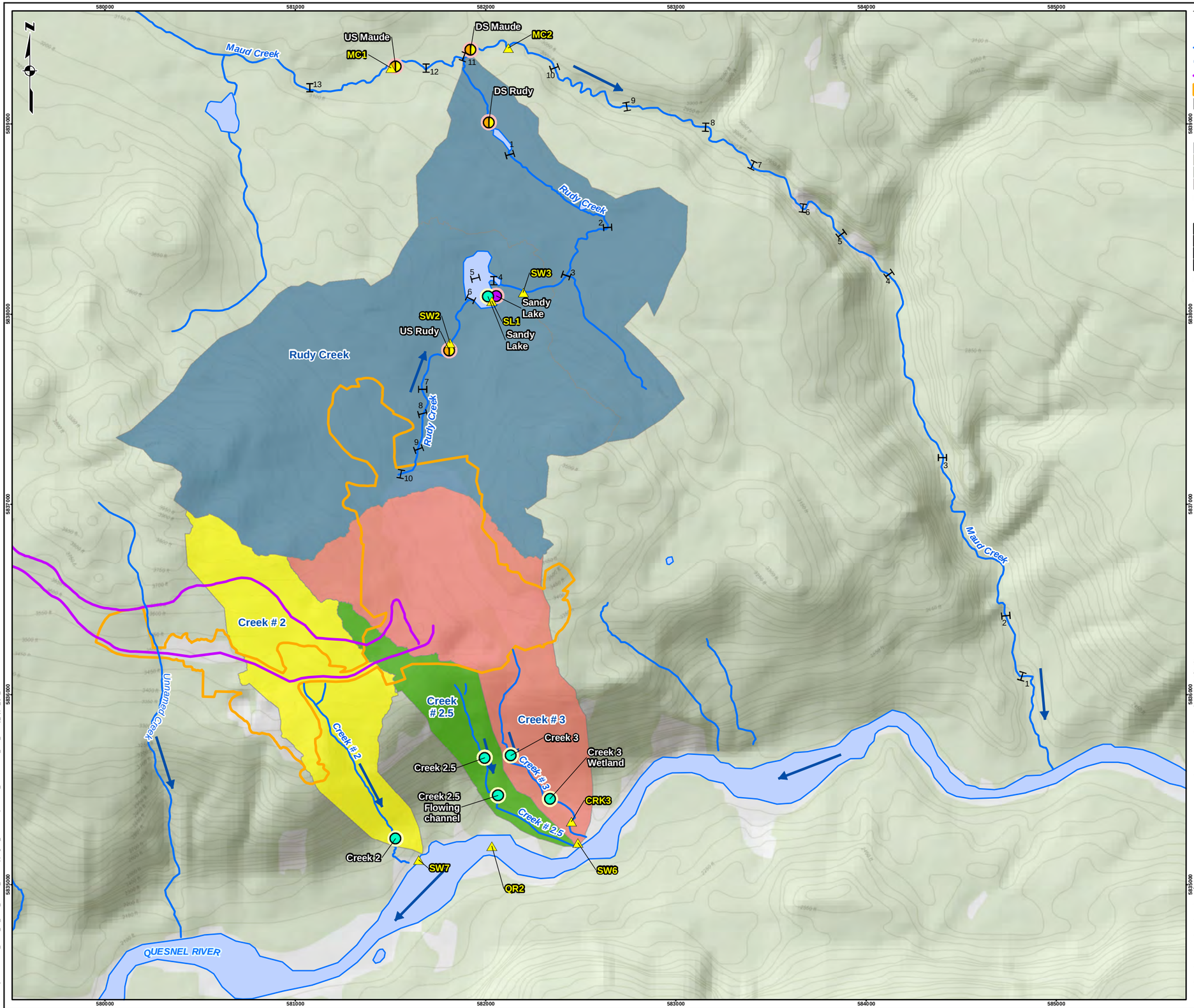


LEGEND

- REACH BREAKS
- WATERCOURSE
- FLOW DIRECTION
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED PROJECT FOOTPRINT
- PROPOSED NEW INFRASTRUCTURE
- HEALTH SAMPLE STATIONS

QR MILL WATERSHED

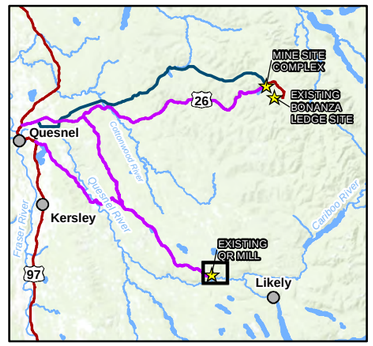
- RUDY CREEK
- CREEK # 2
- CREEK # 2.5
- CREEK # 3

FISH SURVEY TYPE

- RECCI
- RISC
- ABND
- FHAP

FISH CAPTURED

- YES
- NA



REFERENCE(S)

1. TRAILS, WATER FEATURES, ROADS, MUNICIPAL BOUNDARY, PARK/PROTECTED AREAS, BARKERVILLE HISTORIC TOWN/PARK, CITIES (INSET), PROVINCIAL BORDERS (INSET) OBTAINED FROM THE B.C. MINISTRY OF FORESTS, LANDS, NATURAL RESOURCE OPERATIONS AND RURAL DEVELOPMENT.
2. HILLSHADE DERIVED FROM LIDAR DATA FLOWN BY MCELHANNAY CONSULTANTS LTD. JUNE 27, 2016.
3. BASE DATA SOURCE: ESRI, GEOBASE, NRCAN, AND THE GIS USER COMMUNITY.
4. INSET BASE SOURCE: ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS.

NAD83 CSRS
UTM ZONE 10N

0 0.5 1
1:20,000 METRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

QR MILL EXISTING CONDITIONS SAMPLING SITES FOR FRESHWATER FISH

REV.	DESCRIPTION	DATE	INITIALS
B		4/11/2022	M.Y

PROJECT NO.	PHASE	REV.	FIGURE
151-11330-70	00	B	**7.9-6**

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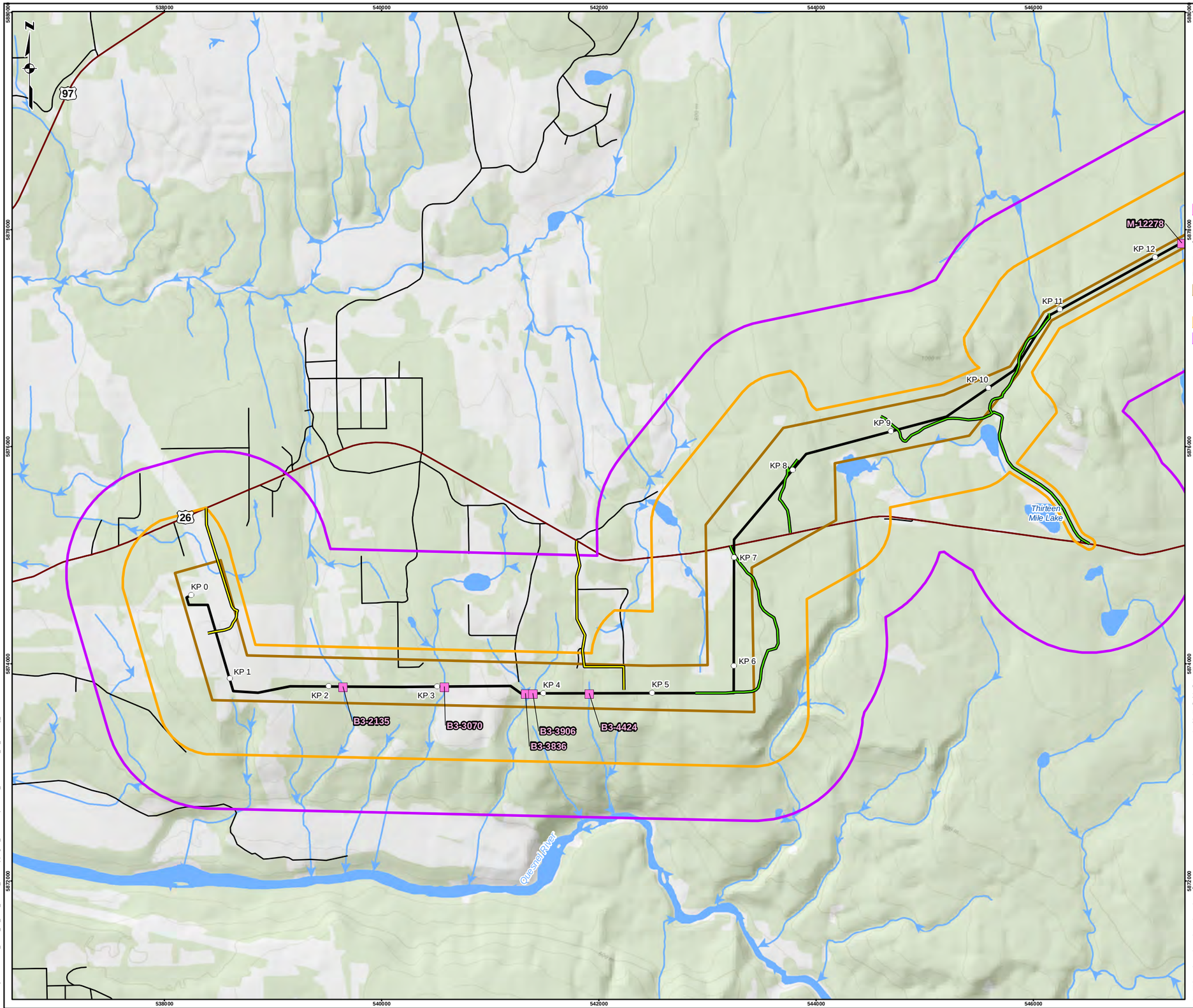
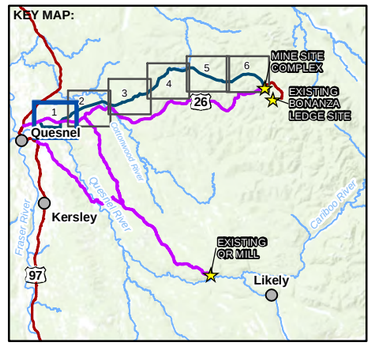


LEGEND

- ACCESS ROAD WATERCROSSING AS OF 2021 (ASSESSED)
- ACCESS ROAD WATERCROSSING AS OF 2021 (NOT ASSESSED)
- WATERCROSSING AS OF 2021 (ASSESSED)
- WATERCROSSING AS OF 2021 (NOT ASSESSED)
- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
- WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- BARLOW SUBSTATION
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE ACCESS ROAD (EXISTING)
- PROPOSED TRANSMISSION LINE ACCESS ROAD (UPGRADE)
- PROPOSED TRANSMISSION LINE CORRIDOR
- PROPOSED MINE SITE SURFACE INFRASTRUCTURE
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA



REFERENCE(S)

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3. INSET BASE SOURCE: ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS.

NAD83 CSRS
UTM Zone 10N

0 1 2
1:35,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE SAMPLING SITES FOR FISH AND FISH HABITAT

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO.	PHASE	PAGE	FIGURE
151-11330-70	00	1 of 6	7.9-7

Y:\GIS\Projects\2019\151_11330_70_BGM_Cariboo_Gold\Mapping\02_fisheries-aquatic\03_EA\02-03-09 9_TL_Crossing_v3.mxd

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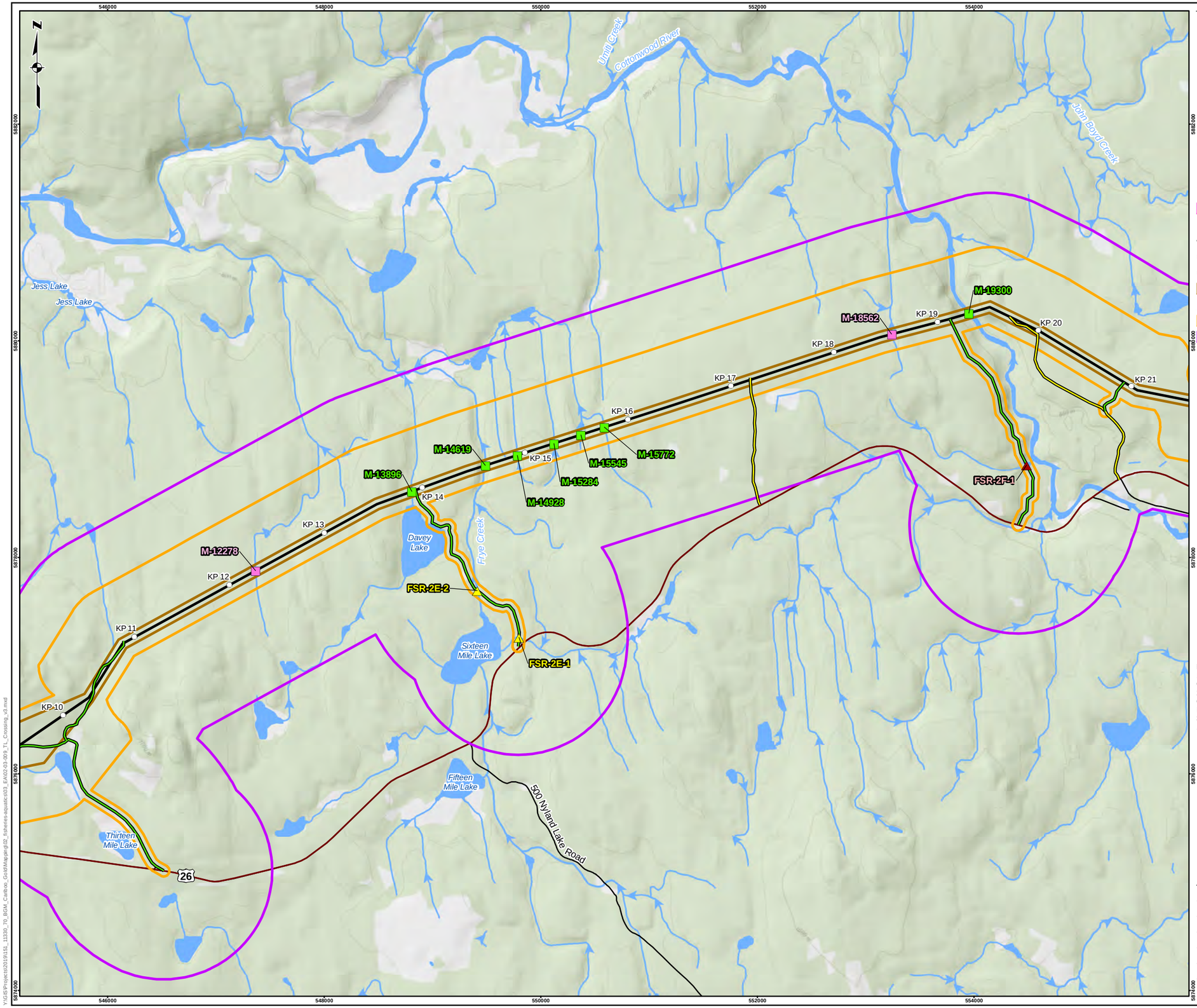

LEGEND

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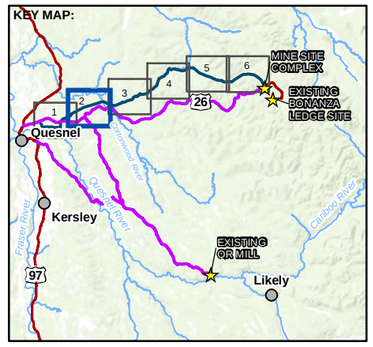
- ACCESS ROAD WATERCROSSING AS OF 2021 (NOT ASSESSED)
- WATERCROSSING AS OF 2021 (ASSESSED)
- WATERCROSSING AS OF 2021 (NOT ASSESSED)
- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
- WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- BARLOW SUBSTATION
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE ACCESS ROAD (EXISTING)
- PROPOSED TRANSMISSION LINE ACCESS ROAD (UPGRADE)
- PROPOSED TRANSMISSION LINE CORRIDOR
- PROPOSED MINE SITE SURFACE INFRASTRUCTURE
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA



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3. INSET BASE SOURCE: ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS.

NAD83 CSRS
UTM Zone 10N

0 1 2
1:35,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE SAMPLING SITES FOR FISH AND FISH HABITAT

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO.	PHASE	PAGE	FIGURE
151-11330-70	00	2 of 6	7.9-7

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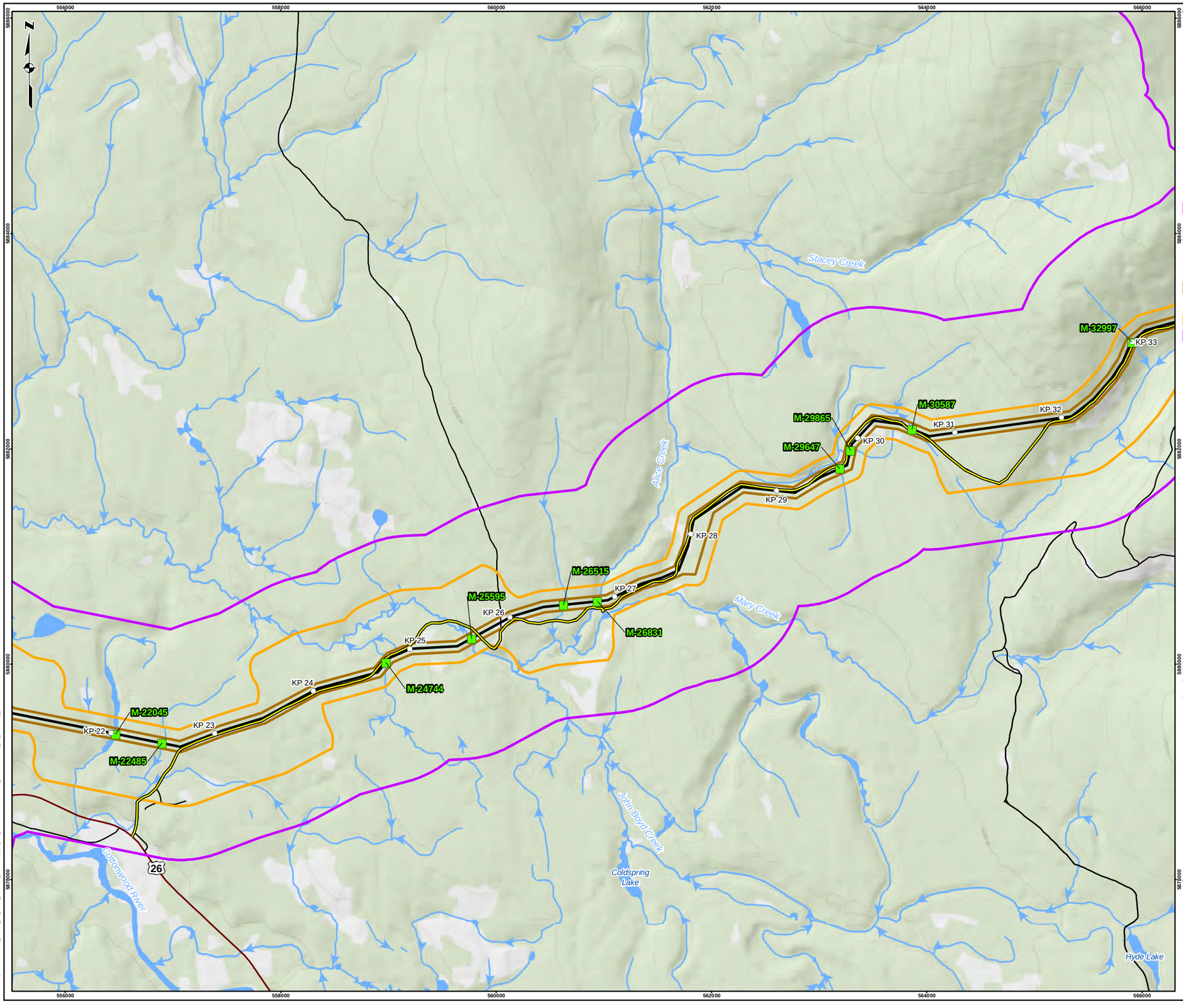

LEGEND

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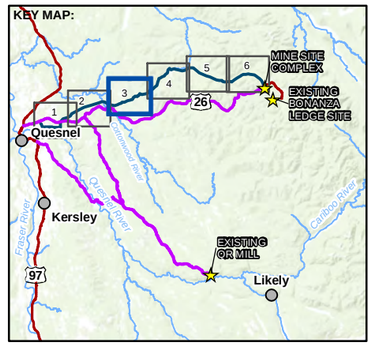
- ACCESS ROAD WATERCROSSING AS OF 2021 (NOT ASSESSED)
- WATERCROSSING AS OF 2021 (ASSESSED)
- WATERCROSSING AS OF 2021 (NOT ASSESSED)
- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
- WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- BARLOW SUBSTATION
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE ACCESS ROAD (EXISTING)
- PROPOSED TRANSMISSION LINE ACCESS ROAD (UPGRADE)
- PROPOSED TRANSMISSION LINE CORRIDOR
- PROPOSED MINE SITE SURFACE INFRASTRUCTURE
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA



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3. INSET BASE SOURCE: ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS.

NAD83 CSRS
UTM Zone 10N

0 1 2
1:35,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE SAMPLING SITES FOR FISH AND FISH HABITAT

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO.	PHASE	PAGE	FIGURE
151-11330-70	00	3 of 6	7.9-7

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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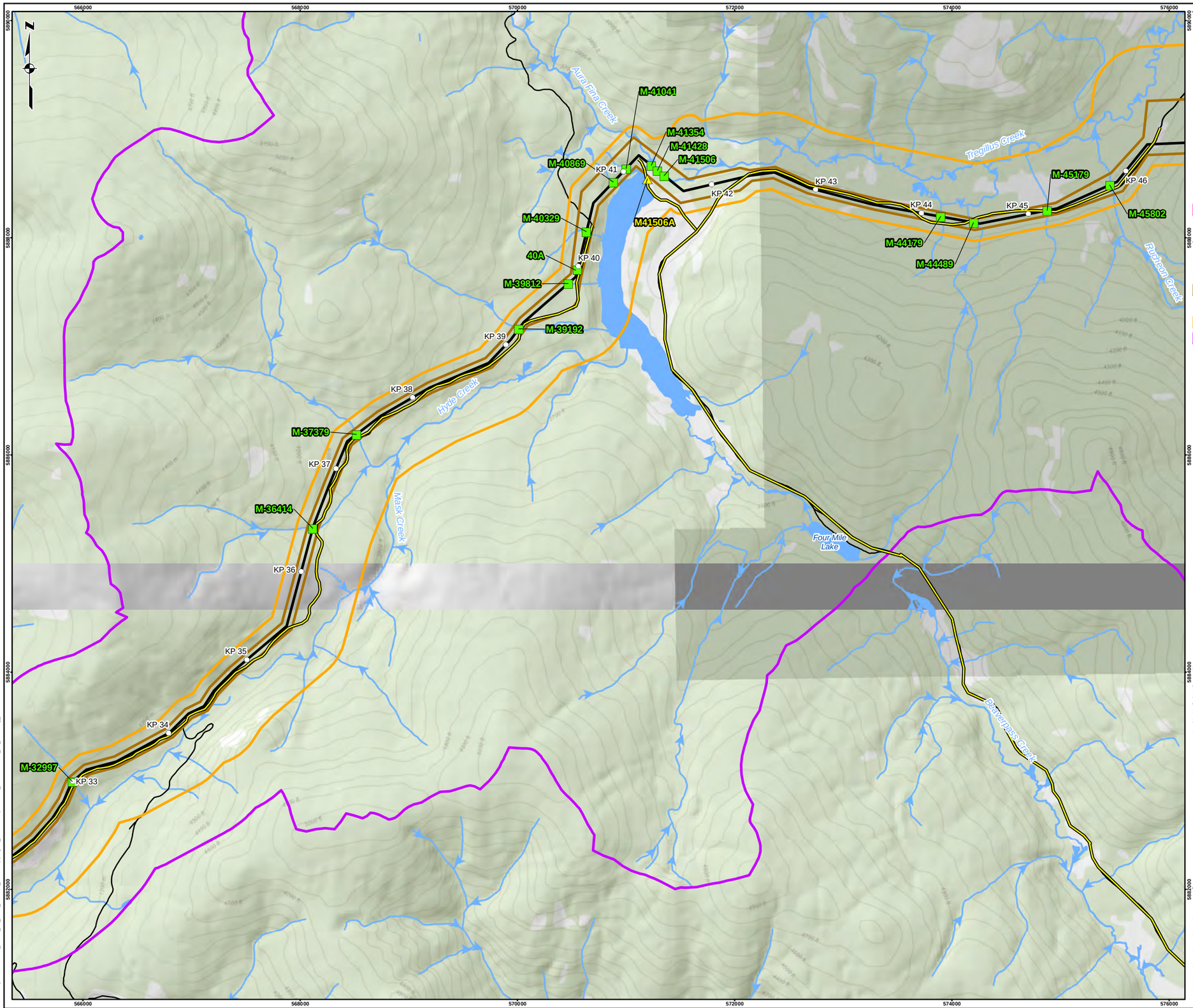

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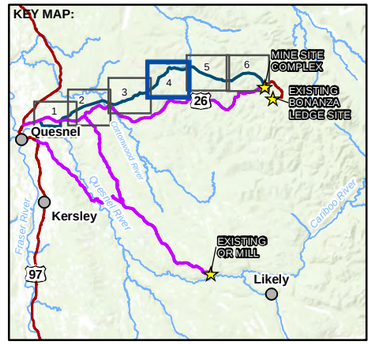
- WATERCROSSING AS OF 2021 (NOT ASSESSED)
- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
- WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- BARLOW SUBSTATION
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE ACCESS ROAD (EXISTING)
- PROPOSED TRANSMISSION LINE ACCESS ROAD (UPGRADE)
- PROPOSED TRANSMISSION LINE CORRIDOR
- PROPOSED MINE SITE SURFACE INFRASTRUCTURE
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA



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NAD83 CSRS
UTM Zone 10N

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OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE SAMPLING SITES FOR FISH AND FISH HABITAT

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE 4 of 6 | FIGURE 7.9-7

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Tregillus Creek

KP 46 KP 47 KP 48 KP 49 KP 50 KP 51 KP 52 KP 53 KP 54 KP 55 KP 56 KP 57

M-45802 M-49092 M-50698 M-52243 M-54183 M-55317 M-56843 M-57580 M-56745

Willow River

Rudheon Creek

Dragon Creek

Slough Creek

LEGEND

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- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
- WATERCOURSE
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- PARKS/PROTECTED AREA
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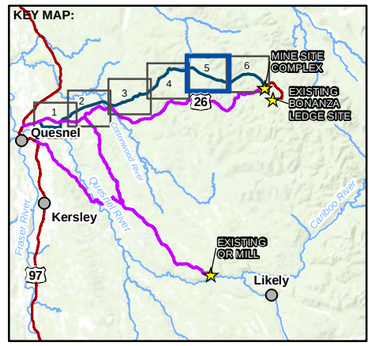

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OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE SAMPLING SITES FOR FISH AND FISH HABITAT

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO.	PHASE	PAGE	FIGURE
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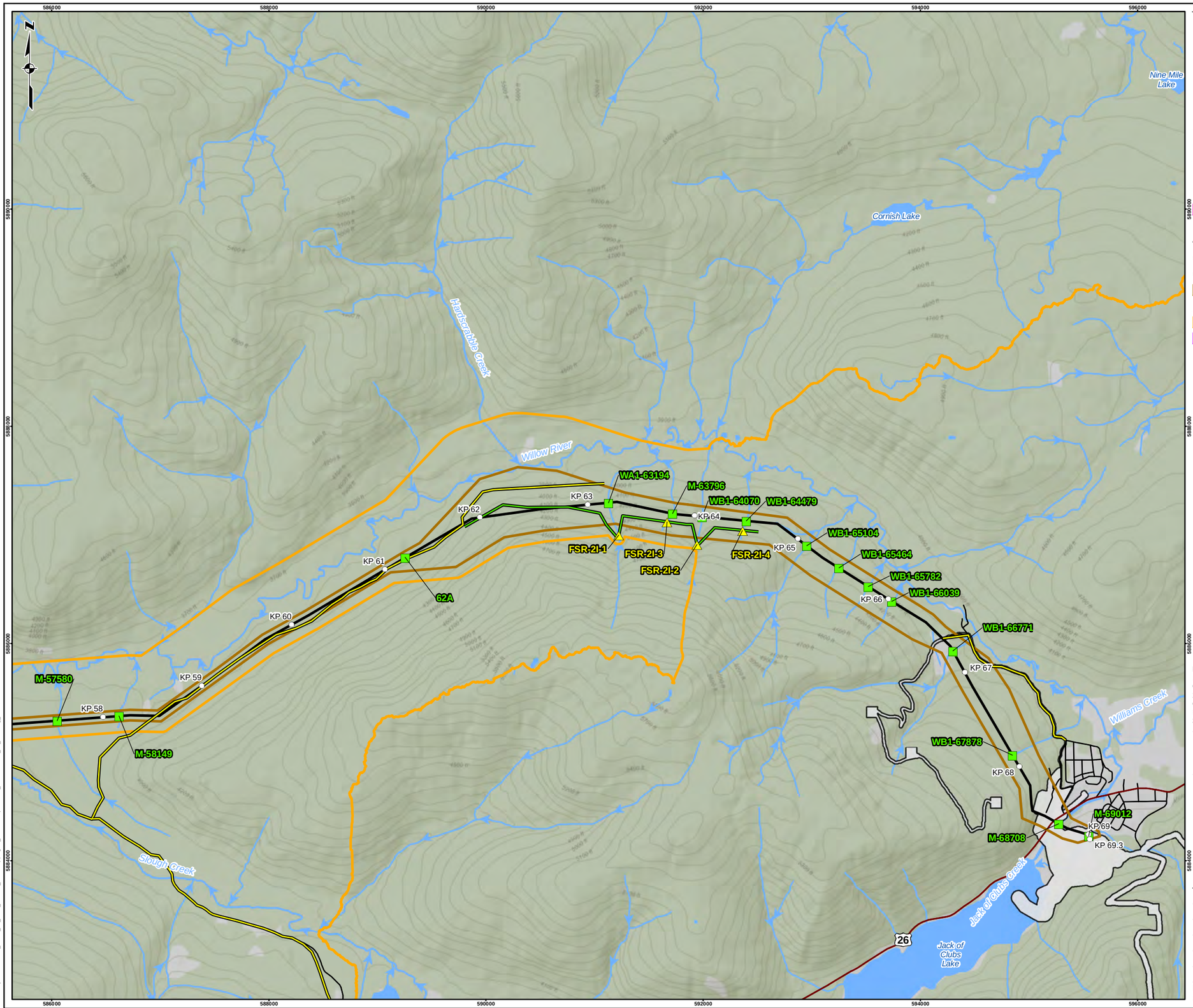

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- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
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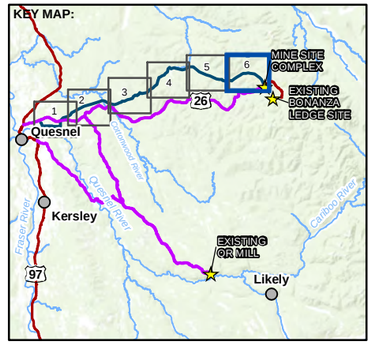

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OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE SAMPLING SITES FOR FISH AND FISH HABITAT

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO.	PHASE	PAGE	FIGURE
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Golder conducted end of fish use surveys at 16 selected reaches in June 2018 at the Mine Site to characterize those streams where fish-bearing streams become non-fish-bearing. To confirm non-fish-bearing status, sampling was conducted in a second year according to provincial guidelines (ENV, 2016a). If the survey captured fish, the survey continued upstream of the next identified barrier.

Golder conducted fish sampling in 2021 to determine fish presence, species assemblage, and fish size in Jack of Clubs Lake by using minnow trapping, short duration gillnetting, and angling. Both floating and sinking gill net gangs of different mesh sizes were set at various locations in the lake to catch a wide range of fish at different depths. Captured fish were identified to species and weighed to the nearest 1 g. Fork length was measured to the nearest millimetre, and sampling effort was recorded. Due to a large amount of fish captured in some minnow traps, fish were only counted and identified to species to reduce handling time and risk of fish mortality.

A hydroacoustic survey was also conducted to quantify the size of the fish population that uses Jack of Clubs Lake. The survey consisted of two night surveys of perpendicular transects, forming a grid pattern across the lake. Targeted species were Bull Trout, Dolly Varden, Lake Trout, Mountain Whitefish, and Redside Shiner. Groundfish (i.e., Burbot and sucker species) were not included as these fish species are less likely to be detected by hydroacoustics since their signal can be masked by the substrate. Both a vertical and horizontal transducer were used. The vertical focused on depths greater than 4 m, while the horizontal was for fish near the surface (< 5 m in depth).

7.9.3.3.2.5 Fish Tissue

Fish samples for chemical analysis were obtained opportunistically during fish distribution and abundance field work. This included samples from 65 locations during August 2016, June 2018, August 2019, June 2019, and July 2021. Fish were not collected from Creek 2, Creek 2.5, or Creek 3 at the QR Mill, as these creeks were dry at the time of sampling.

Fish species samples of Rainbow Trout, Burbot (*Lota lota*), Pygmy Whitefish (*Prosopium coulteri*), Mountain Whitefish (*Prosopium williamsoni*), and Lake Trout (*Salvelinus namaycush*) were collected for muscle and liver tissue analysis as these species are likely to be consumed by humans. Samples of Rainbow Trout, Longnose Sucker (*Catostomus catostomus*), and White Sucker (*Catostomus commersoni*) were collected for whole body tissues analysis as these species are likely to be consumed by wildlife.

The samples were submitted to an accredited laboratory for analysis of moisture content, metals, speciated mercury (i.e., methylmercury), and polycyclic aromatic hydrocarbons. Due to the low volume of liver tissue after dissection, fish liver samples were only analyzed for moisture and metals. Five fish muscle tissue samples were also only analyzed for moisture and metals due to low tissue volume. In addition, for two of the fish dissected for human health analysis, insufficient liver tissue was recovered for chemical analysis and chemical analysis was, therefore, only completed on muscle tissue.

7.9.3.3.2.6 Aquatic Health

Aquatic Health Surveys consisted of the sampling components and locations summarized in Table 7.9-7 (more detailed methods are provided in the Aquatic Health Existing Conditions Report (Appendix 7.9-1).

Table 7.9-7 Number of Aquatic Health Sampling Sites by Watershed, Cariboo Gold Mine Project, 2016 to 2020

Field Component	Unit	Watershed										
		Mine Site								QR Mill		
		Willow River	Jack of Clubs Lake		Jack of Clubs Creek	Slough Creek	Williams Creek		Lowhee Creek	Quesnel Tributaries		
	Station Type	Lotic	Lake	Lentic	Lotic	Lotic	Lotic	Lentic	Lotic	Lotic	Lentic	Lake
Benthic Habitat Assessment By Golder	Sites	5	0	1	4	1	8	4	3	0	0	0
Benthic Habitat Assessment By Hatfield	Sites	0	0	0	0	0	0	0	0	8	1	0
Benthic Invertebrate Taxonomy[a] by Golder	Sites	5	10	1	4	1	8	4	3	0	0	0
Benthic Invertebrate[a] Taxonomy by Hatfield	Sites	0	0	0	0	0	0	0	0	8	1	2
Benthic Invertebrate Tissue Chemistry[b] by Golder	Sites	5	3	1	4	1	8	4	3	5	1	2
Periphyton Taxonomy[c] by Golder	Sites	5	0	0	4	1	8	0	3	7	0	0
Periphyton Biomass[d] By Golder	Sites	5	3	1	4	1	8	4	3	0	0	2
Periphyton Biomass[d] By Hatfield	Sites	0	0	0	0	0	0	0	0	7	0	0
Periphyton Chemistry[c] By Golder	Sites	5	0	1	4	1	7	4	3	7	1	0
Phytoplankton Taxonomy[c] by Golder	Sites	0	3	0	0	0	0	3	0	0	0	2
Zooplankton Taxonomy[e] by Golder	Sites	0	3	0	0	0	0	3	0	0	0	2
Total Sites	Sites	5	10	1	4	1	8	4	3	8	1	2
Years Sampled	Year	2018	2016, 2020	2016, 2018	2016, 2018	2018	2016, 2018	2016, 2018	2016, 2018	2019	2019	2019

Notes:
[a] Identified and enumerated to the lowest practical level, typically genus or species.
[b] Metals and moisture content.
[c] Identified and enumerated to the lowest practical level, typically genus or species. Biomass estimated from cell counts.
[d] As chlorophyll *a*
[e] Identified and enumerated to the lowest practical level, typically genus or species. Biomass estimated from organism counts.

7.9.3.3.3 Data Analysis Methods

7.9.3.3.3.1 Fish Habitat Assessments

On stream reaches where two site cards were completed, one in 2016 and another in 2018, measurements were averaged between the two years. Fish Habitat Assessment data was analyzed to determine fish suitability and rationale for fish-bearing status. Stream classes at the Mine Site, QR Mill and the Transmission Line were assigned based on the Forest Practices Code of British Columbia Fish Stream Identification Guidebook (FLNRORD, 1998a). Based on the historical and survey data, streams were classified based on fish-bearing status and channel width. Those watercourses that did not meet a definition of the stream were assigned a non-classified drainage (NCD) designation.

Stream habitat was also assigned an overall habitat type of Marginal, Important or Critical based on the definitions in the Fish-Stream Crossing Guidebook (FLNRORD, 2012). The definition and their indicators are presented in Table 7.9-8.

Table 7.9.8 Definition and Indicators of Fish Habitat Types

Habitat Type	Definition	Indicators
Critical	Habitat that is critical in sustaining a subsistence, commercial, or recreational fishery, or any species at risk (i.e., terrestrial or aquatic red- and blue-listed species, those designated by COSEWIC, or those SARA listed species, or because of its relative rareness, productivity, and (or) sensitivity.	The presence of high-value spawning or rearing habitat (e.g., locations with an abundance of suitably sized spawning gravels, deep pools, undercut banks, or stable debris, which are critical to the population present), or the presence of any SARA-listed species, its residence, or critical habitat.
Important	Habitat that is used by fish for feeding, growth, and migration but is not deemed to be critical. This category of habitat usually contains a large amount of similar habitat that is readily available to the stock.	Important migration corridors. The presence of suitable spawning habitat. Habitat with moderate rearing potential for the fish species present.
Marginal	Habitat that has low productive capacity and contributes marginally to fish production.	The absence of suitable spawning habitat, and habitat with low rearing potential (e.g., locations with a distinct absence of deep pools, undercut banks, or stable debris, and with little or no suitably sized spawning gravels for the fish species present).

Notes: COSEWIC = Committee on the Status of Endangered Species in Canada; SARA = *Species at Risk Act*

7.9.3.3.3.2 Fish Assessments

The productive capacity of fish habitat was measured by the areal density. Fish removal data from each electrofishing pass were used to estimate population size or the estimated total number of fish that would have been captured if sampling continued until no fish remained at the site. Calculations were completed in the statistical computer program R using the FSA package (R Core Team, 2018; Ogle et al., 2018). Density estimates were calculated based on each site's length and wetted area and are reported as fish/100 m and fish/100 m^2, respectively. Biomass estimates were calculated by multiplying the density estimates by the mean weight for each species per site and are reported as biomass/100 m and biomass/100 m^2.

Hydroacoustic data were analyzed in Echoview ® 11.1 with the objective of calculating the number of fish per unit volume (per m^3 or 1,000 m^3). Fish densities were evaluated using fish tracking methods, which is an analytical method that takes data from the echosounder and isolated targets in the water column that match the specific echo criterion identified in the fish track detection algorithm in Echoview. Population estimates for Jack of Clubs Lake were derived from spatially-explicit volumetric fish densities that were calculated for the horizontal and vertical beam data independently. In addition, species-specific abundance estimates were calculated by dividing the total abundance into three length classes based on the length distribution of fish tracks detected during the hydroacoustic surveys. To evaluate the total biomass of fish in Jack of Clubs Lake, each target identified during fish tracking was assigned a mass (weight in kg or g) based on the target's estimated length and generalized length-weight regression. The regression was calculated directly from the fish captured during the concurrent fish sampling and included all individuals regardless of species.

7.9.3.3.3.3 Fish Tissue

Few guidelines for metals in fish tissues exist. Metal concentrations were compared to available national and provincial guidelines for wildlife consumption (CCME, 2000; ENV, 2019c); it is inferred that where consumption guidelines are met, fish health is also protected) or protection of aquatic life (ENV, 2019c). Comparisons to human health screening values are discussed in Section 7.13 as part of the human health and ecological risk assessment.

7.9.3.3.3.4 Aquatic Health

Aquatic Health data was analyzed using the following:

- Calculation of community metrics (e.g., richness, abundance, diversity indices) and statistical comparisons or comparison to applicable reference models (e.g., benthic invertebrate community data were assessed using the Canadian Aquatic Biomonitoring Network (CABIN) reference condition approach).
- Comparison to available environmental benchmarks (e.g., for tissue chemistry, chlorophyll *a*; ENV, 2019c).

7.9.3.4 Existing Conditions Characterization

Freshwater Fish characteristics for the LAA and RAA are based on the most recent fish and aquatic community and habitat assessment conducted by Golder in 2016, by Golder and Avery Creek Ltd in 2018, by Golder in 2019 for the QR Mill, by Golder in 2020 and 2021 for the Transmission Line, and by Golder in 2021 for Jack of Clubs Lake. Detailed summaries are provided for those watersheds and their relevant watercourses or waterbodies where Project effects are expected to occur and include the Willow River, Williams Creek, Lowhee Creek, Stouts Gulch, and Jack of Clubs Lake. For further details and specifics on fish habitat, refer to Appendix 7.9-2 for the Mine Site and QR Mill, Appendix 7.9-3 for the Transmission Line, and Appendix 7.9-4 for Jack of Clubs Lake.

7.9.3.4.1 Fish Habitat

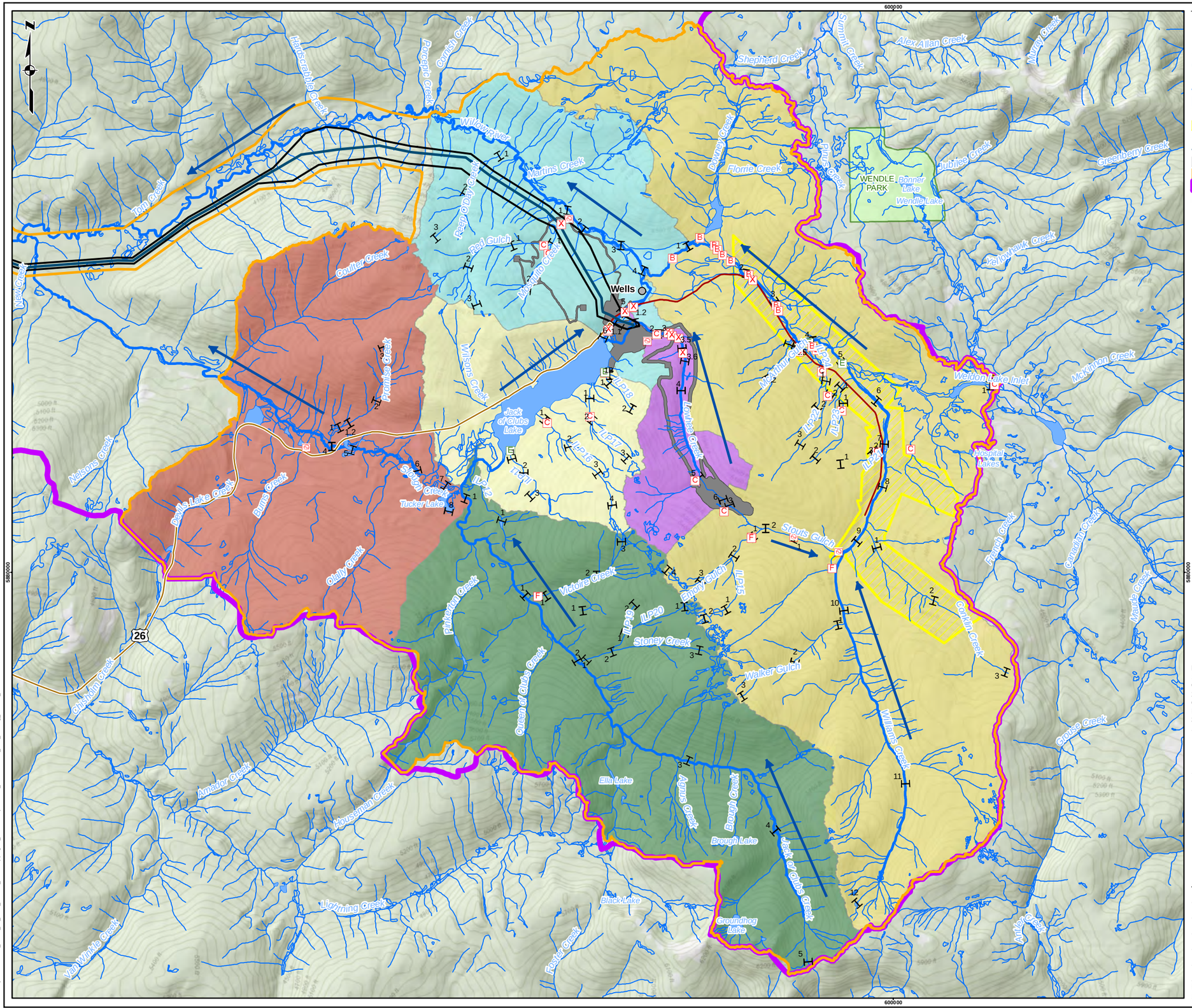
At the Mine Site LAA, headwaters comprise high elevation stream reaches (1,200 to 1,700 m altitude). Watercourses are dominated by steep cascading or riffle streams, with generally poor pool habitat and limiting overwintering habitat. Most fish likely use Jack of Clubs Lake for overwintering habitat (Appendix 7.9-2). Some of the reaches also have wetland or bog habitat. Watercourses have a pronounced spring freshet with turbid water and cold temperatures. Many of the smaller watercourses have permanent or/and seasonal barriers that prevent upstream access to spawning and rearing habitat, including but not limited to braided shallow channels that become dewatered, wetland complexes with debris jams caused by beavers, or steep cascades (Figure 7.9-8). Several existing perched culverts may be barriers to fish habitat during low flows (Figure 7.9-8).

Critical habitat was identified in four reaches of fish-bearing watercourses in the Willow River and Williams Creek watersheds at the Mine Site. No critical habitat was identified at QR Mill (Table 7.9-9). There were 39 fish-bearing reaches identified as important at the Mine Site and all five reaches assessed in fish-bearing streams at the QR Mill were considered important fish habitat (Table 7.9-9). Transmission line crossings are discussed in Section 7.9.3.4.1.8.

Table 7.9.9 Summary by Watershed of Fish-Bearing Reaches and Their Habitat Value

Project Component	Watershed	None	Marginal	Important	Critical	Total Number of Reaches
Mine Site	Jack of Clubs Creek	0	1	5	0	6
	Jack of Clubs Lake	0	0	2	0	2
	Willow River	0	1	4	2	7
	Williams Creek	0	16	17	2	35
	Slough Creek	0	1	7	0	8
	Lowhee Creek	0	6	4	0	10
	Total Number of Reaches	0	25	43	0	68
QR Mill	Quesnel	0	0	5	0	5

Excellent spawning habitat was only identified in two watersheds in a total of three reaches. The majority of reaches (25) were considered to have poor spawning habitat (Table 7.9-10). Excellent rearing habitat (n = 4) was identified in three watersheds. The majority of reaches (n=24) were considered to have moderate rearing habitat. Migration habitat was considered to be excellent in two watersheds in a total of six reaches. Two sites were considered to have no migration habitat but are considered fish-bearing because these locations have perched culverts that, if rectified, could provide fish habitat. Overwintering habitat was found in three watersheds in a total of 10 reaches. There were 14 reaches that were too shallow, lacked flow, or had no pools that would allow overwintering. Only the Willow River watershed and Williams Creek watershed had excellent fish habitat for all stages of fish life histories (Table 7.9-10). Spawning likely occurs in the main tributaries for fish, in particular in the Willow River and Williams Creek. Rainbow Trout, Longnose Sucker, White Sucker, and Lake Chub (*Couesius plumbeus*) have all been observed spawning in the Willow River and Williams Creek. Fish habitat is described in further detail by watershed in the sections below.



LEGEND

- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT

FISH BARRIERS

- B Beaver Dam
- C CASCADES
- CULVERT
- F Falls
- X PERSISTENT DEBRIS ACCUMULATION
- E Ephemeral

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK

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OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

MINE SITE AREA FISH BARRIERS

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The Cariboo Chilcotin Regional Land Use Plan identified Reaches 1, 2, and part of 3 of Jack of Clubs Creek as critical habitat for spawning and rearing fish (Figure 7.9-9, Appendix 7.11-1). There is no other critical habitat identified within the LAA. Other critical habitat identified within the RAA is Lightning Creek and associated tributaries and Quesnel River (Appendix 7.11-1).

Spawning locations for fish species are provided in Figure 7.9-9. Rainbow Trout were observed spawning in 2016 in Reach 1 of Stouts Gulch and Reach 10 of Williams Creek. Rainbow Trout were also observed spawning in 2018 in Reach 1 and 2 of Williams Creek, in Willow River Reach 5, and in Slough Creek Reach 4. Other fish observed during the spawning surveys in 2018 in Willow River Reach 5 include White Sucker and Longnose Sucker and Lake Chub, which were observed spawning in the outlet of Jack of Clubs Lake. Lake Chub were also observed spawning in Williams Creek in Reach 1 and 2.

7.9.3.4.1.1 Jack of Clubs Creek Watershed

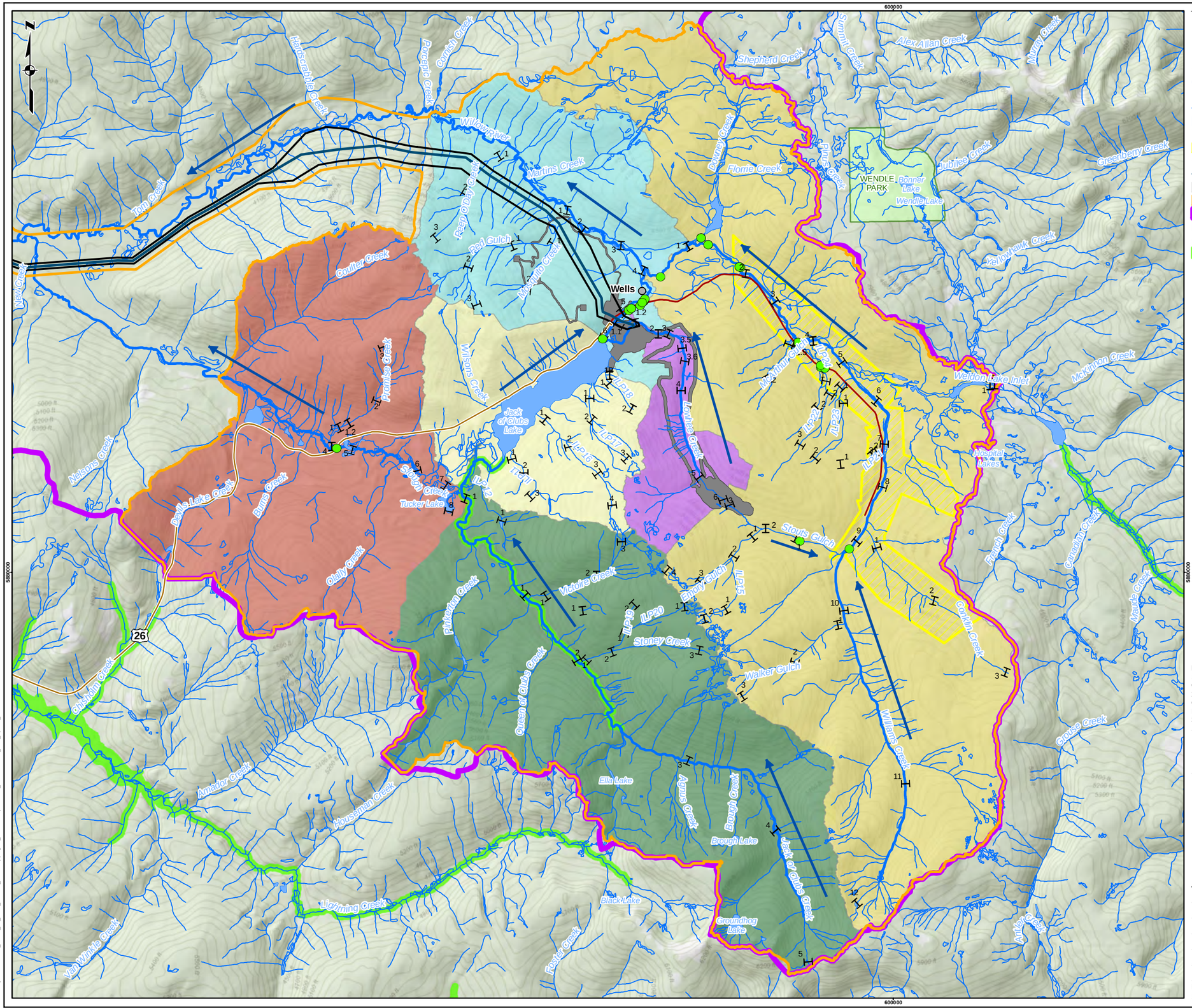
Only the mainstem of Jack of Clubs Creek and the lower reaches of Stoney Creek and Victoire Creek provide fish habitat. The upper reaches and tributaries to these systems, including ILP19 and ILP20 have steep gradients, step-pool morphology that prohibit access upstream to fish but provide food and nutrients to fish downstream. For more details on habitat in the Jack of Clubs Creek Watershed, refer to Appendix 7.9-2.

7.9.3.4.1.2 Willow River Watershed

Critical and important fish habitat in the Willow River watershed is limited to the Willow River mainstem. Critical habitat is present in Reach 1 and 5 of the Willow River and Reach 6 is rated as important. Overwintering habitat was rated as excellent in all the reaches surveyed in the Willow River. Mosquito Creek and Red Gulch have steep gradients which limit fish passage to these watercourses. Only Reach 1 of Mosquito Creek has marginal fish habitat. Peeps O'Day Creek has been heavily influenced by anthropomorphic activity, including culverts, preventing access to fish to available habitat in Reach 2 and Reach 3. Fish habitat is described further for those reaches in the Willow River. For more details on Mosquito Creek, Red Gulch, and Peeps O'Day Creek refer to Appendix 7.9-2.

Table 7.9.10 Summary by Watershed of Fish-bearing Reaches and their Habitat Ratings

Project Component	Watershed	Spawning					Rearing					Migration					Overwintering				
		None	Poor	Moderate	Good	Excellent	None	Poor	Moderate	Good	Excellent	None	Poor	Moderate	Good	Excellent	None	Poor	Moderate	Good	Excellent
Mine Site	Jack of Clubs Creek	1	3	1	1	0	0	1	4	1	0	0	1	3	2	0	0	4	0	2	0
	Jack of Clubs Lake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Willow River	0	1	1	0	1	1	0	0	0	2	0	0	1	0	2	1	1	0	0	5
	Williams Creek	3	11	11	0	2	1	5	15	4	1	1	11	5	7	4	7	6	10	7	4
	Slough Creek	0	6	0	1	0	0	2	4	1	0	0	1	5	1	0	0	0	5	2	0
	Lowhee Creek	4	4	1	0	0	0	6	1	1	1	1	5	2	1	0	6	3	0	1	0
	Total Number of Reaches	8	25	14	2	3	2	14	24	7	4	2	18	16	11	6	14	14	15	13	10
QR Mill	Quesnel River	0	1	1	2	0	0	0	0	4	0	0	1	0	3	0	0	3	2	0	0



LEGEND

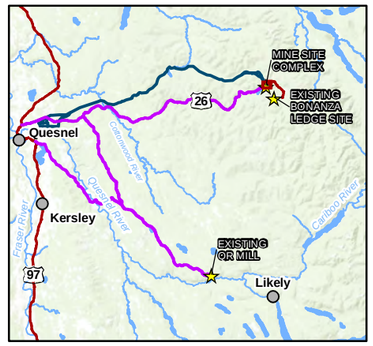
- FISH SPAWNING LOCATION
- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT

CARIBOO CHILCOTIN LAND USE PLAN (LEGAL PLANNING OBJECTIVES)

- CRITICAL HABITAT FOR FISH

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



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3. INSET BASE SOURCE: ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS.

NAD83 CSRS
UTM Zone 10N

0 1 2 3
1:65,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

MINE SITE SPAWNING LOCATIONS

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO.	PHASE	REV.	FIGURE
151-11330-70	00	B	**7.9-9**

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Willow River

Reach 1 of the Willow River is characterized by riffle-pool morphology and has braided sections. Substrate is predominantly cobbles and gravel. Spawning, rearing, migration, and overwintering habitat were considered excellent throughout. A moderate amount of cover was present, and complex habitat features included overhanging vegetation, deep pools, and large woody debris (LWD) throughout. The presence of suitable spawning gravel was also noted.

Reach 5 of the Willow River is characterized by riffle-pool-glide morphology with substrate predominantly composed of fines and gravels. Spawning habitat was rated as moderate, while rearing, overwintering, and migration habitat was considered excellent. Cover was provided by boulders, undercut banks, and overhanging vegetation.

Reach 6 of the Willow River flows from the outlet at Jack of Clubs Lake and is characterized by glide morphology with fines substrate. This uniformity of morphology is caused by the manmade channel that was excavated through the historic tailings deposit (Andrews, 1989).

Mosquito Creek

Mosquito Creek is characterized by riffle-pool morphology in Reach 1 and progressively gets steeper through Reach 2 with step-pool morphology until Reach 3 and Reach 4, which have cascade-pool morphology. This change in gradient from 4 to 19% in Reach 1 to 27% in upper reaches limits available fish habitat to Reach 1 of Mosquito Creek. Spawning habitat in Reach 1 is rated as moderate due to the presence of spawning gravels downstream from the Hardscrabble Road culvert. Substrates are predominantly gravel and cobbles in Reach 1. Rearing habitat is rated as good due to the variety and abundance of cover provided predominantly by overhanging vegetation, small woody debris (SWD), and undercut banks. Overwintering habitat in Mosquito Creek was rated as poor due to the lack of deep pools and likely low flow volumes in winter. Due to the steep gradient, migratory habitat is also rated as poor for all reaches.

Peeps O'Day Creek

Reach 1, which is characterized by riffle morphology, has substrates predominantly composed of fines. These fines are likely the result of upstream activity, which has resulted in high turbidity and heavy siltation in downstream habitat. Fish habitat, including spawning, rearing, overwintering, and migration, is rated as poor.

7.9.3.4.1.3 Jack of Clubs Lake Watershed

The tributaries to Jack of Clubs Lake, which include ILP11, ILP16, ILP17, and ILP18, are small steep gradient streams that provide marginal habitat. Information on Jack of Clubs Lake has been gathered from historical reports, as reported in the Cariboo Gold Project Lake Discharge Study (Appendix 7.4-7) and the Fish and Fish Habitat Assessment of Jack of Clubs Lake Report (Appendix 7.9-4).

Jack of Clubs Lake Tributaries

ILP11, ILP16, ILP17, and ILP18 are small non-fish-bearing streams that have a low productive capacity for fish and lack spawning habitat and overwintering habitat. These streams have steep gradients or barriers that prevent access to fish. Many of the lower reaches are characterized by riffle-pool morphology which becomes cascade-pool morphology in higher reaches. Gradients range from 11 to 38% in lower reaches and can be as steep as 44% in higher reaches. Substrate is predominantly gravel and cobbles. If accessible from the lake, the lower reaches may provide moderate rearing habitat with a variety and abundance of cover, including overhanging vegetation, SWD, and undercut banks. Overwintering likely occurs in Jack of Clubs Lake.

Jack of Clubs Lake

Jack of Clubs Lake is a deep oligotrophic lake. It is approximately 2.4 km long by 500 m wide and is up to 60 m deep. The depth increases gradually from the east end of the lake, moving away from the tailings beach. The western boundary of the lake is a large wetland complex with poorly defined channels, which is the Jack of Clubs Creek inlet into the lake. The eastern shoreline is a beach composed of fine-grained mill tailings from historic mining operations deposited between 1933 and 1967 (SNC Lavalin, 2011). Azimuth (2010) characterized substrate composition at the eastern shore as either soft and silty, clay/silt substrate with small amounts of gravel sparsely distributed on the lakebed. Bottom sediments were intermixed with organic material. Riparian area varies on each shore of the lake. On the eastern shoreline, there is little to no vegetation at the mine tailings. Near the Willow River, there is emergent grass, shrubs, and mixed young deciduous and coniferous trees near the outflow. Next to Highway 26, there is a steep embankment with a narrow band of vegetation consisting of disturbed grasses and coniferous trees. The south shore is a mature coniferous forest.

Good cover and in-lake structure for fish were present around the lake's littoral zone. Cover consisted primarily of sunken trees and occasionally large boulders. The abundance of cover was highest along the south shoreline where coniferous trees were growing to the edge of the lake, compared to the remainder of the lake that had minimal riparian vegetation. Three common substrate types were described in the lake. Most of the lakebed was a clay/silt substrate type dominating the deeper sections of the lake. A silt/sand combination was found along the shorelines in the northern section of the lake. A sand/gravel type was found throughout the lake, but mainly in the northern half of the lake. Substrate in the area near the proposed mine diffuser discharge location at the east end of the lake was mainly composed of a mix of sand and silt, with areas of sand and gravel and some clay and silt closer to shore.

7.9.3.4.1.4 Lowhee Creek Watershed

Lowhee Creek

Lowhee Creek has a large 14 m long log jam at the end of Reach 3 that currently prevents fish passage upstream. Fish habitat below the log jam is considered to be marginal and drains into a large wetland complex prior to its confluence with the Willow River. Fish habitat in the wetland complex in Reach 1.1 provides excellent rearing habitat due to abundant and variable cover, including deep pools, overhanging vegetation, and undercut banks. Spawning habitat is available where clean gravels and flows are optimum and was rated as moderate as the predominant substrate is fines and gravels. Overwintering habitat and migration were rated good. Upstream from the wetland complex, in

Reaches 1.2, 2, and 3, Lowhee Creek is characterized by riffle-pool morphology and with gravel and cobble substrates. Reaches 1.2 and 2 have shallow, low flows that limit fish habitat rearing, spawning, overwintering, and migration. Reach 3 provides a more suitable fish habitat and has good rearing habitat due to moderate cover and suitable depths and flows. Spawning substrates were lacking and were therefore rated as poor. Overwintering was also rated as poor due to the lack of deep pools. Migration was rated as moderate up until the log jam, which prohibits fish passage.

Fish habitat upstream from the log jam provides mostly rearing habitat; however, in Reach 3.5, the gradient becomes steep and may inhibit fish passage. The morphology is characterized by step-pools in Reaches 3.5, 4, and 5. Spawning habitat is limited due to the absence of gravels as the substrate is characterized by boulders and cobbles. Overwintering habitat is lacking as there are no deep pools in these upper reaches and likely reduced winter flows.

Lowhee Creek Tributaries

Tributaries to Lowhee Creek include F Road 0.1 Tributary, Core Shack 2 Tributary, and Watson Gulch. These tributaries are likely food and nutrient streams only and do not have suitable habitat for spawning, rearing, overwintering, or migration due to steep gradients and low flows.

7.9.3.4.1.5 Williams Creek Watershed

Williams Creek mainstem has critical and important fish habitat. Critical habitat was identified in Williams Creek Reach 1 and Reach 10. Important fish habitat is also available in Reach 1 of ILP24, Walker Gulch, Conklin Gulch, and Emory Gulch. Reaches 1 and 2 in Stouts Gulch also contain important fish habitat. Hospital Creek and associated ponds located within the tributaries also provide important habitat for fish in the Williams Creek watershed. The lower reaches of MacArthur Gulch, ILP22, ILP23, and ILP24 are accessible to fish and provide moderate fish habitat. For full details on fish habitat in Walker Gulch, Conklin Gulch, MacArthur Gulch, ILP-21, ILP- 22, ILP-23, ILP-24, and Hospital Creek refer to Appendix 7.9-2.

Williams Creek

Reaches 1 and 2 of Williams Creek are characterized by riffle-pool morphology and gravel and fines substrate. Fish habitat for spawning, rearing, overwintering, and migration are all available. Cover for rearing includes overhanging vegetation, deep pools, undercut banks, and instream vegetation. Some beaver dams were noted in Reach 2. Reach 5 and 6 of Williams Creek are characterized by riffle-glide morphology and cobble and gravel substrate. Some fines were also noted in Reach 5. These reaches have low flow, which may inhibit migration to suitable habitat. Rearing fish habitat was rated as good when flows are sufficient, with overhanging vegetation, deep pools, and boulders noted for cover. Spawning habitat for salmonids is also available when flows are sufficient and was rated as moderate. Reach 10 and Reach 11 are characterized by riffle-glide morphology with cobbles and boulder substrate. Reach 10 had critical spawning and migration habitat and moderate rearing and overwintering habitat. Critical habitat was identified by the presence of suitable areas of gravels, flow, depth, and cover. Cover for fish is provided by overhanging vegetation and boulders. In 2016, spawning Rainbow Trout were observed in Reach 10 just below the confluence with Stouts Gulch (Figure 7.9-9). Reach 11 has trace amounts of cover for fish and mostly cobble substrate, which may be too large for salmonids to spawn. Spawning, rearing, and migration habitat were rated as moderate and overwintering habitat was rated as poor due to the lack of deep pools.

Stouts Gulch

Reaches 1 to 3 of Stouts Gulch are fish-bearing. Stouts Gulch Reach 1 is composed of cascade-pool morphology and is occasionally confined. Substrate is predominantly cobble with gravel. Gradients range from 4 to 7%. Abundant total cover is provided by overhanging vegetation, with deep pools and instream vegetation. Rearing habitat is rated as good due to the presence of pools and boulder refuge. Spawning habitat is rated as moderate due to the presence of some gravels near the mouth, and overwintering habitat is rated as poor due to the limited number of deep pools. In 2016, Rainbow Trout were observed spawning at the upper end of Reach 1 of Stouts Gulch (Figure 7.9-9). Migratory habitat is rated as poor due to the presence of a hung culvert where the Cariboo Wagon Trail crosses Stouts Gulch, near the downstream end of the reach, but the presence of fish indicates that fish are able to pass during suitable flows.

Stouts Gulch Reach 2 runs southeast from Emory Gulch. Reach 2 is composed of cascade-pool morphology and is occasionally confined. Gradients range from 6% to 12%. Abundant total cover is provided by deep pools, with overhanging vegetation and undercut banks. Rearing habitat is rated as good due to the presence of abundant and variable cover, with deep pools. Spawning habitat is rated as moderate due to limited gravel substrate, and the overwintering habitat is rated as good due to the presence of some deep pools. Migratory habitat is rated as good, with some steeper gradients noted, but no barriers or obstructions are present within the reach.

Stouts Gulch Reach 3 runs southeast from the Bonanza Ledge Site downstream to its confluence with Emory Gulch. Reach 3 is composed of riffle-pool morphology and is occasionally confined. Substrate is predominantly cobble with gravel. Gradients range from 5 to 20%. Abundant total cover is provided by overhanging vegetation, with SWD and undercut banks. Rearing habitat is rated as moderate due to the presence of variable cover and some shallow pools. Spawning habitat is rated as poor due to the substrate not being conducive to spawning. Overwintering habitat is rated as poor due to the lack of deep pools and low flow volume. Migratory habitat was rated as moderate due to the low flow volume, with no physical obstructions observed. At the beginning of Reach 4, a bedrock cascade and steep gradient prevent upstream access into Reach 4.

Emory Gulch

Emory Gulch Reach 1 is composed of step-pool morphology and is frequently confined. Substrate is predominantly cobble with gravel. Gradients range from 8 to 13%. Abundant total cover is provided by overhanging vegetation, with boulder and deep pools. Rearing habitat is rated as good due to the presence of variable cover, deep pools, and optimum depths and flows. Spawning habitat is rated as moderate due to some gravel patches, and overwintering habitat is rated as excellent due to the presence of some very deep pools. Migratory habitat is rated as moderate due to the steep gradient. At the beginning of Reach 2, a bedrock cascade and steep gradients prevent upstream access into Reach 2.

7.9.3.4.1.6 Slough Creek Watershed

Slough Creek is a separate sub-catchment to the Jack of Clubs watershed. The headwaters begin at Tucker Lake, immediately west of Jack of Clubs Lake. Only the upper reaches (Reaches 4 to 8) are located within the Mine Site LAA. These reaches have fish habitat that is considered important to fish.

The main tributary to Slough Creek is Promise Creek, and only the lower reach (Reach 1) has important habitat value. For full details on Slough Creek watershed fish habitat refer to Appendix 7.9-2.

7.9.3.4.1.7 Quesnel River Watershed

Important fish habitat was only identified in Maud Creek and Rudy Creek. None of the habitat in the creeks is considered excellent, but good spawning, rearing, and migration habitat has been noted in most of the reaches surveyed in Maud Creek and Rudy Creek (Table 7.9-10). Only moderate overwintering habitat exists in Sandy Lake and Reach 13 of Maud Creek. Creek #2, #2.5, and #3 lack flow and are very steep.

Maud Creek

Both Reach 11 and Reach 13 of Maud Creek are composed of riffle-pool habitat. Upstream from the confluence of Rudy Creek, Reach 13 has boulder and cobble substrate with gradients ranging between 3% and 6%. Reach 13 has abundant cover with overhanging vegetation, LWD, and SWD. Rearing, migrating, and overwintering habitat is considered moderate, and spawning habitat was considered poor due to large sections of fines, with small gravel patches throughout. Reach 11 downstream from the confluence with Rudy Creek has fines and gravel substrate with a similar gradient to Reach 13. Habitat in Reach 11 was rated higher (good) for rearing, spawning, and migration, but overwintering was rated as poor due to a lack of deep pools.

Rudy Creek

Reach 7 and Reach 1 of Rudy Creek are characterized by riffle-pool morphology. Reach 7 upstream of Sandy Lake has predominantly gravel and cobbles substrate, with gradients between 1 and 5% within the reach. An abundance of cover is provided in Reach 7, predominantly by overhanging vegetation, with LWD, SWD, and undercut banks. Rearing habitat is rated as good, having overhanging vegetation as cover and undercut banks throughout. Spawning habitat is rated as good below a 1.25 m high cascade that is located 64 m from the downstream end of the site, with suitable spawning gravel present. Overwintering habitat is rated as poor due to the lack of deep pools, and migratory habitat is rated as poor as there were no fish caught upstream of the cascade. The cascade is likely an obstruction but is potentially passable by fish during higher flows.

Sandy Lake is a relatively shallow lake with a northeast aspect and sparse emergent vegetation consisting mainly of sedge and cattails. Submergent vegetation and floating algae were not observed. Riparian vegetation consisted of mixed forest and shrubs.

Reach 1 downstream of Sandy Lake has substrate and is predominantly gravel and fines. Gradient is measured to be 2% within the reach. An abundance of cover is provided in Reach 1, predominantly by overhanging vegetation, with LWD and SWD. Rearing habitat is rated as moderate due to the amount of cover. Spawning habitat is rated as poor due to the large sections of fines, with small gravel patches throughout. Overwintering habitat is rated as poor due to the lack of deep pools, and migratory habitat is rated as moderate as there were no obstructions to fish noted.

Creeks #2, #2.5, and #3

Creeks #2, #2.5, and #3 are characterized by steep gradients (18 to 70%), with intermittent scour and flows. Substrates are large, either cobbles or boulders, and channel definition is intermittent. No connectivity to the Quesnel River was identified in Creek #2.5 or Creek #3. Due to the low flows, lack of connectivity, and steep gradients, these watercourses are assumed to be non-fish-bearing.

7.9.3.4.1.8 Transmission Line Corridor

There are 64 potential watercourse crossings along the Transmission Line route, including crossings along six access roads that may require upgrades. Out of the 56 watercourse crossings assessed in July 2020 and 2021 along the Transmission Line route, 15 sites were determined to have no fish habitat (habitat quality determined as None; Table 7.9-11, Figure 7.9-10). All of these sites are small unnamed watercourses. There were 22 sites that had marginal habitat quality, 17 sites that had important habitat quality, and two sites that had habitat quality deemed as critical (Table 7.9-11, Figure 7.9-10). The critical habitat sites are located at John Boyd Creek and the Cottonwood River.

Table 7.9.11 Summary of Habitat Quality Ratings for Fish at Watercourse Crossings along the Transmission Line

Watershed	None	Marginal	Important	Critical	Total Sites Assessed	Not assessed	Total Sites
Quesnel	-	-	-	-	0	5	5
Cottonwood	3	8[3]	5[1]	2	18	2	20
Willow River	12	14[1]	12[1]	0	38	0	38
Total Sites	15	22	17	2	56	7	63

Note: Superscript number indicates number of access road watercourse crossings.

Critical Habitat

The Cottonwood River is the largest fish-bearing watercourse along the Transmission Line route. It provides good spawning and rearing habitat, with excellent overwintering and migration habitat. The crossing location is a large channel with consistent riffle habitat. Deep pools were the dominant cover type, and boulders were the subdominant cover type.

John Boyd Creek provides high quality fish habitat, with excellent rearing, overwintering, and migration habitat. Spawning habitat in John Boyd Creek was good, with patches of suitable spawning gravel throughout the assessed section of the watercourse. The dominant cover type in John Boyd Creek was deep pool habitat, and subdominant cover was from boulders.

Both crossing locations had an average gradient of 2%.

538000 540000 542000 544000 546000

5880000 5878000 5876000 5874000 5872000

97 26

KP 0 KP 1 KP 2 KP 3 KP 4 KP 5 KP 6 KP 7 KP 8 KP 9 KP 10 KP 11 KP 12

B3-2135 B3-3070 B3-3836 B3-3906 B3-4424

Thirteen Mile Lake

Quesnel River

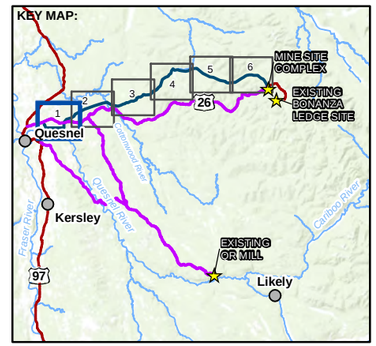
LEGEND

HABITAT QUALITY
- CRITICAL
- IMPORTANT
- MARGINAL
- NOT ASSESSED
- NONE

FISH BEARING
- YES
- NO
- UNKNOWN

- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
- WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- BARLOW SUBSTATION
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE ACCESS ROAD (EXISTING)
- PROPOSED TRANSMISSION LINE ACCESS ROAD (UPGRADE)
- PROPOSED TRANSMISSION LINE CORRIDOR
- PROPOSED MINE SITE SURFACE INFRASTRUCTURE
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA

KEY MAP:



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UTM Zone 10N

0 1 2

1:35,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE WATER CROSSING HABITAT QUALITY

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE: 1 of 6 | FIGURE 7.9-10

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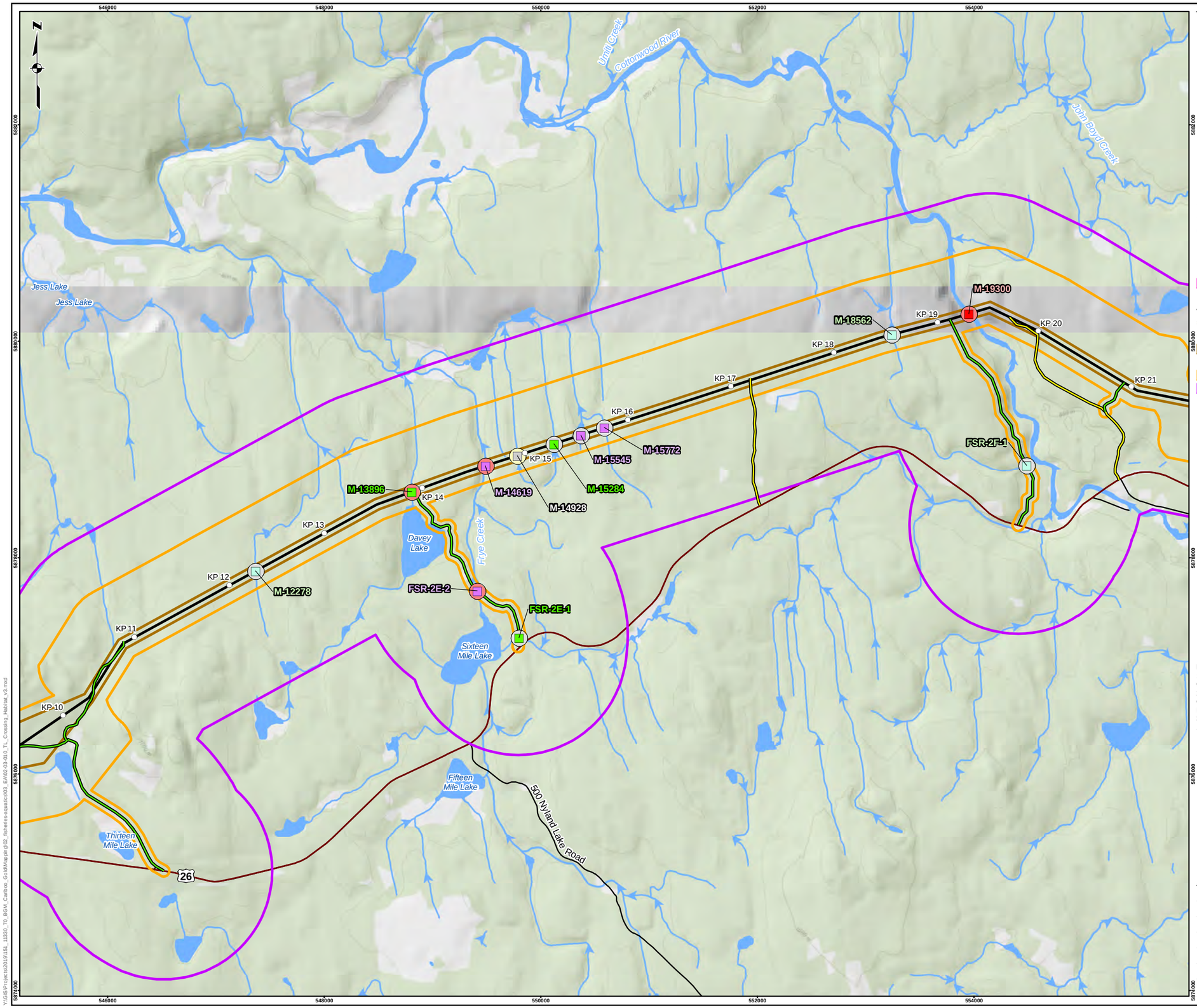
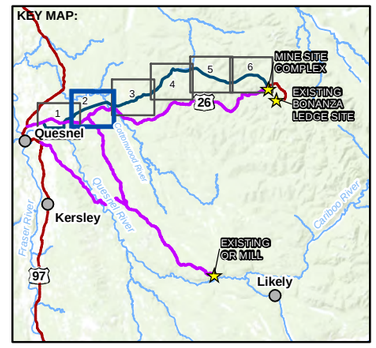


LEGEND

HABITAT QUALITY
- CRITICAL
- IMPORTANT
- MARGINAL
- NOT ASSESSED
- NONE

FISH BEARING
- YES
- NO
- UNKNOWN

- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
- WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- BARLOW SUBSTATION
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE ACCESS ROAD (EXISTING)
- PROPOSED TRANSMISSION LINE ACCESS ROAD (UPGRADE)
- PROPOSED TRANSMISSION LINE CORRIDOR
- PROPOSED MINE SITE SURFACE INFRASTRUCTURE
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA



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NAD83 CSRS
UTM Zone 10N

0 1 2
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OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE WATER CROSSING HABITAT QUALITY

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE: 2 of 6 | FIGURE 7.9-10

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5886000 5884000 5882000 5880000 5878000

N

Stacey Creek

Alice Creek

Mary Creek

John Boyd Creek

Coldspring Lake

Hyde Lake

Cottonwood River

M-32997

KP 33

KP 32

M-30587

KP 31

KP 30

M-29865

M-29647

KP 29

KP 28

M-26515

KP 27

KP 26

M-26831

KP 25

M-25595

KP 24

M-24744

M-22045

KP 22

KP 23

M-22485

26

LEGEND

HABITAT QUALITY
- CRITICAL
- IMPORTANT
- MARGINAL
- NOT ASSESSED
- NONE

FISH BEARING
- YES
- NO
- UNKNOWN

- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
- WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
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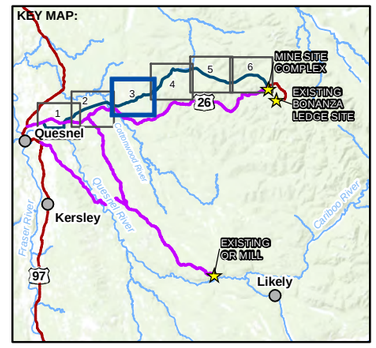
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA

KEY MAP:



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NAD83 CSRS
UTM Zone 10N

0 1 2

1:35,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE WATER CROSSING HABITAT QUALITY

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70
PHASE 00
PAGE: 3 of 6
FIGURE 7.9-10

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566000 568000 570000 572000 574000 576000

5890000 5888000 5886000 5884000 5882000

N

Aura Find Creek
Tregillus Creek
Ruchaun Creek
Hyde Creek
Mask Creek
Four Mile Lake
Beaverpass Creek

M-41041
M-41354
M-41428
M-41506
M41506A
M-40869
KP 41
KP 42
KP 43
KP 44
KP 45
KP 46
M-44179
M-45802
M-44489
M-45179
M-40329
40A
KP 40
M-39812
KP 39
M-39192
KP 38
M-37379
KP 37
M-36414
KP 36
KP 35
KP 34
M-32997
KP 33

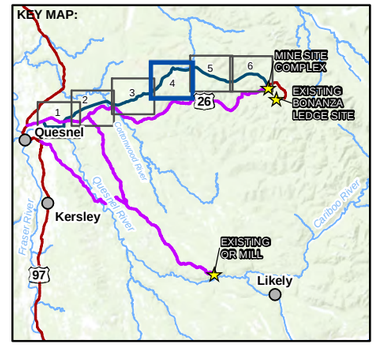
LEGEND

HABITAT QUALITY
- CRITICAL
- IMPORTANT
- MARGINAL
- NOT ASSESSED
- NONE

FISH BEARING
- YES
- NO
- UNKNOWN

- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
- WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- BARLOW SUBSTATION
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE ACCESS ROAD (EXISTING)
- PROPOSED TRANSMISSION LINE ACCESS ROAD (UPGRADE)
- PROPOSED TRANSMISSION LINE CORRIDOR
- PROPOSED MINE SITE SURFACE INFRASTRUCTURE
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA

KEY MAP:



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NAD83 CSRS
UTM Zone 10N

0 1 2
1:35,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE WATER CROSSING HABITAT QUALITY

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70
PHASE 00
PAGE: 4 of 6
FIGURE 7.9-10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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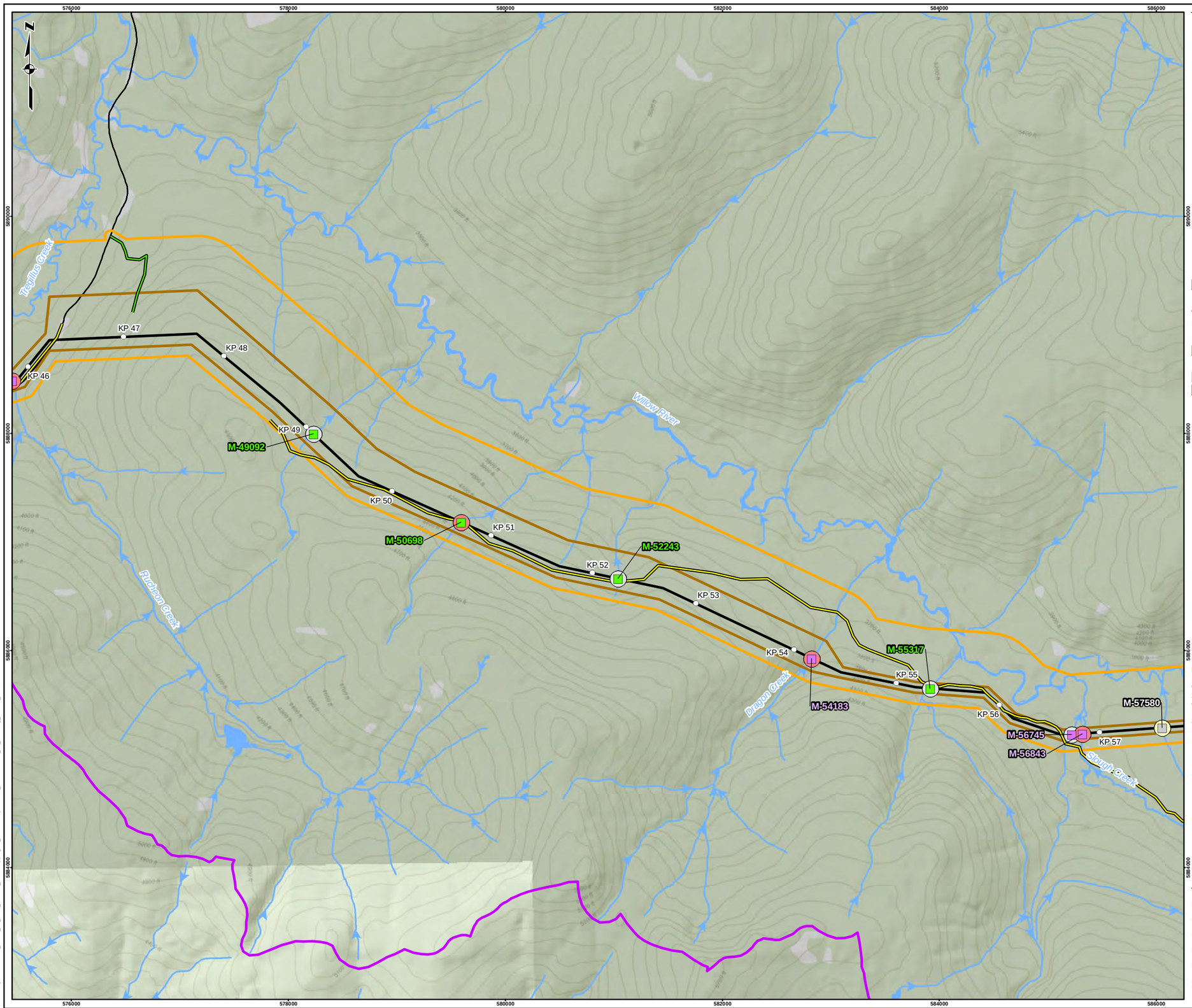


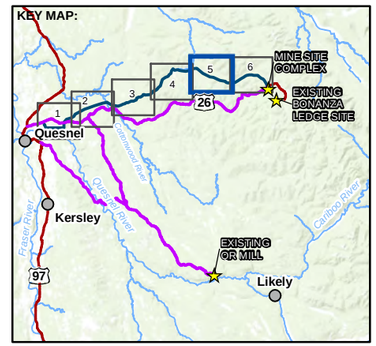
LEGEND

HABITAT QUALITY
- CRITICAL
- IMPORTANT
- MARGINAL
- NOT ASSESSED
- NONE

FISH BEARING
- YES
- NO
- UNKNOWN

- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
- WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- BARLOW SUBSTATION
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE ACCESS ROAD (EXISTING)
- PROPOSED TRANSMISSION LINE ACCESS ROAD (UPGRADE)
- PROPOSED TRANSMISSION LINE CORRIDOR
- PROPOSED MINE SITE SURFACE INFRASTRUCTURE
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA

KEY MAP:



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NAD83 CSRS
UTM Zone 10N

0 1 2
1:35,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE WATER CROSSING HABITAT QUALITY

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO.	PHASE	PAGE:	FIGURE
151-11330-70	00	5 of 6	7.9-10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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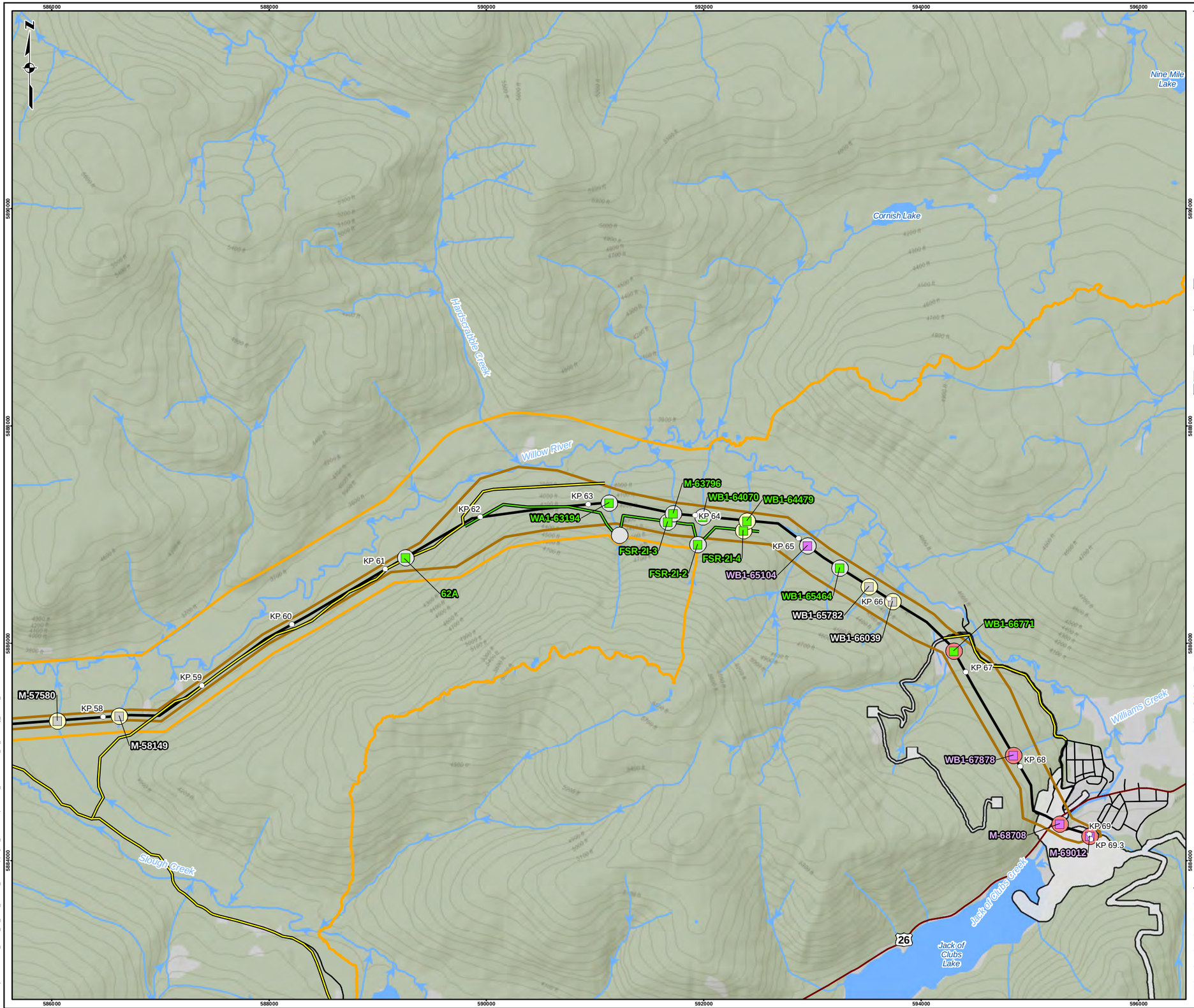

LEGEND

HABITAT QUALITY
- CRITICAL
- IMPORTANT
- MARGINAL
- NOT ASSESSED
- NONE

FISH BEARING
- YES
- NO
- UNKNOWN

- POPULATED COMMUNITY
- HIGHWAY
- EXISTING ACCESS ROADS
- FLOW DIRECTION
- WATERCOURSE
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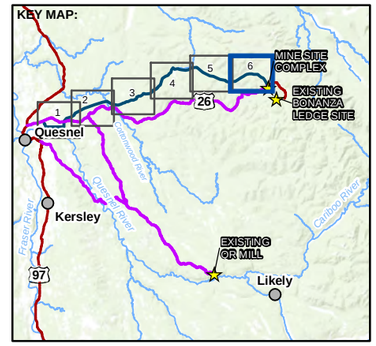

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3. INSET BASE SOURCE: ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS.

NAD83 CSRS
UTM Zone 10N

0 1 2
1:35,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

TRANSMISSION LINE WATER CROSSING HABITAT QUALITY

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE: 6 of 6 | FIGURE 7.9-10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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Important Habitat

Seventeen watercourse crossings have important habitat. Five of the crossings are located on unnamed watercourses. Named watercourses with important habitat include Frye Creek, Alice Creek, Hyde Creek, Aura Fina Creek, Tregillus Creek, Rucheon Creek, Dragon Creek, New Creek, Slough Creek, Peeps O'Day Creek, Lowhee Creek, and the Willow River. It should be noted that the Lowhee Creek crossing is actually located 200 m away from the Transmission Line right-of-way (ROW), as it has been previously diverted and does not follow the historical route as mapped in the Freshwater Atlas (FWA) and is a mapping error.

The crossing locations characterized as Important provided moderate or good spawning, rearing, overwintering, and migration habitat, except Dragon Creek which had poor spawning, rearing, and overwintering habitat and moderate migration habitat. Generally, the average gradient at the 17 watercourses was between 2 to 9%. Of the Important habitat crossing locations, fish have historically been documented within eleven of the watercourses, and Golder captured fish at eight crossing locations in 2016 and 2021.

Marginal Habitat

Twenty-two crossing locations have Marginal fish habitat. Of these 22 sites, 18 are located on unnamed watercourses. Named watercourses with Marginal habitat include Julius Creek, Albrecht Creek, Montgomery Creek, and Mosquito Creek.

The majority of the total assessed crossing locations were classified as Marginal habitat. These watercourses generally fit into one or more of the following three different categories that reduced the quality of overall habitat present:

- Steep average gradients of 13 to 60% with cascade habitat features;
- Shallow water depths that limited the quality of rearing, migration, and overwintering habitat; and
- Wetland complexes that limited fish migration potential.

Fish have been historically identified in four of the 22 crossing locations that were classified as providing Marginal fish habitat.

No Fish Habitat

Fourteen of the watercourse crossings were considered to have no fish habitat. They are all located on unnamed watercourses.

These crossing locations provided no fish habitat, were NCDs, and did not have continuous channels. These crossings are assumed to be non-fish-bearing at the crossing location and did not have a connection to potential upstream or downstream habitat (if present). These NCDs were typically from road ditches that dissipated into a vegetated area with very low gradient. Migration potential at these crossing locations was nonexistent, and water depths were typically not sufficient to support resident fish populations.

7.9.3.4.2 Aquatic Resources

7.9.3.4.2.1 Jack of Clubs Creek Watershed

- **Lotic Stations**: The benthic community in Stoney Creek, Victoire Creek, and Jack of Clubs Creek was dominated by Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa or similar proportions of EPT taxa and chironomids, and classified by the CABIN Reference Condition Approach (RCA) analysis as similar to reference. The periphyton community was dominated by cyanobacteria and mean chlorophyll *a* concentrations were below the BC WQG. Concentrations of metals in benthic invertebrate tissues were generally similar among stations, except for zinc, which was higher in tributary stations (Victoire Creek and Stoney Creek) than in mainstem stations. Concentrations of selenium did not exceed the dietary WQG in benthic invertebrate tissues, except in Jack of Clubs Creek in 2018. Concentrations of metals in periphyton tissue were lower in samples collected from tributary stations than mainstem stations.

7.9.3.4.2.2 Jack of Clubs Lake Watershed

- **Lentic Stations**: The benthic invertebrate community in the Willow River at the outlet of Jack of Clubs Lake is variable; in some years, it did not have a benthic community, and in other years, it was dominated by chironomids. The phytoplankton chlorophyll *a* concentration in the water column at the outlet of the lake indicated the habitat was oligotrophic. Concentrations of several metals (arsenic, iron, mercury, lead, silver) in benthic invertebrate and periphyton tissue were higher than at lotic stations in the Jack of Clubs watershed. For benthic invertebrate tissue, concentrations of metals were similar to or lower than concentrations in Jack of Clubs Lake. The dietary WQG for selenium was not exceeded in benthic invertebrate tissue samples.
- **Jack of Clubs Lake Stations**: Consistent with historical data, benthic invertebrate density and family level richness were lower in the northeast end of the lake, which is closest to the shoreline with exposed tailings and bioavailable metals. The benthic community in Jack of Clubs Lake was dominated by chironomids and Veneroida (freshwater clams) or, in the northeast portion of the lake Diptera (excluding Chironomidae), Amphipoda, and Chironomidae. The phytoplankton community was dominated by chrysophytes and cryptophytes, and chlorophyll *a* concentrations indicated the lake was oligotrophic. The zooplankton community was dominated by rotifers. Concentrations of metals in benthic invertebrate tissue were variable throughout the lake, but concentrations were generally higher than measured at lotic or lentic stations with the LAA. The dietary WQG for selenium was exceeded in benthic invertebrate tissues from the middle and south end of the lake.

7.9.3.4.2.3 Lowhee Creek Watershed

The benthic community in Lowhee Creek was dominated by EPT taxa and classified by the CABIN RCA analysis as similar to or mildly divergent from the reference condition, depending on the year and specific exposure station. The periphyton community was dominated by diatoms and chlorophytes upstream and chrysophytes and cyanobacteria downstream. Mean chlorophyll *a* concentrations were below the BC WQG. Concentrations of metals in benthic invertebrate tissues were generally similar among stations, and concentrations of selenium in benthic invertebrate tissues did not exceed the dietary WQG, except in lower Lowhee Creek in 2018. Concentrations of metals in periphyton tissue were generally higher at the upstream station near the existing Bonanza Ledge Site compared to the downstream stations.

7.9.3.4.2.4 Stouts Gulch Watershed

The benthic community in Stouts Gulch was dominated by EPT taxa. The CABIN RCA analysis classified the benthic community as similar to or mildly divergent from the reference depending on the year. The periphyton community was dominated by cyanobacteria upstream near the Bonanza Ledge Site and by diatoms downstream near the confluence with Williams Creek, and mean chlorophyll *a* concentrations were below the BC WQG. Concentrations of metals in benthic invertebrate tissues were generally similar among stations, and the dietary WQG for selenium was not exceeded. Concentrations of metals in periphyton tissue were generally higher at the downstream station relative to the upstream station, except for chromium.

7.9.3.4.2.5 Williams Creek Watershed

- **Lotic Stations**: The benthic community was dominated by chironomids at the Conklin Gulch station and EPT taxa at Williams Creek and other tributary stations. The CABIN RCA analysis classified the benthic community as similar to the reference (Williams Creek near Barkerville), mildly divergent from the reference (Conklin Gulch), or divergent from the reference (Williams Creek near the confluence with the Willow River). The periphyton community and mean chlorophyll *a* concentrations were variable between stations. The mean chlorophyll *a* concentration in Conklin Gulch was at the BC WQG. Concentrations of metals in benthic invertebrate tissue were generally higher at downstream stations than upstream and tributary stations, and the dietary WQG for selenium was not exceeded, except at an upstream tributary and near the outlet. Concentrations of metals in periphyton tissue were generally similar among stations.
- **Lentic Stations**: The benthic community in the lentic stations was dominated by chironomids or Order Tubificida (*oligochaete worms*). Phytoplankton chlorophyll *a* concentrations in the water column indicated the habitat was oligotrophic at all three stations. Concentrations of metals in benthic invertebrate tissue were generally higher in the northern end of the wetland sampled compared to the southern end of the wetland and Weldon Lake and the dietary WQG for selenium was not exceeded. Concentrations of metals in periphyton tissue were generally higher in the wetland sampled than in Weldon Lake.

7.9.3.4.2.6 Willow River Watershed

The benthic community at stations in the Willow River watershed was dominated by EPT taxa, except for stations adjacent to Wells and downstream of the Mosquito Creek confluence, where chironomids were the dominant taxa. The CABIN RCA analysis classified the benthic community as mildly divergent from the reference condition at all stations in the watershed, except for the benthic community at the upstream station adjacent to Wells, which was classified as similar to reference. The periphyton community was dominated by diatoms upstream and cyanobacteria and chlorophytes downstream. The mean chlorophyll a concentration was below the BC WQG. Concentrations of metals in benthic invertebrates were generally higher in upstream and tributary stations than in stations downstream of Mosquito Creek. The dietary WQG for selenium was not exceeded in benthic invertebrate tissues. Concentrations of metals in periphyton were generally higher in the tributary station than in mainstem stations.

7.9.3.4.2.7 Quesnel River Watershed

The following summarizes existing conditions information obtained from lotic, lentic, and lake stations within the small portion of the Quesnel River watershed occupied by the QR Mill LAA.

- **Lotic Stations**: The benthic communities in the Quesnel River and its tributaries were dominated by EPT taxa, except in Rudy Creek, where chironomids were dominant. The CABIN RCA analysis classified the benthic community as similar to reference. The mean chlorophyll *a* concentrations were variable between stations. The periphyton community was dominated by chlorophytes, diatoms, or cyanobacteria, depending on the watercourse. Concentrations of metals in benthic invertebrate tissues were generally lower in samples collected from tributary stations than mainstem stations, except for mercury and zinc, which were higher in tributary stations than in mainstem stations. Concentrations of selenium did not exceed the dietary WQG in benthic invertebrate tissues. Concentrations of metals in periphyton tissue were variable between tributary stations and mainstem stations.
- **Lentic Station**: The benthic community in Creek #3 wetland was dominated by non-biting midges. Concentrations of metals in benthic invertebrate tissue were within the range of metal concentrations in lotic and lake stations in the LAA. The dietary WQG for selenium was exceeded. For periphyton tissue, concentrations of metals were similar to or lower than concentrations in lotic and lake stations in the Quesnel River watershed.
- **Lake Stations**: The benthic communities in lake stations in the LAA were dominated by non-biting midges. The phytoplankton community was dominated by chlorophytes and dinoflagellates at a reference lake and by chrysophytes and diatoms at Sandy Lake. Chlorophyll *a* concentrations indicated that Sandy Lake was mesotrophic, and Unnamed Lake was between mesotrophic and eutrophic. The zooplankton community was dominated by rotifers and dipterans at Unnamed Lake and cyclopoid copepods at Sandy Lake. Concentrations of metals in benthic invertebrate and periphyton tissue were generally higher in a reference lake than in Sandy Lake. The dietary WQG for selenium in benthic invertebrate tissue was exceeded at both lake stations.

7.9.3.4.3 Fish

7.9.3.4.3.1 Fish Species Presence at the Mine Site

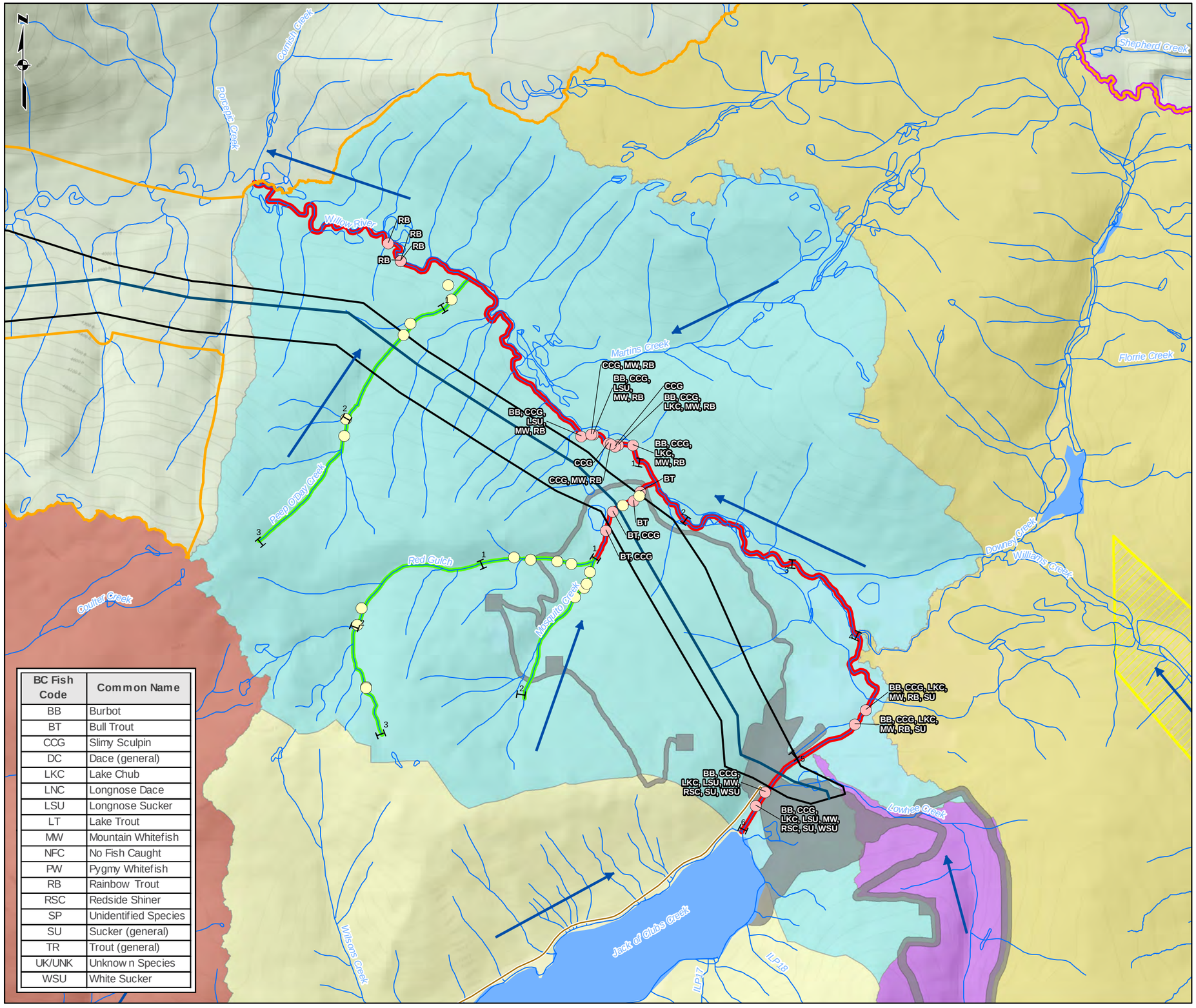
Fish known to be present in the Mine Site LAA are presented in Table 7.9-12, Figure 7.9-11. Only resident fish species occur within the Mine Site LAA. These include four salmonid species: Rainbow Trout, Bull Trout, Mountain Whitefish, Lake Trout (*Salvelinus namaycush*), and Pygmy Whitefish. There are three sucker species; Largescale Sucker (*Catostomus macrocheilus*), Longnose Sucker, and White Sucker. Slimy Sculpin (*Cottus cognatus*), Burbot, Lake Chub, Longnose Dace (*Rhinichthys cataractae*), and Redside Shiner (*Richardsonius balteatus*) were also captured.

Spawning and overwintering habitat limits fish distribution to the mainstems of many of the larger watercourses, including the Willow River, Williams Creek, Jack of Clubs Creek, and Slough Creek, or the lower reaches of smaller tributaries that flow into these watercourses (Figure 7.9-11). Most of the smaller tributaries are non-fish-bearing or have seasonal populations when water flow allows upstream access. During the spring and fall spawner surveys in the Willow River and Williams Creek, fish were only observed during the late spring through early fall, using the watercourses for spawning and rearing (Avery Creek Ltd, 2019).

Table 7.9.12 Fish Species Documented in the Cariboo Gold Project Area

Common Name	Scientific Name	BC Code	LAA/RAA	Jack of Clubs Creek		Jack of Clubs Lake		Williams Creek		Slough Creek		Willow River		Lowhee Creek		Quesnel		Transmission Line	Total No. of Watersheds within Mine Site	Total No. of Watersheds within QR Mill
				H	S	H	S	H	S	H	S	H	S	H	S	H	S			
Bull Trout	*Salvelinus confluentus*	BT	LAA/RAA	X	X	X	X	X	X	X	-	X	X	-	-	-	-	X	5	0
Burbot	*Lota lota*	BB	LAA/RAA	-	-	X	-	X	X	X	X	-	X	-	-	-	-	X	4	0
Chinook Salmon	*Oncorhynchus tshawytscha*	CH	RAA	-	-	-	-	-	-	-	-	X	-	-	-	X	-	X[1]	1	1
Chiselmouth	*Acrocheilus alutaceus*	CMC	RAA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	0	0
Coho Salmon	*Oncorhynchus kisutch*	CO	RAA	-	-	-	-	-	-	-	-	X	-	-	-	X	-	X[1]	1	1
Dolly Varden	*Salvelinus malma*	DV	RAA	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	0	1
Kokanee	*Oncorhynchus nerka*	KO	LAA/RAA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	0	0
Lake Chub	*Couesius plumbeus*	LKC	LAA/RAA	-	-	-	-	X	X	-	X	-	X	X	-	-	X	X	4	1
Lake Trout	*Salvelinus namaycush*	LT	LAA	-	-	X	X	-	-	-	-	-	-	-	-	-	-	X	1	0
Largescale Sucker	*Catostomus macrocheilus*	CSU	LAA	-	-	X	-	-	-	X	-	-	-	-	-	-	-	X	2	0
Leopard Dace	*Rhynichthys falcatus*	LDC	RAA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	0	0
Longnose Dace	*Rhinichthys cataractae*	LNC	LAA/RAA	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	1	0
Longnose Sucker	*Catostomus catostomus*	LSU	LAA/RAA	-	-	X	-	-	X	-	X	-	X	-	-	-	X	X	4	1
Mountain Whitefish	*Prosopium williamsoni*	MW	LAA/RAA	-	-	X	X	X	X	X	-	X	X	-	-	-	-	X	4	0
Northern Pikeminnow	*Ptychocheilus oregonensis*	NSC	LAA/RAA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	0	0
Peamouth Chub	*Mylocheilus caurinus*	PCC	RAA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	0	0
Pink Salmon	*Oncorhynchus gorbuscha*	PK	RAA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X[1]	0	0
Pygmy Whitefish	*Prosopium coulteri*	PW	LAA	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	1	0
Rainbow Trout	*Oncorhynchus mykiss*	RB	LAA/RAA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	6	1
Redside Shiner	*Richardsonius balteatus*	RSC	LAA/RAA	-	-	X	X	-	X	-	-	-	X	-	-	-	-	X	3	0
River Lamprey	*Lampetra ayresi*	RL	RAA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	0	0
Slimy Sculpin	*Cottus cognatus*	CCG	LAA/RAA	-	-	-	-	X	X	X	X	X	X	-	-	-	-	X	3	0
Sockeye Salmon	*Oncorhynchus nerka*	SK	RAA	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	0	1
Steelhead	*Oncorhynchus mykiss*	ST	RAA	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	0	1
White Sucker	*Catostomus commersoni*	WSU	LAA/RAA	-	-	-	X	X	X	X	X	-	X	X	-	-	-	X	4	0
Total				**2**	**2**	**9**	**6**	**7**	**9**	**7**	**7**	**6**	**9**	**3**	**1**	**6**	**3**	**23**	**15**	**8**

Notes: H = historical desktop information, S = surveyed by Golder in 2016, 2018, 2019, or 2021. - = not documented; X = documented; LAA = local assessment area; RAA = regional assessment area; BC = British Columbia; QR Mill = Quesnel River Mill; 1. Also occur in the LAA for the Transmission Line.



BC Fish Code	Common Name
BB	Burbot
BT	Bull Trout
CCG	Slimy Sculpin
DC	Dace (general)
LKC	Lake Chub
LNC	Longnose Dace
LSU	Longnose Sucker
LT	Lake Trout
MW	Mountain Whitefish
NFC	No Fish Caught
PW	Pygmy Whitefish
RB	Rainbow Trout
RSC	Redside Shiner
SP	Unidentified Species
SU	Sucker (general)
TR	Trout (general)
UK/UNK	Unknown Species
WSU	White Sucker

LEGEND

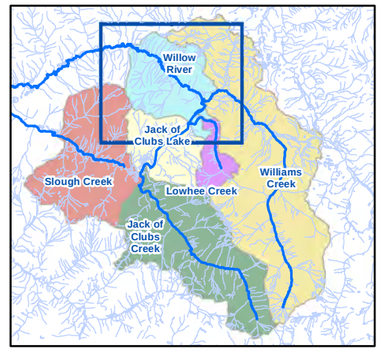
- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT
- FISH BEARING STREAM
- NON-FISH BEARING STREAM

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



REFERENCE(S)

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3. INSET BASE SOURCE: ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS.

NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:23,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

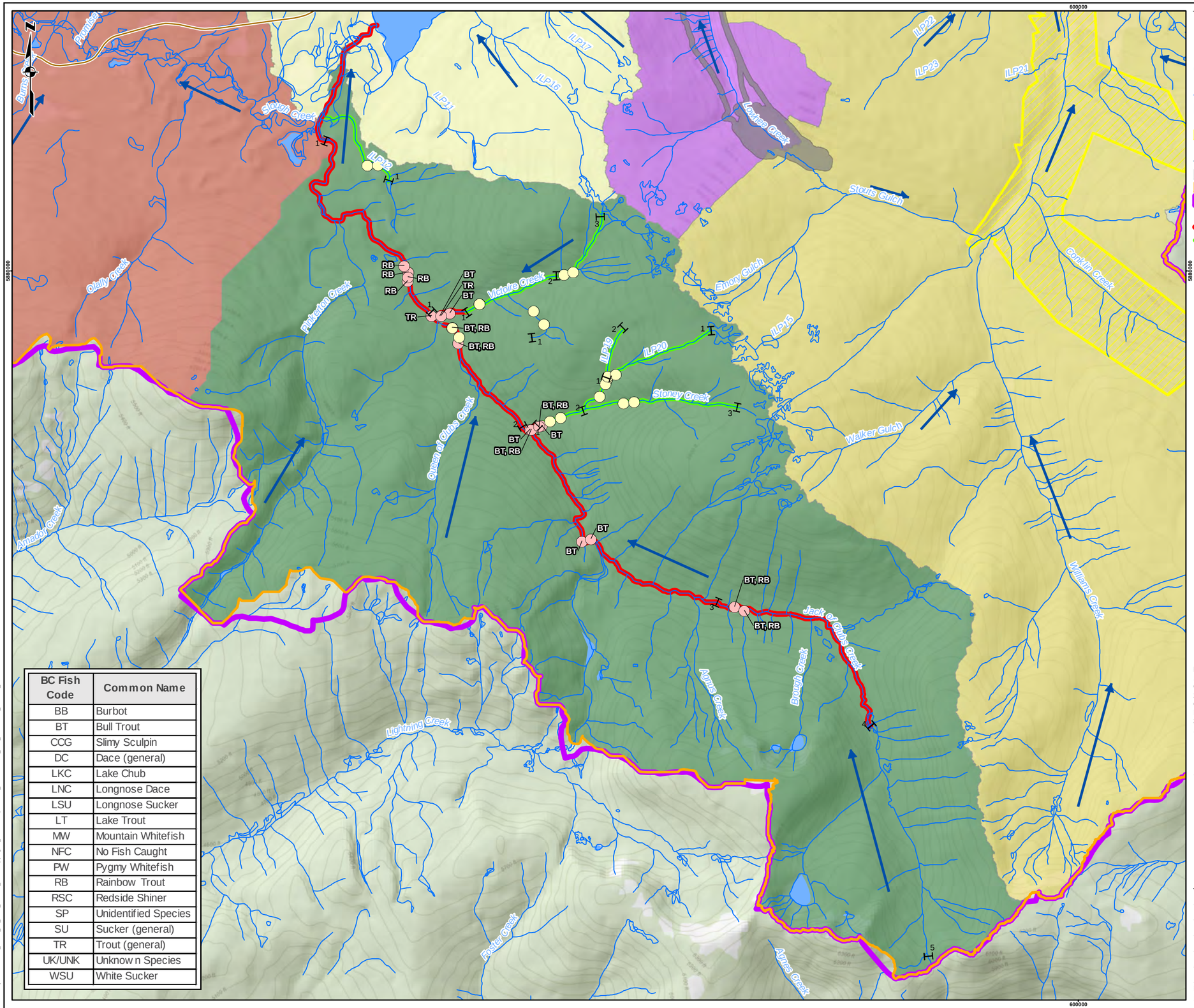
FISH DISTRIBUTION IN THE MINE SITE LOCAL ASSESSMENT AREA

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70
PHASE 00
PAGE: 1 of 8
FIGURE 7.9-11

Y:\GIS\Projects\2019\151_11330_70_BGM_Cariboo_Gold\Mapping\02_fisheries-aquatics\03_EA\02-03-009_Fish_Distribution_Minesite_v2.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B



BC Fish Code	Common Name
BB	Burbot
BT	Bull Trout
CCG	Slimy Sculpin
DC	Dace (general)
LKC	Lake Chub
LNC	Longnose Dace
LSU	Longnose Sucker
LT	Lake Trout
MW	Mountain Whitefish
NFC	No Fish Caught
PW	Pygmy Whitefish
RB	Rainbow Trout
RSC	Redside Shiner
SP	Unidentified Species
SU	Sucker (general)
TR	Trout (general)
UK/UNK	Unknown Species
WSU	White Sucker

LEGEND

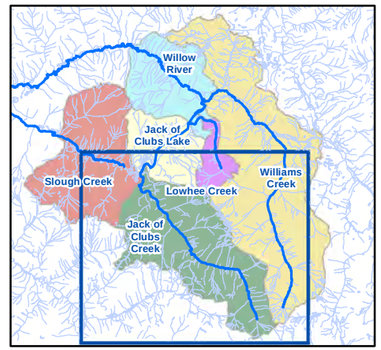
- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT
- FISH BEARING STREAM
- NON-FISH BEARING STREAM

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



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NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:37,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

FISH DISTRIBUTION IN THE MINE SITE LOCAL ASSESSMENT AREA

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE: 2 of 8 | FIGURE 7.9-11

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

0

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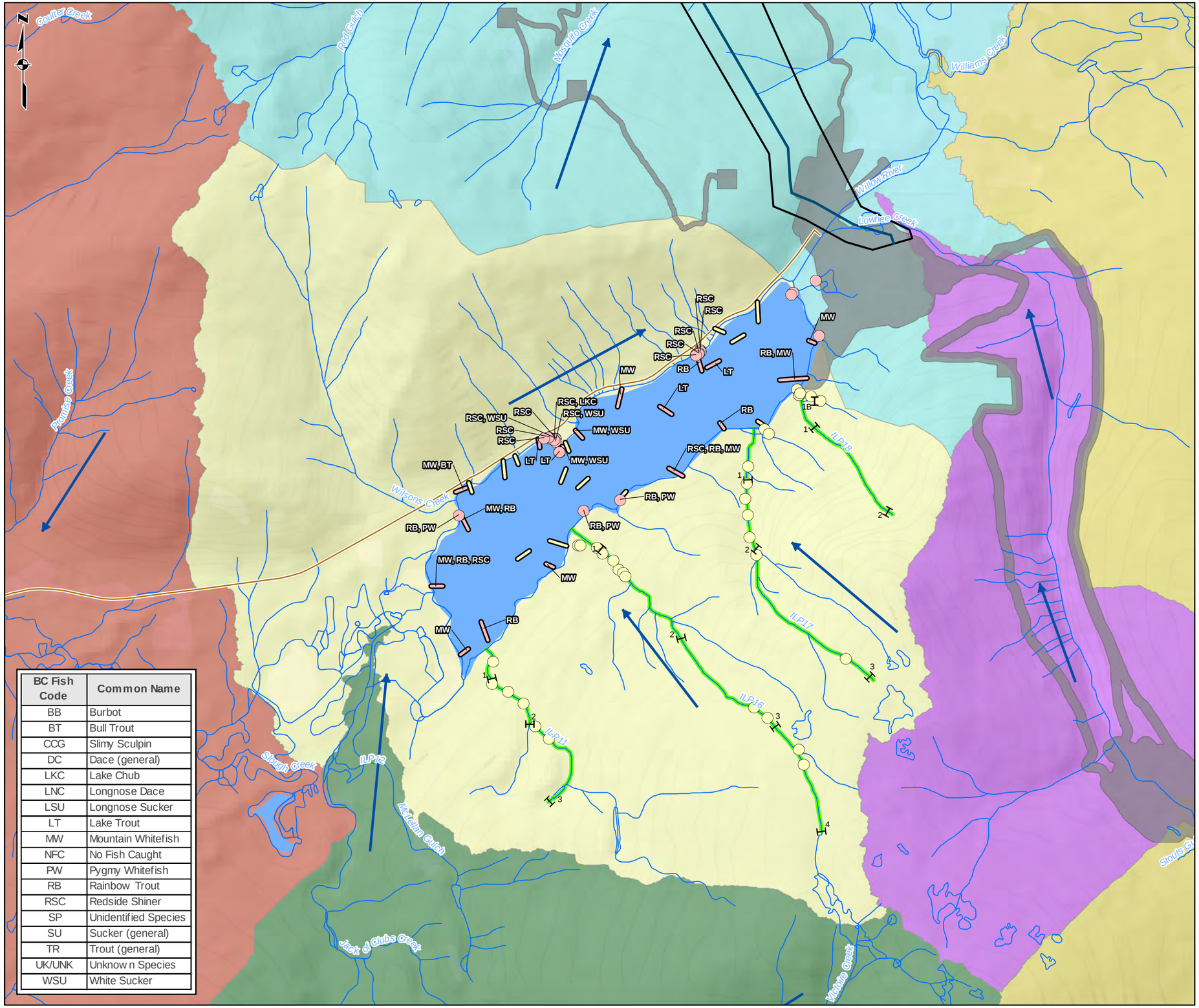

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RSC	Redside Shiner
SP	Unidentified Species
SU	Sucker (general)
TR	Trout (general)
UK/UNK	Unknown Species
WSU	White Sucker

LEGEND

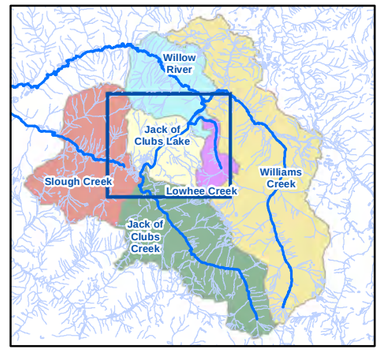
- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT
- FISH BEARING STREAM
- NON-FISH BEARING STREAM

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



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3. INSET BASE SOURCE: ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS.

NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:20,000 KILOMETRES

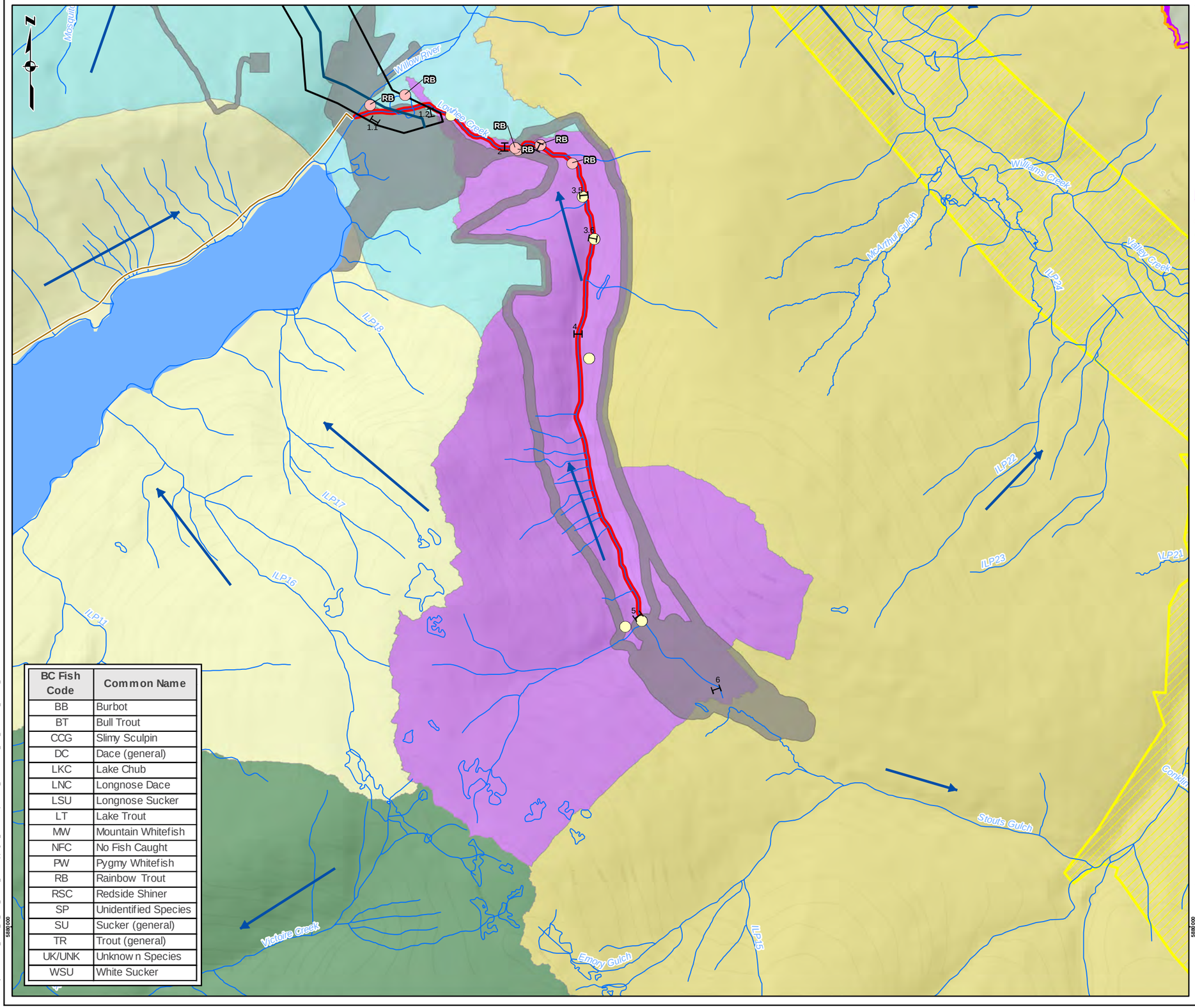
OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

FISH DISTRIBUTION IN THE MINE SITE LOCAL ASSESSMENT AREA

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70
PHASE 00
PAGE: 3 of 8
FIGURE 7.9-11



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LEGEND

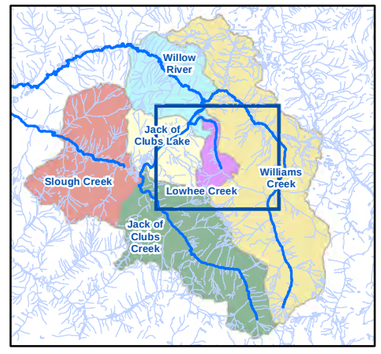
- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT
- FISH BEARING STREAM
- NON-FISH BEARING STREAM

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



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3. INSET BASE SOURCE: ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS.

NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:20,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

FISH DISTRIBUTION IN THE MINE SITE LOCAL ASSESSMENT AREA

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70
PHASE 00
PAGE: 4 of 8
FIGURE 7.9-11

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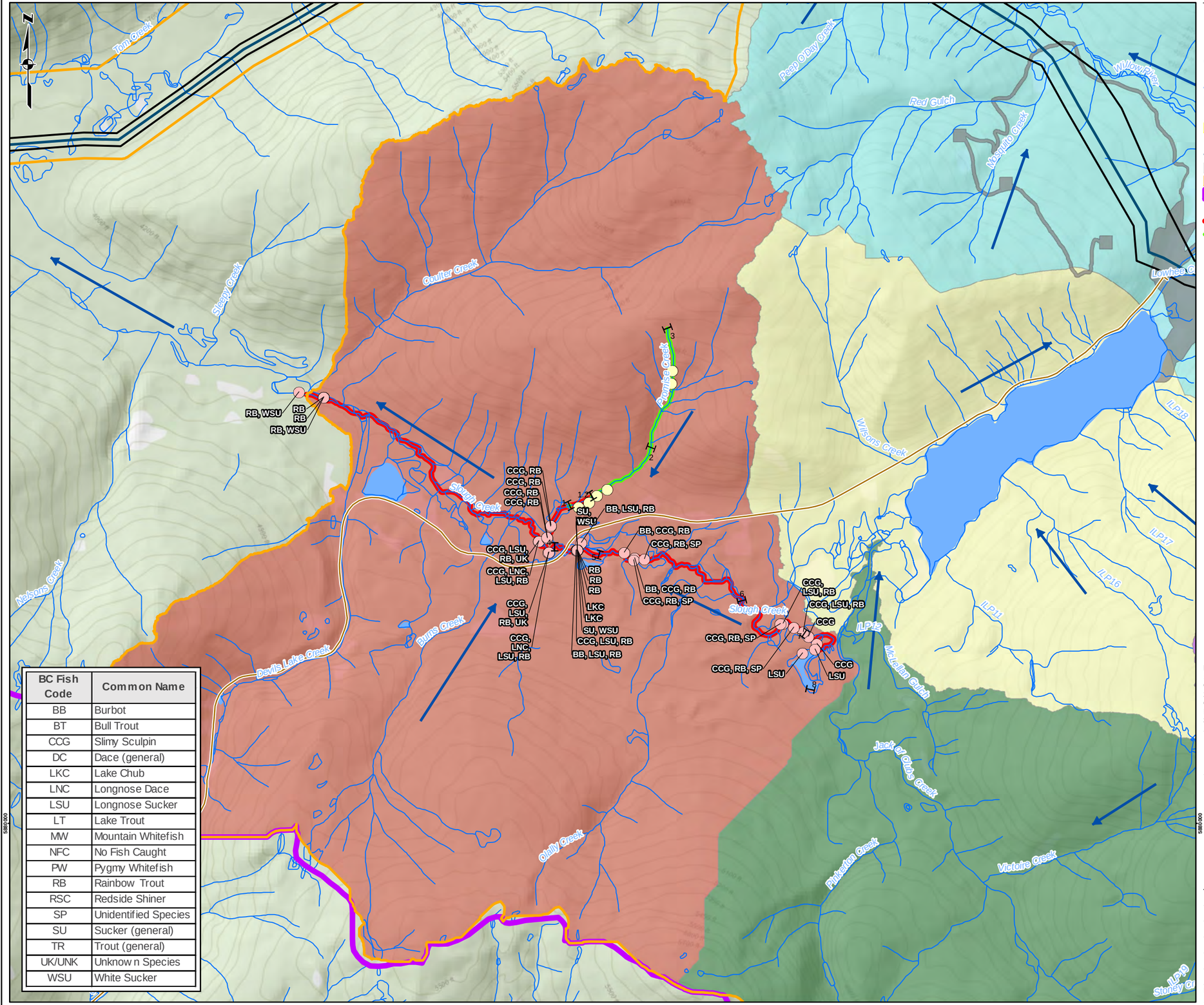
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B



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RSC	Redside Shiner
SP	Unidentified Species
SU	Sucker (general)
TR	Trout (general)
UK/UNK	Unknow n Species
WSU	White Sucker

LEGEND

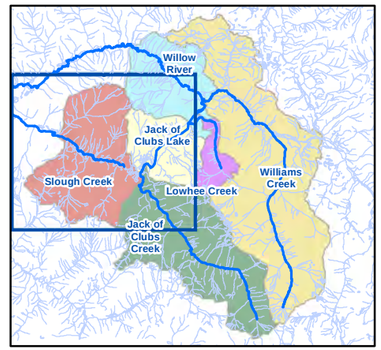
- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT
- FISH BEARING STREAM
- NON-FISH BEARING STREAM

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

- WILLOW RIVER
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



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NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:30,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

FISH DISTRIBUTION IN THE MINE SITE LOCAL ASSESSMENT AREA

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE: 5 of 8 | FIGURE 7.9-11

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

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600000

5880000

BC Fish Code	Common Name
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LEGEND

- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
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- FISH BEARING STREAM
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FISH CAPTURED

- NO
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MINE SITE WATERSHED

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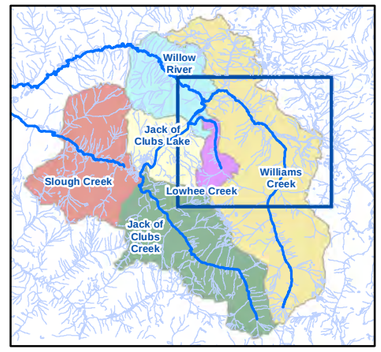

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NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:25,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

FISH DISTRIBUTION IN THE MINE SITE LOCAL ASSESSMENT AREA

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE: 6 of 8 | FIGURE 7.9-11

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

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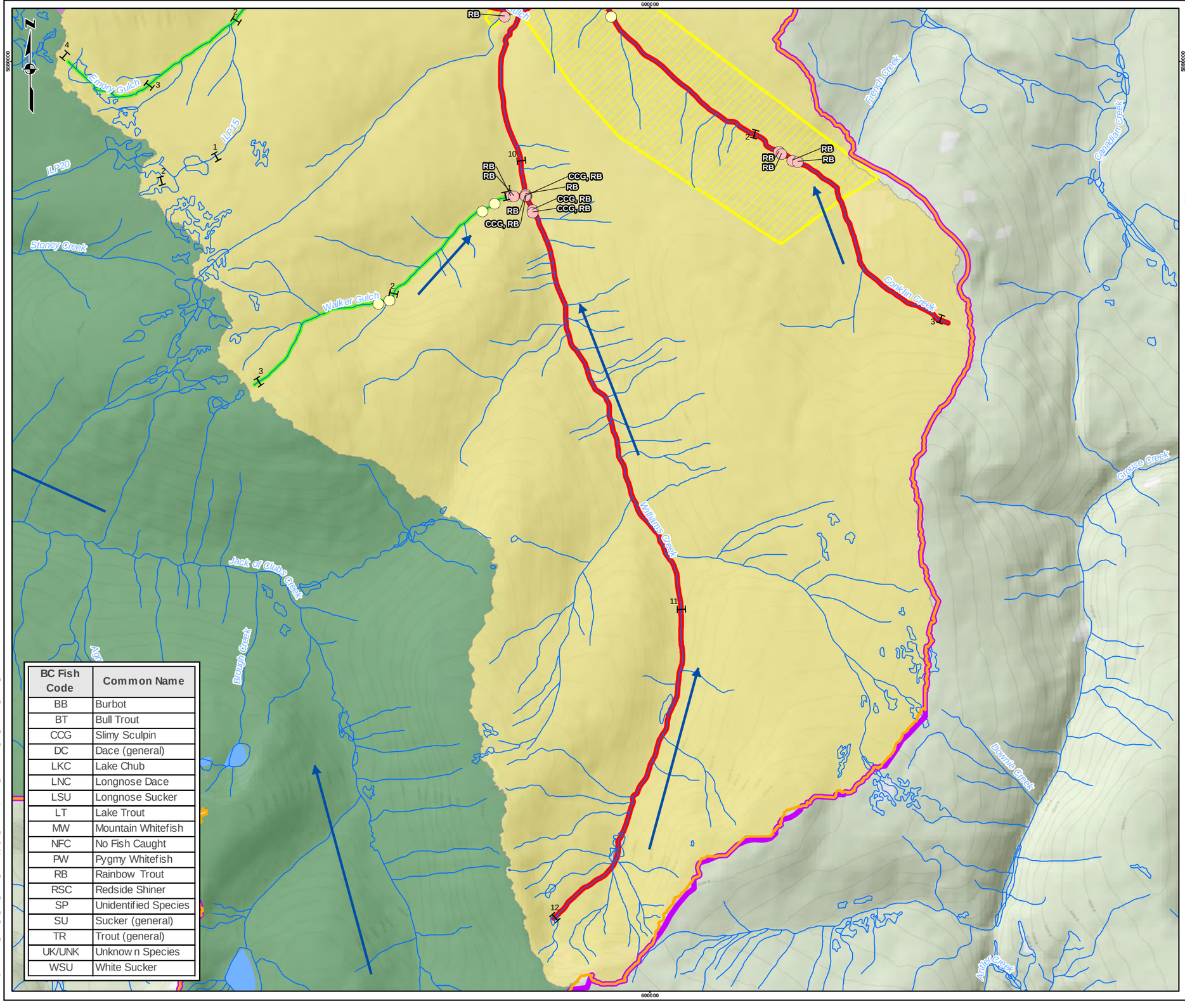

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LEGEND

- REACH BREAKS
- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
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- FISH BEARING STREAM
- NON-FISH BEARING STREAM

FISH CAPTURED

- NO
- YES

MINE SITE WATERSHED

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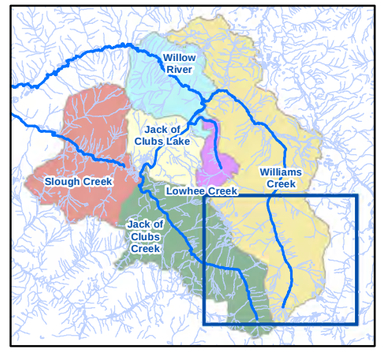
- JACK OF CLUBS CREEK
- JACK OF CLUBS LAKE
- LOWHEE CREEK
- SLOUGH CREEK
- WILLIAMS CREEK



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NAD83 CSRS
UTM Zone 10N

0 0.5 1
1:25,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

FISH DISTRIBUTION IN THE MINE SITE LOCAL ASSESSMENT AREA

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70
PHASE 00
PAGE: 7 of 8
FIGURE 7.9-11

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25mm

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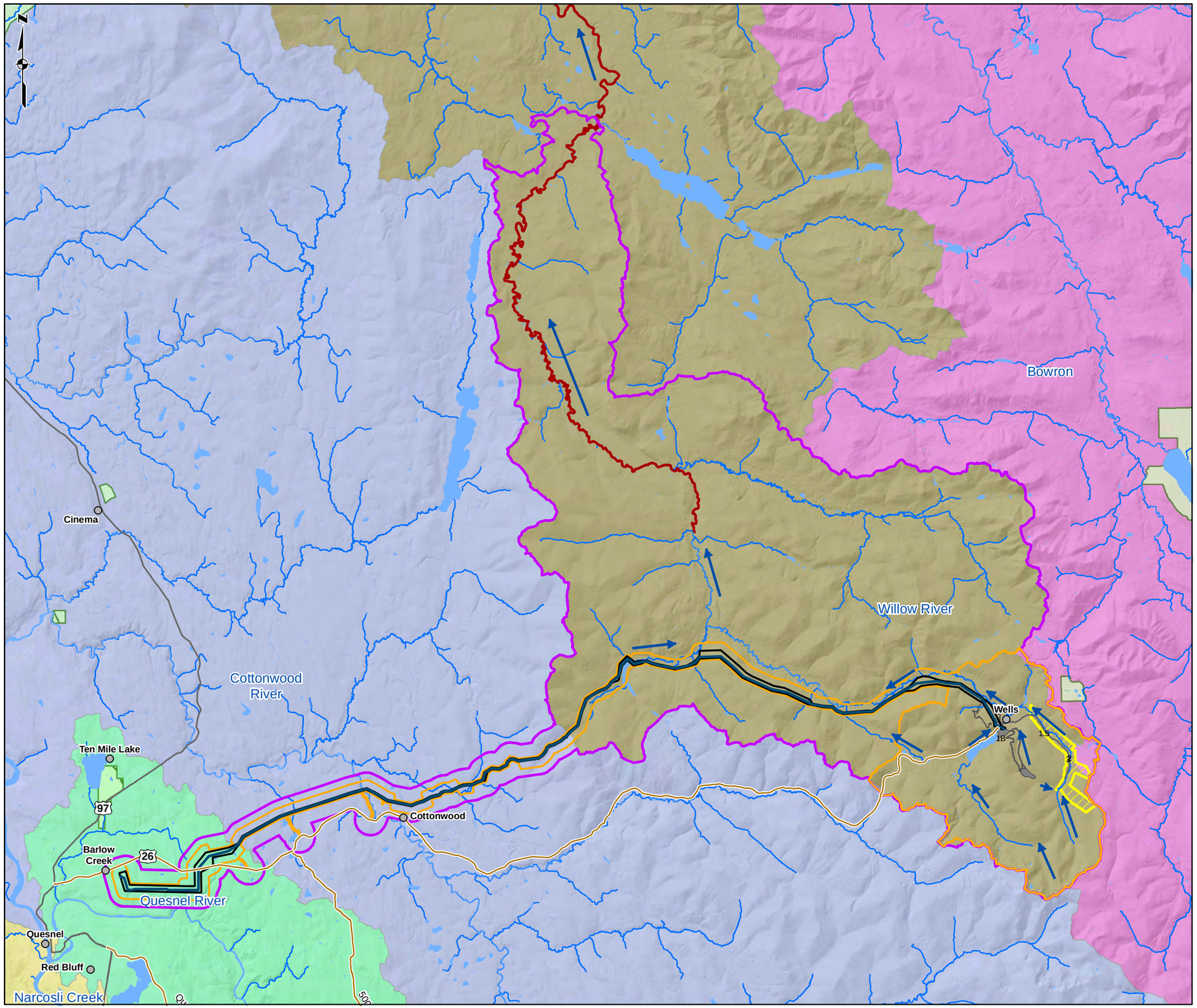
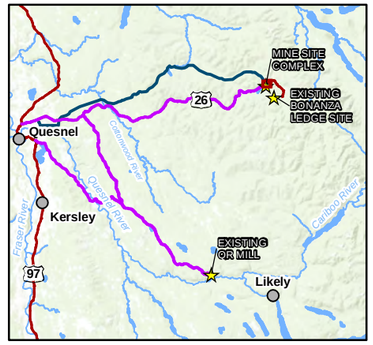


LEGEND

- POPULATED COMMUNITY
- HIGHWAY
- FLOW DIRECTION
- KNOWN UPSTREAM ANADROMOUS FISH EXTENT (WILLOW RIVER)
- WATERCOURSE
- MAIN WATERCOURSE
- WATERBODY
- PARKS/PROTECTED AREA
- BARKERVILLE HISTORIC TOWN AND PARK
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED TRANSMISSION LINE CORRIDOR
- FRESHWATER FISH LOCAL ASSESSMENT AREA
- FRESHWATER FISH REGIONAL ASSESSMENT AREA
- PROPOSED SURFACE FOOTPRINT

WATERSHED GROUPS

- BOWRON
- COTTONWOOD RIVER
- NARCOSLI CREEK
- QUESNEL RIVER
- WILLOW RIVER



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NAD83 CSRS
UTM Zone 10N

0 5 10 15
1:250,000 KILOMETRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

FISH DISTRIBUTION IN THE
MINE SITE LOCAL ASSESSMENT AREA

REV.	DESCRIPTION	DATE	INITIALS
A		7/26/2022	M.Y

PROJECT NO. 151-11330-70 | PHASE 00 | PAGE: 8 of 8 | FIGURE 7.9-11

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm
0

Within the Mine Site RAA, anadromous fish species include Chinook Salmon (*Oncorhynchus tshawytscha*) and Coho salmon (*Oncorhynchus kisutch*) in the Willow River. There are no accounts of anadromous fish species within the Mine Site LAA (Government of BC, 2018).

The most common fish in watercourses near the Mine Site is Rainbow Trout, which are present in all six watersheds (Table 7.9-12), followed by Bull Trout, which is present in five watersheds. Burbot, Lake Chub, Longnose Sucker, Mountain Whitefish, and White Sucker are present in four watersheds. Redside Shiner and Slimy Sculpin were present in only three watersheds and Largescale Sucker in two watersheds. Pygmy Whitefish and Lake Trout are only found in Jack of Clubs Lake, while Longnose Dace was only found in the Slough Creek watershed.

The Willow River, Williams Creek, and Jack of Clubs Lake watersheds have the most fish species present in the LAA and RAA at nine species (Table 7.9-12). During the 2021 Jack of Clubs Lake sampling, an additional fish species, White Sucker, was captured but has not been previously recorded in the lake. The least number of fish species occur in the Jack of Clubs Creek watershed, with only two confirmed fish species, Rainbow Trout and Bull Trout.

During the 2016 and 2018 surveys, additional fish species were confirmed in Williams Creek and the Willow River and were either sucker or minnow species (Table 7.9-12).

Arctic Char (*Salvelinus alpinus*) was historically identified in Slough Creek, but the current approximate distributions of Arctic Char occur in the coastal areas of Alaska and the Northwest Territories (Taylor, 2015). Arctic Char are therefore excluded from the LAA and RAA, and this sighting is likely mistaken for another char species such as Bull Trout or Dolly Varden (*Salvelinus malma*). Dolly Varden is primarily a coastal species and often mistaken for Bull Trout, so most references to Dolly Varden are likely Bull Trout.

7.9.3.4.3.2 Fish Species Presence at QR Mill

Within the QR Mill LAA, there are only three resident fish species present: Rainbow Trout, Lake Chub, and Longnose Sucker (Table 7.9-12, Figure 7.9-12).

Within the QR Mill RAA, Chinook Salmon are present in the lower reaches of Maud Creek. Velocity barriers and steep gradients in Maud Creek prevent upstream migration. Within the Quesnel River, there are accounts of Chinook Salmon, Coho Salmon, Sockeye Salmon (*Oncorhynchus nerka*), Rainbow Trout, including Steelhead, and Dolly Varden (*Salvelinus malma*). A velocity barrier located outside the City of Quesnel is a barrier to Pink Salmon (*Oncorhynchus gorbuscha*) (FIDQ; Government of BC, 2019d).

During the 2019 surveys, fish were only present in Rudy Creek, Sandy Lake, and Maud Creek. The most common fish species captured was Rainbow Trout in both Rudy Creek and Maud Creek. Maud Creek has the greatest number of fish species, with all three species captured in the 2019 surveys. Only Lake Chub was captured in Sandy Lake.

7.9.3.4.3.3 Fish Species Presence along the Transmission Line

There are 18 watercourse crossings that have confirmed fish presence along the Transmission Line route (Table 7.9-13, Figure 7.9-10). Historical records indicate the most common fish species encountered along the Transmission Line route is Rainbow Trout (n=18) and Bull Trout (n=10). Other common fish species include Slimy Sculpin (n=7), Longnose Sucker (n=6), Mountain Whitefish (n=6), and Redside Shiner (n=8) (Table 7.9-12). The least common fish species include Arctic Grayling, Chiselmouth (*Acrocheilus alutaceus)*, Largescale Sucker, Coho Salmon, Lake Trout, Lake Chub, Pygmy Whitefish, and River Lamprey (*Lampetra ayresi*).

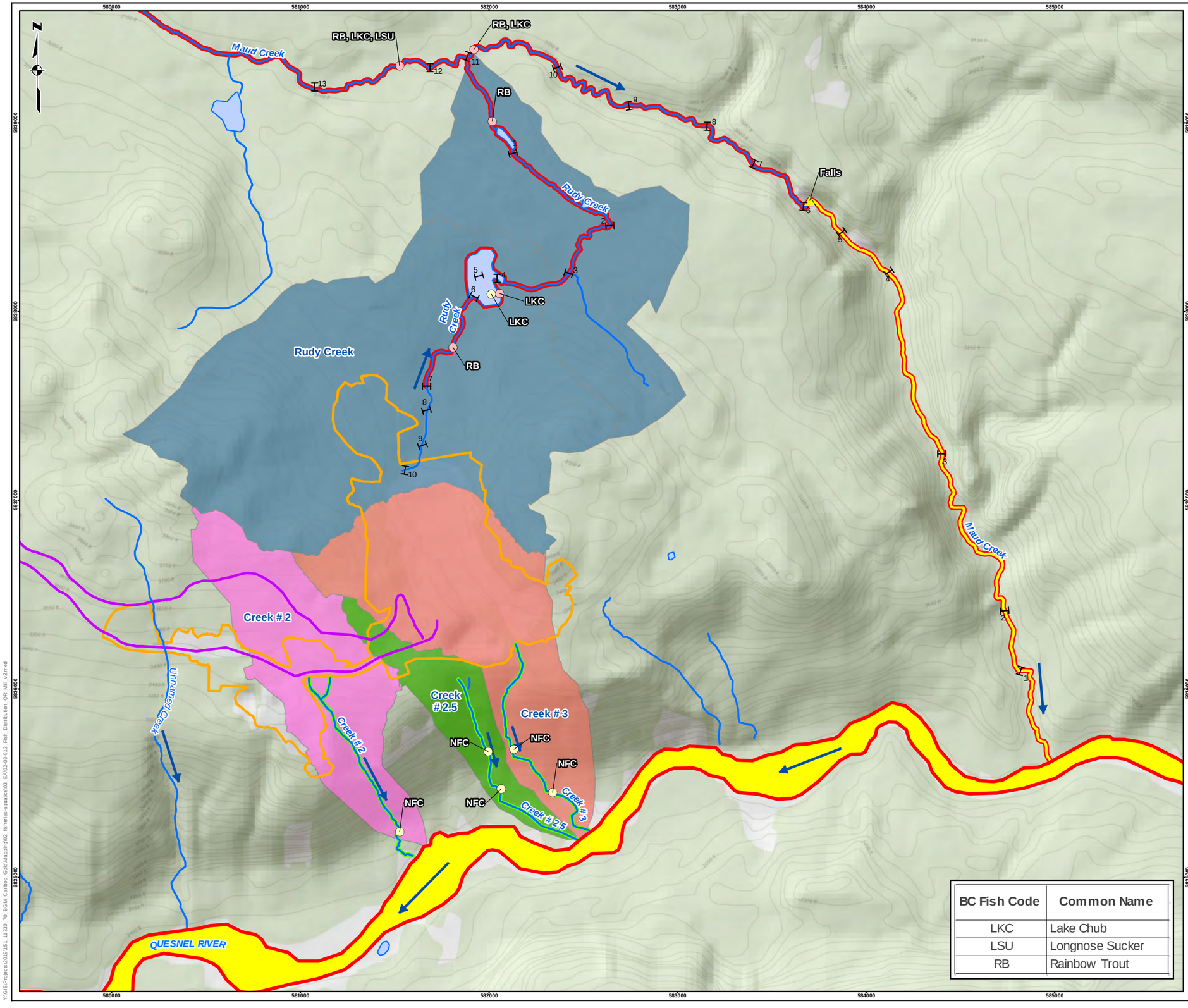
Table 7.9.13 Summary of Fish-Bearing Status of Transmission Line Watercourse Crossings

Watershed	Fish-Bearing	Non-Fish-Bearing	Unknown	Total Sites
Quesnel	0	0	5	5
Cottonwood	7	4	9	20
Willow River	11	14	13	38
Total Sites	**18**	**18**	**27**	**63**

Note: Based on 2020 Transmission Line route.

During the 2018 (those sites within the Mine Site), 2020, and 2021 surveys conducted by Golder, the most common fish species captured was Rainbow Trout at seven crossings. Rainbow Trout were captured at the Willow River, Dragan Creek, John Boyd Creek, Lowhee Creek, Frye Creek, Aura Fina Creek, Tregillus Creek, Slough Creek, and one Unnamed Creek. Other fish species captured included Slimy Sculpin (n=1), Redside Shiner (n = 1), Mountain Whitefish (n=1), Longnose Sucker (n = 1), White Sucker (n=1) Table 7.9-12).

Watercourse crossings that have the most historical fish presence include the Cottonwood River (17 fish species), the Willow River (18 fish species), Tregillus Lake Creek (8 fish species), Slough Creek (n = 6), and Aura Fina Creek (n = 6). The remaining watercourse crossings have less than five fish species, and there were six watercourse crossings with only one fish species identified, which was Rainbow Trout (Table 7.9-12).



LEGEND

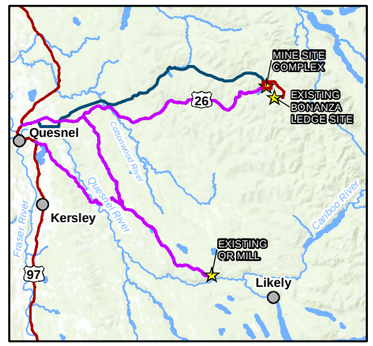
- FISS OBSTACLES
- REACH BREAKS
- WATERCOURSE
- FLOW DIRECTION
- PROPOSED TRANSPORTATION ROUTE
- PROPOSED PROJECT FOOTPRINT
- PROPOSED NEW INFRASTRUCTURE

QR MILL WATERSHED

- RUDY CREEK
- CREEK # 2
- CREEK # 2.5
- CREEK # 3

FISH CAPTURED

- YES
- NO
- FISH BEARING STREAM
- NON-FISH BEARING STREAM
- KNOWN UPSTREAM ANADROMOUS FISH EXTENT



BC Fish Code	Common Name
LKC	Lake Chub
LSU	Longnose Sucker
RB	Rainbow Trout

REFERENCE(S)

1. TRAILS, WATER FEATURES, ROADS, MUNICIPAL BOUNDARY, PARK/PROTECTED AREAS, BARKERVILLE HISTORIC TOWN/PARK, CITIES (INSET), PROVINCIAL BORDERS (INSET) OBTAINED FROM THE B.C. MINISTRY OF FORESTS, LANDS, NATURAL RESOURCE OPERATIONS AND RURAL DEVELOPMENT.
2. HILLSHADE DERIVED FROM LIDAR DATA FLOWN BY MCELHANNAY CONSULTANTS LTD. JUNE 27, 2016.
3. BASE DATA SOURCE: ESRI, GEOBASE, NRCAN, AND THE GIS USER COMMUNITY.
4. INSET BASE SOURCE: ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS.

NAD83 CSRS
UTM ZONE 10N

0 0.5 1
1:20,000 METRES

OSISKO DEVELOPMENT

CARIBOO GOLD PROJECT

FISH DISTRIBUTION IN THE
QR MILL LOCAL ASSESSMENT AREA

REV.	DESCRIPTION	DATE	INITIALS
B		4/11/2022	M.Y

PROJECT NO.	PHASE	REV.	FIGURE
151-11330-70	00	B	7.9-12

Y:\GIS\Projects\2019\151_11330_70_BGM_Cariboo_Gold\Mapping\02_fisheries-aquatic\s03_EA\02-03-013_Fish_Distribution_QR_Mill_v2.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

7.9.3.4.3.4 Conservation Status

There are no *Species at Risk Act* (SARA) listed fish species present in the Project LAAs or RAAs.

In BC, species and ecological communities are assigned to a Red, Blue, or Yellow list based on their Conservation Status Rank by the BC Conservation Data Centre (CDC). Indigenous taxa that are considered extirpated, endangered, or threatened in BC are Red-listed. Extirpated taxa no longer exist in the wild in BC but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Species that are of special concern because of factors rendering them vulnerable to human or natural disturbance are Blue-listed. Taxa of special concern have characteristics that make them particularly sensitive or vulnerable to human activities or natural events. Blue-listed taxa are at risk, but are not extirpated, endangered, or threatened. Yellow-listed species include species and ecological communities that are generally not at risk. The BC CDC classifies the Bull Trout as Special Concern, vulnerable to extirpation or extinction to apparently secure (Blue-listed species with rank of S3S4). The species is widespread, but there is sensitivity to access development and habitat degradation. Small individual population sizes and long-term population declines also support the designation, although populations have appeared to stabilize (BC CDC, 2011). Bull Trout are listed as Special Concern under SARA, but only for the Western Arctic and Coastal Populations. This population of Bull Trout is part of the Pacific Population, Fraser River above Hell's Gate Canyon, and is considered Not at Risk (COSEWIC, 2012a).

Chinook Salmon belong to DU11 Upper Fraser River Stream Spring Population, which are listed as Endangered Under COSEWIC. Historic placer mining in the Willow River systems have resulted in significant habitat alteration via large amounts of fine sediment washed in the river. Sedimentation can reduce egg-to-fry survival and adversely affect the aquatic insect community for rearing Chinook Salmon. Other threats include ecosystem modification changes due to climate change and resulting in a shift of groundwater available caused by changes in the volume and timing of snowmelt (COSEWIC, 2018).

Coho Salmon in the Quesnel River are part of the Upper Fraser sub-population of the Interior Fraser River population. Under COSEWIC, the Interior Fraser population is listed as Threatened, and much of their habitat has been impacted by logging and other human disturbances (COSEWIC, 2016). Threats include invasive species, increased water temperature, drought, land use, and increased urbanization (COSEWIC, 2016).

Sockeye Salmon in the Quesnel River are part of the DU16 Quesnel – S population, which is listed as Endangered under COSEWIC (COSEWIC, 2017). Threats to this population include modifications to freshwater ecology of Quesnel Lake and contaminants (COSEWIC, 2017).

7.9.3.4.3.5 Fish Distribution and Abundance

Fish distribution is identified in Figure 7.9-11 at the Mine Site and Figure 7.9-12 at the QR Mill. Each watershed is further summarized in the sections below. Abundance information is only available for the Willow River, Williams Creek, Slough Creek, Jack of Clubs Creek, and the Quesnel Tributaries at the QR Mill. No abundance data are available for the Transmission Line, except for those crossings within the Mine Site LAA.

Based on the 2016 and 2018 abundance surveys, the highest abundance of Rainbow Trout, Bull Trout, Slimy Sculpin, Lake Chub, and White Sucker occurs in the Williams Creek watershed. The highest abundance of Burbot, Largescale Sucker, Mountain Whitefish, and Redside Shiner occurs in the Willow River Watershed (Table 7.9-14). For full details on fish abundance for Jack of Clubs Creek and Slough Creek refer to Appendix 7.9-2. For 2021 fish abundance in Jack of Clubs Lake, refer to Appendix 7.9-4; a summary is provided in the section below.

Table 7.9.14 Summary of 2016 and 2018 Fish Abundance by Watershed with the Mine Site and QR Mill

Project Component	Watershed	Species	Individuals per 100 m	Individuals per 100 m^2	Biomass per 100 m (g)	Biomass per 100 m^2 (g)
Mine Site	Willow River	BB	28	4	488	66
	Willow River	BT	3	2	199	114
	Willow River	CCG	431	55	1,635	201
	Willow River	LKC	33	4	60	6
	Willow River	LSU	8	1	155	16
	Willow River	MW	129	17	2,627	327
	Willow River	RB	107	14	1,957	284
	Willow River	RSC	221	21	1,155	114
	Willow River	SU	5	1	1	0
	Willow River	WSU	21	2	0	48
	Williams Creek	BB	18	3	354	55
	Williams Creek	BT	22	5	103	42
	Williams Creek	CCG	922	309	2,092	689
	Williams Creek	DC	8	1	90	13
	Williams Creek	LKC	294	69	644	153
	Williams Creek	LSU	5	1	33	4
	Williams Creek	MW	55	8	298	44
	Williams Creek	RB	220	61	3,538	1,173
	Williams Creek	RSC	8	1	0	0
	Williams Creek	SP	2	0	0	0
	Williams Creek	SU	55	9	5	1
	Williams Creek	TR	1	0	1	0
	Williams Creek	WSU	77	19	694	168
QR Mill	Quesnel Tributaries	LKC	0	0	138	35
	Quesnel Tributaries	LSU	0	0	2	0
	Quesnel Tributaries	RB	51	48	3,331	1,552
	Quesnel Tributaries	RSC	0	0	0	0

Notes: BB = Burbot, BT = Bull Trout, CCG = Slimy Sculpin, LKC = Lake Chub, LSU = Largescale Sucker, LNC = Longnose Dace, MW = Mountain Whitefish, RB = Rainbow Trout, RSC = Redside Shiner, SP = unidentified, species, SU = Sucker spp., TR = Trout spp., WSU = White Sucker; m = metres; m^2 = square metres; g = grams; QR Mill = Quesnel River Mill

Willow River Watershed

Within the Mine Site LAA, the Willow River has only resident fish species. Fish species captured include Burbot, Lake Chub, Longnose Sucker, Mountain Whitefish, Rainbow Trout, Redside Shiner, Slimy Sculpin, White Sucker, and an unidentified sucker. No barriers to fish passage within the Willow River were identified in the Mine Site LAA. The highest number of fish species were captured in Reach 6 of the Willow River (seven species), followed by Reach 5 (six species) and Reach 1 (five species). Rainbow Trout were observed spawning in Willow River.

Only Reach 1 of Mosquito Creek is fish-bearing. Bull Trout and Slimy Sculpin were captured in Reach 1 during the 2016 surveys, but no fish were captured in the 2018 surveys.

All reaches of Peeps O' Day Creek and Red Gulch are non-fish-bearing, and no fish were captured during the surveys.

Reach 1 of the Willow River had the highest abundance of Rainbow Trout, Mountain Whitefish, Slimy Sculpin, and Mountain Whitefish. Reach 5 of the Willow River had the highest abundance of Burbot, while Reach 6 had the highest abundance of Longnose Sucker, White Sucker, Lake Chub, and Redside Shiner. Based on the snorkel surveys conducted by Avery Creek, fish abundance in the Willow River peaks in late spring and summer, with Mountain Whitefish being more abundant than Rainbow Trout.

Jack of Clubs Lake Watershed

Jack of Clubs Lake is fish-bearing, with Rainbow Trout and Mountain Whitefish were captured via gill net in the summer of 2016. Lake Chub were captured around the lake margins. None of the tributaries to Jack of Clubs Lake are fish-bearing due to steep gradients, multiple barriers, and no deep pools. ILP18 also has intermittent subsurface flow.

The average abundance and biomass of pelagic fish in Jack of Clubs Lake estimated from hydroacoustic surveys was 5,204 fish and 1,560 kg of biomass (4,682 fish and 1,572 kg in Survey 1; and 5,725 and 1,548 kg in Survey 2). Mean fish track densities, generated from geospatial interpolation of point data, ranged between 0.04 to 0.27 fish per 1,000 m^3 across each 100 × 100 m cell. The overall mean size of fish targets was 160 mm, although the mean length of targets detected in the vertical beam was approximately three times greater than in the horizontal beam.

The highest densities of fish were in the southern half of the lake along the lake's deepest section, with high-density patches mapped in the southern bay of the lake along the southwestern shoreline. Numerically, Redside Shiner was the most dominant species in the lake, making up just over 40% of the population in both surveys. A lower abundance of fish was observed in the upper 5 m of the water column for both surveys when compared to the abundance in the deeper stratum. Fish density was more variable between surveys in the upper 5 m of the water column when compared to the remainder of the water column. The lower abundance and variable density in the upper water column are attributed to higher water temperatures at the surface of the lake, causing fish to seek shelter in the lower water column where the temperature is lower.

Abundance estimates presented in the report likely do not include juvenile Bull Trout or Rainbow Trout as they would likely still be in the tributaries where they were spawned. Furthermore, numerous schools of Redside Shiners were observed in the shallow littoral areas while sampling. These near shore areas were not sampled with the hydroacoustic equipment due to shallow depths; therefore, the abundance of Redside Shiner has likely been underestimated. It is also possible that some of the targets assigned to Redside Shiner, particularly those at depths greater than 10 m, could represent other species, such as juvenile Mountain Whitefish or Lake Trout.

Lowhee Creek Watershed

Reaches 1 to 5 of Lowhee Creek are fish-bearing. Only Rainbow Trout were captured in Lowhee Creek during the 2016 and 2018 surveys.

Abundance sampling was not conducted within Lowhee Creek or its tributaries.

Williams Creek Watershed

A total of nine fish species were captured in the Williams Creek mainstem, including Bull Trout, Burbot, Lake Chub, Longnose Sucker, Mountain Whitefish, Rainbow Trout, Redside Shiner, Slimy Sculpin, and White Sucker. All nine were captured in Reach 5. Within the mainstem of Williams Creek, Rainbow Trout and Slimy Sculpin were found in all reaches sampled.

Rainbow Trout were the most common fish species captured in the fish-bearing reaches of the tributaries to Williams Creek. Rainbow Trout and Slimy Sculpin were captured in the lower fish-bearing reaches of ILP22, ILP22-Ditch, Conklin Gulch, and Walker Gulch. Bull Trout, Rainbow Trout, and Slimy Sculpin were captured in Reach 1 of ILP21. Only Rainbow Trout were captured in Stouts Gulch and Emory Gulch.

Within the Williams Creek mainstem, the highest number of species were captured in Williams Creek Reach 1 (four to seven species, assuming the unidentified sucker were White Sucker and did not include an unknown species) and Williams Creek Reach 5 (seven species), followed by Williams Creek Reach 6 (five species, assuming the unidentified trout were either Bull Trout or Rainbow Trout), and Williams Creek Reach 2 (four species). The lowest number of species were captured in Williams Creek Reach 10 and Williams Creek Reach 11 (two species in each).

The highest abundance of Rainbow Trout and Slimy Sculpin were recorded in Reach 5 in August 2016. The highest abundance of Bull Trout was recorded in Reach 6. The highest abundance of Mountain Whitefish, Burbot, suckers, Lake Chub, and dace were captured in Reach 1. Redside Shiner were captured in Williams Creek Reach 1 in August 2018. Based on the surveys conducted by Avery Creek Ltd., Rainbow Trout are the most abundant fish species, followed by Mountain Whitefish.

Quesnel River Watershed

Both Rudy Creek and Maud Creek are fish-bearing within the LAA. Only Rainbow Trout were captured in Rudy Creek during the 2018 surveys, while Maud Creek contains Rainbow Trout, Lake Chub, and Longnose Sucker. Only Lake Chub was captured in Sandy Lake.

The highest abundance of fish captured in Maud Creek was in Reach 11. The highest abundance of Rainbow Trout was located in Reach 1 in Rudy Creek.

Creeks #2, #2.5, and #3 are non-fish-bearing.

Transmission Line Corridor

No distribution or abundance surveys were conducted along the Transmission Line corridor. Potential and confirmed presence and absence information is provided in Section 7.9.4.3.1.11 and on Figure 7.9-10.

7.9.3.4.3.6 Fish Tissue

At the Mine Site, there was a total of 141 samples analyzed between 2016 and 2021. This included 54 fish muscle tissue samples, 41 fish liver tissue samples, and 46 whole body tissue samples. At the QR Mill, only 12 whole body tissue samples were analyzed. The fish sampling program for the QR Mill targeted a larger number of fish, but several of the watercourses were dry at the time of sampling. There were no Transmission Line fish tissue samples analyzed. Collection of fish from the Transmission Line for tissue analysis was not conducted because the construction and operation of the line and ROW are expected to be managed through a Construction Environmental Management Plan that will prevent or minimize the potential for water discharges at the outset. This will include addressing the potential for metal leaching or acid rock drainage from construction materials and appropriate handling of fuel or other sources of hydrocarbons.

The fish tissue chemistry results, including those for mercury and selenium. are provided in Appendix 7.13-1, Attachment B. A summary of the results compared to relevant national and provincial guidelines is provided below. Total mercury and methylmercury concentrations in fish muscle and whole body were compared to the BC and CCME wildlife consumption guideline of 0.033 mg/kg wet weight for methylmercury (ENV, 2001b; CCME, 2000). Total selenium concentrations in fish muscle and whole body were compared to the BC guideline for selenium of 4 mg/kg dry weight (ENV, 2019c). Liver tissue samples were analyzed, but a comparison of concentrations to guidelines is not discussed here as national and provincial guidelines are not available for liver tissues. The results are provided in Appendix 7.13-1, Attachment B, for information purposes.

Concentrations of total mercury in fish muscle samples ranged from 0.022 to 1.140 mg/kg wet weight (n = 54; Section 7.13, Appendix 7.13-1, Attachment B) with 42 samples exceeding the wildlife consumption guideline of 0.033 mg/kg wet weight (ENV, 2001b; CCME, 2000). Concentrations of total mercury in whole body fish samples ranged from 0.007 to 0.234 mg/kg wet weight (n = 46), with 11 samples exceeding the wildlife consumption guideline. Concentrations of total mercury in fish liver samples ranged from 0.014 to 1.49 mg/kg wet weight (n = 41).

Concentration of methylmercury in fish muscle samples ranged from 0.013 to 1.53 mg/kg wet weight (n = 18), with 13 samples exceeding the wildlife consumption guideline. Concentrations of methylmercury in whole body fish samples ranged from 0.020 to 0.029 mg/kg wet weight (n = 4), with no whole body fish samples exceeding the wildlife consumption guideline. Concentrations of methylmercury in fish liver samples ranged from 0.022 to 1.88 mg/kg wet weight (n = 12).

Selenium concentrations are provided in Table 7.9-15; the guideline of 4 mg/kg dry weight (ENV, 2014c) was exceeded in several sample types from several locations in the Mine Site LAA. This guideline is intended to be applied to the average of eight samples; however, it can still be used to screen results where fewer samples are available. In most of the watercourses in the LAA, the fish population is small and eight samples could not be collected. Selenium did not exceed the guideline in fish collected from the QR Mill LAA.

Table 7.9-15 Summary of Selenium Concentrations in Fish Tissue Samples

Watercourse	Species	Tissue	n	Mean (mg/kg dw)	Minimum (mg/kg dw)	Maximum (mg/kg dw)	Number of Samples Exceeding Guideline[(a)]
Slough Creek	RB	Muscle	10	5.81	3.98	8.30	8
	RB	Liver	8	41.14	10.50	70.70	8
	RB	Whole Body	11	4.97	3.32	7.03	7
Willow River	RB, BB, MW	Muscle	20	2.53	0.621	3.69	0
	RB, BB, MW	Liver	10	18.63	2.32	65.30	8
	RB	Whole Body	9	2.44	1.90	2.84	0
Jack of Clubs Lake	RB, MW, LT, BT	Muscle	17	4.06	2.35	6.34	8
	RB, MW, LT, BT	Liver	17	22.4	4.50	56.90	17
Jack of Clubs Lake	RB	Whole Body	9	2.78	2.20	3.52	0
Williams Creek	RB, MW	Muscle	7	3.12	2.78	4.09	1
	RB, MW	Liver	6	14.46	3.55	19.70	5
Wetland-S	LSU	Whole Body	5	0.950	0.592	1.25	0
Maude Creek	RB	Whole Body	5	3.41	3.23	3.86	0
Sandy Lake	LKC	Whole Body	5	2.47	1.65	3.99	0
Rudy Creek	RB	Whole Body	2	2.37	2.04	2.69	0

Notes: n = number of samples; BB = Burbot; BT = Bull Trout; LT = Lake Trout; RB = Rainbow Trout; MW = Mountain Whitefish; LKC = Lake Chub; LSU = Longnose Sucker; mg = milligram; kg = kilogram; dw = dry weight.
[(a)] Selenium concentrations were compared to the ENV (2014) tissue guideline of 4 mg/kg dry weight for the protection of fish and fish-eating wildlife. Liver concentrations were screened to the guideline for information purposes only.

7.9.3.4.4 Indigenous and Local Knowledge

A summary of Indigenous and local knowledge regarding species of Indigenous and cultural use and value, and Indigenous and local knowledge related to freshwater fish is provided below. Only those watercourses, waterbodies, and fish species present in the Project LAAs and RAAs will be carried forward in the assessment.

Fish from Jack of Clubs Lake was an important food source for Indigenous people in the area (Jorgenson, 2012). Indigenous people moved seasonally to harvest fish which were dried and stored to be consumed during the winter. Ice fishing also occurred in Jack of Clubs Lake and surrounding lakes, including Dragon Lake, Ten Mile Lake, and Bowron Lakes (Dewhirst, 2002). Salmon and whitefish are mentioned as subsidence and commercial fisheries. Salmon fishing was popular in the Fraser River, the Bear River, Bear Lake, and Bowron Lakes (Jorgenson, 2012).

Important fisheries include the Fraser River salmon run; however, concerns over water quality from industry, including the Mount Polley tailings storage facility breach and migration caused by the 2019 landslide at Big Bar, remain a concern for many Indigenous nations with regard to harvesting and consuming fish, especially salmon.

Lhtako Dené Nation

Fish of cultural use and value to the Lhtako Dené Nation include char, Dolly Varden (Bull Trout), Lingcod (Burbot), sturgeon, suckers, trout, Rainbow Trout, whitefish, and Chum, Pink, Sockeye, and Chinook Salmon (Table 7.9-16). Char species reference Arctic Char; however, char likely refers to other Salvelinus species, such as Bull Trout or Lake Trout, as Arctic Char distribution occurs further north. During the summer, Chinook Salmon are harvested in early July and Sockeye Salmon in late July. During the winter, whitefish, char, Dolly Varden, and sturgeon are important fish species captured during ice fishing. Quesnel Lake is considered critical to the survival of large runs of salmon (DM Cultural Services, 2019).

Jack of Clubs Lake was previously used for fishing but concerns over water quality and contamination in the lake have prevented use of the lake for fishing.

Table 7.9-16 Summary of Important Fish Species Identified by Lhtako Dené Nation

Species Name	Scientific Name	Season(s) Harvested	Locations Captured
Char[1]	*Salvelinus sp*	October	Lakes during spawning
Dolly Varden[1]	*Salvelinus malma*	-	-
Lingcod	*Lota lota*	-	Rivers and lakes
Chum Salmon	*Oncorhynchus keta*	-	-
Pink Salmon	*Oncorhynchus gorbuscha*	-	-
Sockeye Salmon (Kokanee)	*Oncorhynchus nerka*	Spring	Rivers and lakes
Chinook Salmon (spring salmon)	*Oncorhynchus tshawytcha*	July	Streams
Sturgeon	*Acipenser transmontanus*	-	-
Suckers	*Catostomus macrocheitus*	-	Rivers
Trout	*Salmo gairdneri*[2]	Spring	Lakes
Rainbow Trout	*Oncorhynchus mykiss*	-	-
Whitefish	*Prosopium williamsonii*	-	Rivers and lakes

Notes: "-" dash indicates no data.
[1] Likely not Arctic Char or Dolly Varden but refers to other Salvelinus species, Bull Trout, or Lake Trout.
[2] This species name is likely for Rainbow Trout (*Oncorhynchus mykiss*), as *Salmo gairdneri* is an older version of the name.
Source: Adapted from DM Cultural Services 2019.

Xatśūll First Nation and Williams Lake First Nation

Fish of cultural use and value include Chinook and Sockeye salmon, other fish species identified include Burbot, char, Lingcod, sturgeon, Dolly Varden, Rainbow Trout, and suckers (Table 7.9-17). Changes to fish populations, in particular salmon, have been decreasing, including those populations in the Fraser River and the Quesnel River. Water quality concerns are also noted for Quesnel Lake, the Quesnel River, the Fraser River, Williams Lake, and Jack of Clubs Lake, and associated contamination of fish. August is considered Pesqelqlélten or "Many salmon month" in reference to Sockeye salmon fishing in the Fraser River (Landmark Resource Management Ltd, 2021).

Table 7.9-17 Summary of Important Fish Species Identified in the Joint Xatśūll First Nation and Williams Lake First Nation Traditional Land Use Study

Species Name	Scientific Name
Burbot	*Lota lota*
Char[1]	*Salvelinus alpinus*[1]
Sockeye Salmon (Kokanee)	*Oncorhynchus nerka*
Lingcod	*Ophiodon elongatus*[2]
Chinook Salmon (spring salmon)	*Oncorhynchus tshawytscha*
Sturgeon	*Acipenser transmontanus*
Dolly Varden[1]	*Salvelinus malma*
Sockeye Salmon (Kokanee)	*Oncorhynchus nerka*
Suckers	*Catostomidae*
Rainbow Trout	*Oncorhynchus mykiss*

Notes: "-" dash indicates no data.
[1] Likely not Arctic Char or Dolly Varden but refers to other Salvelinus species in the area, Bull Trout or Lake Trout.
[2] Lingcod likely refers to Burbot and is often used as a regional name for Burbot. *Ophiodon elongatus* does not occur in the traditional territory and is a marine species.
Source: Adapted from Landmark Resource Management Ltd 2021.

7.9.3.4.5 Local and Regional Climate Projections for Fish and Fish Habitat

The Project resides in the semi-arid to humid slopes of the Cariboo Mountains where there is no distinct wet or dry season. The area has moderate annual precipitation and high annual snow accumulation accompanied by long cold winters. Historical and projected climate data for climate hazards was obtained from publicly available resources. Although both the Mine Site and QR Mill are located relatively close to each other, climate data was obtained for the two locations to better represent the climate conditions and regional differences. The Environmental and Climate Change Canada (ECCC) weather stations used for the Project include Barkerville Station (Climate ID: 1090660) for the Mine Site and Camille Lake Station (Climate ID: 1091235) for the QR Mill (ECCC, 2021a and 2021b).

At the Barkerville Station, the mean annual temperature between 1888 to 2017 ranged between a minimum of -3.8°C and a maximum of 7.4°C, with a long term mean of 1.8°C. The highest median temperature is from May through October, peaking in July or August. The mean annual total precipitation was 1,032 millimetres (mm), mean annual rainfall was 529 mm, and mean annual snowfall was 503 mm. Annual peak monthly mean flows occur in spring, between April and June, and during or soon after snowmelt.

At the Camille Lake Station, the mean annual temperature between 1981 to 2010 ranged between a minimum of -8.2°C and a maximum of 14.3°C, with a long term mean of 3.7°C. The median monthly temperatures were lowest between December and February. The highest median monthly temperatures were recorded from March through October. The mean annual total precipitation was 536 mm, mean annual rainfall was 369 mm, and mean annual snowfall was 174 mm. Annual peak monthly mean flows occur in spring, between April and June, and during or soon after snowmelt.

To predict future regional climate changes, climate projection information obtained from ClimateData.ca was evaluated. Due to the lack of available historical data from the two Mine Site locations, data from Wells, BC and Quesnel Forks, BC were considered.

In Wells, BC, for the 1951-1980 period, the annual average temperature was 1°C; for 1981-2010, it was 1.9°C. Under a high emissions scenario (which assumes that greenhouse gas concentrations will increase at approximately the same rate as they are increasing today), annual average temperatures are projected to be 3.4°C for the 2021-2050 period. Annual average precipitation for the 1951-1980 period was 906 mm. Under a high emissions scenario, this is projected to be 6% higher for the 2021-2050 period.

In Quesnel Forks, BC, for the 1951-1980 period, the annual average temperature was 2.5°C; for 1981-2010, it was 3.3°C. Under a high emissions scenario, annual average temperatures are projected to be 4.9°C for the 2021-2050 period. Annual average precipitation for the 1951-1980 period was 672 mm. Under a high emissions scenario, this is projected to be 6% higher for the 2021-2050 period.

Research on climate change undertaken as part of the Wells-Barkerville Community Forest Mapping Project notes that climate projections will be warmer and wetter in the Wells area over the next 100 years (Morgan and Wright, 2020), with mean annual temperatures rising by five degrees from historical averages and precipitation increasing by approximately 113 mm; however, the summers are expected to be dryer. Dryer summers will likely result in an increase in the number and severity of wildfires over the next several decades. The increased temperatures will likely decrease the length of time that ice and snow cover will occur during the winter months.

Projected climate impacts that may interact with fish and fish habitat include:

- Drought severity will increase for the region;
- Winter temperature will increase significantly in the next decades. These temperature increases will cause decreases in the annual number of freeze-thaw cycles;
- Winter precipitation is projected to increase;
- For the 2021-2050 horizon, the amount of precipitation that falls on the wettest day of the year will increase, and the number of days of heavy precipitation (more than 20 mm) will also increase. The Prairie Climate Centre (2022) mentions that these indicators should be used with extreme caution and that the confidence in these outputs is really low; and
- Changes in temperature, precipitation, and drought may affect the growth of riparian species, including those planted during reclamation. The successful growth of vegetation species is dependent on temperature.

Projected climate impacts may cause a change in available habitat through two pathways, including changes in water quality and water quantity. Potential changes in water quality include changes in water temperature, changes to riparian function, and reduced effluent water quality. Increased water temperatures can create stressful conditions for fish or can cause changes in their life history timing, including fry emergence. Changes to water quantity include increased drought severity and precipitation, altering the water balance which may limit habitat availability. Either watercourse can dry up during severe drought conditions or cause flooding during extreme precipitation events. Both of these extremes can limit migration to the preferred habitat. Some of the watercourses at the Mine Site already have low flow conditions which may become dry under climate change.

7.9.3.4.6 Existing Data Limitations

Existing conditions data limitations for Freshwater Fish include:

- Late changes in Project design resulted in the absence of baseline data. These include access roads associated with the Transmission Line that will require upgrades.
- Abundance data by reach for one year in one season provides only a small data set of where fish are located and what habitat they are using. For example, mark recapture studies assume that each individual has a chance of being captured.
- No age or size analysis to determine life stage and general population information. Size analysis is available for Jack of Clubs Lake fish. Information on eggs, juveniles, and adults is limited to fish habitat quality ratings, including spawning and rearing ratings.
- Instream flow studies for fish species life history requirements have not been conducted and can only be based on fish habitat ratings collected during fish habitat surveys.
- Fish habitat ratings are general and are not species specific.
- If no fish were captured, information on fish use is limited to fish habitat information and habitat quality ratings.
- No long-term water temperature data is available, which may inform the timing for certain life history stages. For example, when the emergence of fry may occur or where water temperature may exceed preferred temperatures for fish species.

7.9.4 Potential Effects

7.9.4.1 Methods

Project activities have the potential to cause adverse effects to the Freshwater Fish VC and include both land-based activities and instream activities. Potential effects were reviewed by Project phase as well as the potential for activities associated with the phases of the Project to interact with the Freshwater Fish VC sub-components of fish, aquatic resources, and fish habitat. These activities included discharges, runoff, and instream works. Fisheries and Oceans Canada (DFO) Pathways of Effects diagrams for land-based and in-water activities are used to describe potential effects to fish, aquatic resources, and fish habitat (DFO, 2018). Key potential effects are discussed in terms of these pathways of effects to fish and fish habitat. If applicable, primary measurement indicators were used to assess potential effects to each sub-component.

The effects assessment for Freshwater Fish assumes that all Project activities will occur according to the intended design of the Project. Potential effects from spills, equipment malfunctions, emergencies, or accidents are discussed in Chapter 9.0 Malfunctions and Accidents and not discussed further in this section.

7.9.4.2 Subcomponents, Assessment Endpoints, and Measurement Indicators

Primary Measurement Indicators and Assessment Endpoints provide a means of determining an incremental Project-related change to VCs. These are summarized for the Freshwater Fish subcomponents in Table 7.9-18.

Table 7.9-18 Assessment Endpoints and Measurement Indicators for Freshwater Fish VC

Sub-component	Primary Measurement Indicators	Assessment Endpoints
Fish Habitat (Riparian and Instream)	• Water quality – change in parameter concentrations compared to baseline conditions and to water quality guidelines for freshwater aquatic life • Sediment quality – change in parameter concentrations compared to baseline conditions and to sediment quality guidelines for freshwater aquatic life • Change to channel morphology (bank stability and erosion) • Water quantity – change in timing, frequency, and flow of water • Benthic invertebrate community metrics	The maintenance of a functional riparian area that supports fish populations relative to existing baseline The maintenance of water quality, water quantity, and benthic invertebrate community structure that supports fish populations relative to the existing baseline
Aquatic Resources	• Abundance and diversity of phytoplankton, zooplankton, periphyton, and benthic invertebrates • Water quality – change in parameter concentrations compared to baseline conditions and to water quality guidelines for freshwater aquatic life • Water quantity – change in timing, frequency, and flow of water • Sediment quality – change in parameter concentrations compared to baseline conditions and to sediment quality guidelines for freshwater aquatic life	Maintenance of phytoplankton, zooplankton, periphyton, and benthic invertebrate community structure relative to baseline conditions
Fish	• Fish species presence or absence, fish population metrics, and direct mortality • Habitat loss or alteration • Change in water quality parameter concentrations in fish-bearing watercourses as compared to baseline conditions and water quality guidelines for freshwater aquatic life	Maintenance of fish populations relative to baseline conditions

7.9.4.3 Project Interactions

Project components and activities have the potential to interact with and lead to effects on Freshwater Fish. Interactions and potential effects by phase are identified in Table 7.9-19.

Table 7.9-19 Potential Project Interactions – Freshwater Fish

Project Component or Activity	Potential Interaction with Freshwater Fish			Potential Effects or Pathway of Interaction
	Fish	Aquatic Health	Fish Habitat	
Construction Phase				
Procurement of employment and labour, services, goods, and use of infrastructure in the region	X	-	-	Direct mortality to fish from potential increase of fishing pressure in the Willow River, Jack of Clubs Lake, and other tributaries used for fishing
Land clearing, transformation, and compaction	X	X	X	Change in surface water quality leading to changes in fish, fish habitat, and aquatic resources
Site grading, excavations, including blasting, and fill to support infrastructure	X	X	X	
Construction of Willow River bridge and bypass	X	X	X	Direct mortality to fish, eggs, or larvae from instream works Habitat loss or alteration due to changes in riparian vegetation Change in surface water quality leading to changes in fish and fish habitat
Treatment and discharge to Jack of Clubs Lake of water from new and historical underground mine	X	X	X	Habitat loss or alteration due to changes in water quantity Change in surface water quality leading to changes in fish, fish habitat, and aquatic resources
Equipment maintenance/machinery and vehicle refuelling	X	X	X	Change in surface water quality leading to changes in fish, fish habitat, and aquatic resources
Installation of WTP at the Mine Site Complex	X	X	X	Change in surface water quality leading to changes in fish, fish habitat, and aquatic resources Habitat loss or alteration due to changes in water quantity
Construction of the surface water management system (two sedimentation ponds: one at the Mine Site Complex and upgrade of the one at Bonanza Ledge) and water diversion for contact and non-contact water	X	X	X	
Construction of culverts at road crossings of channels or streams	X	X	X	Direct mortality to fish, eggs, or larvae from instream works Habitat loss or alteration due to changes in riparian vegetation Change in surface water quality leading to changes in fish and fish habitat

Project Component or Activity	Potential Interaction with Freshwater Fish			Potential Effects or Pathway of Interaction
	Fish	Aquatic Health	Fish Habitat	
Construction of a tailings dewatering plant at QR Mill	X	X	X	Direct mortality to fish, eggs, or larvae from instream works Habitat loss or alteration due to changes in riparian vegetation Change in surface water quality leading to changes in fish and fish habitat
Upgrades of water management system at QR Mill	X	-	X	
Drawdown of existing tailings storage facility at QR Mill, treatment, and discharge to Rudy Creek	X	X	X	
Land clearing and site preparation for the Transmission Line	X	X	X	Direct mortality to fish, eggs, or larvae from instream works Habitat loss or alteration due to changes in riparian vegetation Change in surface water quality leading to changes in fish and fish habitat
Construction/installation of transmission line and ancillary structures	X	X	X	Direct mortality to fish, eggs, or larvae from instream works Habitat loss or alteration due to changes in riparian vegetation Change in surface water quality leading to changes in fish and fish habitat
Operations Phase				
Procurement of employment and labour, services, goods, and use of infrastructure in the region	X	-	-	Direct mortality to fish from potential increase of fishing pressure in the Willow River, Jack of Clubs Lake, and other tributaries used for fishing
Overburden and soil stockpile area maintenance at the Mine Site	X	X	X	Change in surface water quality leading to changes in fish, fish habitat, and aquatic resources
Equipment maintenance/machinery and vehicle refuelling	X	X	X	Habitat loss or alteration due to changes in water quantity Change in surface water quality leading to changes in fish, fish habitat, and aquatic resources
Treat and discharge effluent at the Mine Site Complex to Jack of Clubs Lake and contingency into Willow River	X	X	X	
Water intake and use	X	-	X	
Operation of Water Management System (sedimentation ponds at Mine Site Complex and Bonanza Ledge Site) and water diversion system	X	X	X	
Operation of water management system at QR Mill	X	X	X	
Treatment and discharge of effluent at the QR Mill to Rudy Creek	X	X	X	

Project Component or Activity	Potential Interaction with Freshwater Fish			Potential Effects or Pathway of Interaction
	Fish	Aquatic Health	Fish Habitat	
Deposition and compaction of tailings at the Filtered Stack Tailings Storage Facility (FSTSF) at QR Mill	X	X	X	
Transmission line and ancillary structure operations and maintenance	X	X	X	Direct mortality to fish from potential increase of fishing pressure in tributaries used for fishing
Road use and maintenance (traffic from the transportation of workers, goods, equipment and machinery, and services on Mine Site and access roads)	X	X	X	Direct mortality to fish from potential increase of fishing pressure in the Willow River, Jack of Clubs Lake, and other tributaries used for fishing
Progressive reclamation as opportunities arises	X	X	X	Habitat loss or alteration due to changes in water quantity Change in surface water quality leading to changes in fish, fish habitat, and aquatic resources
Closure Phase				
Treatment and discharge of water from the WTP and water pipeline at the Mine Site Complex	X	X	X	Habitat loss or alteration due to changes in water quantity Change in surface water quality leading to changes in fish, fish habitat, and aquatic resources
Construction of Spillway Closure	X	X	X	Change in surface water quality leading to changes in fish, fish habitat, and aquatic resources
Decommissioning of surface infrastructure	X	X	X	
Treatment and discharge of water from the WTP and water pipeline at the QR Mill	X	X	X	
Decommissioning of transmission line ancillary structures no longer in use	X	X	X	
Post-Closure Phase				
On-going water treatment at the Mine Site and QR Mill, until no longer required	X	X	X	Changes in surface water quality leading to change in fish, fish habitat, and aquatic resources.
Decommissioning of the WTPs	X	X	X	
Dismantling and removal of WTPs (Mine Site and QR Mill)	X	X	X	

Notes: WTP = water treatment plant; QR Mill = Quesnel River Mill; FSTSF = filtered stack tailings storage facility; X = potential interaction; - = no interaction identified.

7.9.4.4 Discussion of Potential Effects

Potential effects to Freshwater Fish may occur through various pathways, including land or in-water Project activities. Project activities may also have more than one pathway, and if unmitigated, these pathways can cause direct or indirect effects to Freshwater Fish that can lead to a reduction in aquatic health, fish health, and fish population. For the purposes of the Freshwater Fish assessment, the potential pathways and their effects are grouped into categories which represent all the pathways that could lead to a potential effect on aquatic health, fish, or fish habitat. These categories also include assessments from other subcomponents, including Water Quality and Water Quantity, which will provide information regarding the potential effects on Freshwater Fish. The categories include:

- Direct mortality to fish;
- Instream habitat and riparian habitat loss or alteration;
- Change to surface water quality resulting in effects to fish, fish habitat, and aquatic resources; and
- Change in surface water quantity resulting in effects to fish and fish habitat.

7.9.4.4.1 Direct Mortality to Fish

Direct mortality to fish may include impacts that cause direct injury or mortality to fish, including eggs and larvae. Effects to fish from this pathway may include effects to species at risk and traditional use species.

7.9.4.4.1.1 Mine Site

Instream works required may cause direct mortality to fish, eggs, or larvae, including equipment and construction vehicles in aquatic habitats. Instream works may be required during the construction of the Willow Creek clear span bridge and installation of the pipeline and diffuser into Jack of Clubs Lake and the Willow River contingency diffuser.

During construction and operations, an increase in the workforce has the potential to increase recreational fishing pressure on sport-fish species. This could include Project personnel and their families in Wells, at the campsite, and in other areas, including Prince George and Quesnel.

7.9.4.4.1.2 QR Mill

There are no anticipated changes to roads within the existing QR Mill. A new camp will be built, and the increase in workforce has the potential to increase recreational fishing pressure on sport-fish species. This could include Project personnel at the campsite, and in other areas, including Prince George and Quesnel.

7.9.4.4.1.3 Transmission Line

There are no anticipated new roads for the construction of the Transmission Line. Some roads require upgrades that may include upgraded culverts or bridges and therefore require instream work.

During operations, linear projects such as transmission lines and access roads have the potential to create or increase access to previously inaccessible fishing areas. Despite being unmarked and not advertised, these corridors are maintained and can provide public access (Cott et al., 2015). As a result, fishing pressure on sport-fish species may increase, leading to increased mortality, stress, or injury to fish.

7.9.4.4.2 Loss or Alteration of Instream or Riparian Habitat

Loss of instream habitat and riparian habitat includes the direct loss of these habitats from Project activities. Loss of fish habitat may lead to effects to fish, including changes to fish behaviour and fish communities, including species at risk or traditional use species.

7.9.4.4.2.1 Mine Site

There is no anticipated instream fish habitat loss as a result of the majority of mine infrastructure because the construction of the mine will occur on existing disturbed areas away from watercourses. Construction of the Mine Site is located on brownfield sites that have been previously disturbed by historical mining operations. The new Camp Access Road at the Mine Site Complex will connect to a new watercourse crossing at the Willow River via clear-span bridge. B-road, which connects the A-Road to the Mine Site Complex, will require upgrading and has two existing watercourse crossings in the Lowhee Creek Watershed, one at Lowhee Creek and one at an unnamed tributary to Lowhee Creek. These crossings are anticipated to remain the same. Construction of the Willow River bridge could constrict the river and alter fish habitat. Unless appropriately designed and installed, the bridge could cause bank erosion, slumping, and debris jams, which may cause a migration blockage to fish. Installation of the pipeline and diffuser in Jack of Clubs Lake and the contingency diffuser in the Willow River may cause instream fish habitat and/or riparian alteration or loss depending on detailed design and installation methods. The diffuser in Jack of Clubs Lake may disturb part of the littoral zone before being placed at the bottom of the lake. The diffuser will also require an engineered pad installed on the bottom of the lake to support the diffuser, and the pipeline will require protection as it enters the lake to prevent damage due to scouring.

A loss of 0.07 ha of riparian habitat is anticipated at the watercourse crossing for the Willow River. The discharge pipeline to Jack of Clubs Lake will parallel the north shoreline of Jack of Clubs Lake and may alter riparian habitat depending on the final design location.

Potential effects from riparian habitat loss include bank erosion and increased sedimentation into watercourses. Disturbance to habitat may also be caused by the operation of construction vehicles or machinery near the aquatic habitat.

7.9.4.4.2.2 QR Mill

There will be no fish habitat loss as a result of the mine infrastructure because there are no watercourses within the footprint, and the construction will be completed within existing disturbed areas. There are no anticipated culverts, bridges, or new linear developments to or at the QR Mill.

7.9.4.4.2.3 Transmission Line

There will be no instream loss of fish habitat along the Transmission Line route. The Transmission Line infrastructure will be placed outside of beds and banks of watercourses. Existing access roads will be used; however, seven watercourse crossings may require upgrades to existing infrastructure (Figure 7.9-7). Upgrades to the existing infrastructure will follow provincial and federal best management practices to reduce potential harmful alteration, disruption, or destruction to fish habitat. Potential effects to fish and fish habitat for access roads are similar to those discussed for the Mine Site.

Riparian vegetation clearing will be required during construction of the Transmission Line at each watercourse crossing within the ROW where limits of approach cannot be maintained while retaining vegetation. For the preferred ROW, this may be up to 22 ha, which reflects the width of the ROW and the riparian area model obtained from the Cariboo Chilcotin Landuse Plan. Clearing in riparian areas will be limited to vegetation that is above height requirements, and the understory will remain intact. Regular riparian vegetation maintenance during operations will be required to prevent vegetation from interacting with or falling onto the Transmission Line. Potential effects from the removal of riparian vegetation include changes to cover, food production, and shade. Riparian vegetation stabilizes watercourse banks and prevents bank erosion. Loss or alteration of riparian habitat could reduce riparian function and the services it provides for watercourses. Potential effects to fish habitat from the loss of riparian vegetation include:

- Reduction in LWD that provides cover for fish;
- Reduction in small organic debris inputs and nutrients and organic litter into watercourses that are important for benthic invertebrate production; and
- Reduction in overhanging vegetation that provides cover for fish and provides bank stability, and limits erosion and sedimentation.

During the Closure and Post-Closure Phases, riparian areas will be allowed to regrow, and there are no anticipated potential effects to fish from riparian areas.

During Transmission Line construction, there is potential for increased mobilization of fine-grained materials in surface water runoff that could change water quality and aquatic habitat through increased suspended sediment and deposition.

7.9.4.4.3 Change to Surface Water Quality Resulting in Effects Fish, Fish Habitat, and Aquatic Resources

Changes to water quality can include changes in water temperature, changes in pH, changes in nutrient concentrations, changes in contaminant concentrations, including metals, and changes in sediment. This pathway can lead to changes in fish habitat and aquatic resources, which ultimately can affect fish. For example, total suspended solids (TSS) can increase from works in or near watercourses caused by disturbing the beds and banks of the stream. Increases in TSS can lead to fish gill abrasion, loss of visual acuity for detecting prey and, when deposited on the streambed, smothering of eggs, leading to poor reproductive success and reduced abundance of fish. Increases in TSS can reduce spawning habitat, can change the behaviour of fish, and reduce their health, which can then lead to changes in fish community composition or abundance.

7.9.4.4.3.1 Mine Site

Aquatic resources and fish health may be affected by changes in surface water and sediment quality related to the release of treated effluent to Jack of Clubs Lake and the Willow River downstream during operations and closure. When water management structures are removed in post-closure (end of active care period), untreated water will be released from the Bulk Fill Area (BFA) and Waste Rock Storage Facility (WRSF), and historical groundwater seepages near Jack of Clubs Lake and near the Bonanza Ledge Site (Lowhee Creek, Stouts Gulch). The potential for these effects to occur has been evaluated in Section 7.4.7. The Constituents of Potential Concern (COPC) carried forward in the Surface Water

assessment (Section 7.4.7) are TSS, chloride, sulphate, nitrate, nitrite, ammonia, and metals. Most of the COPCs evaluated exert toxicity to aquatic life through ventilation/respiration of water rather than through dermal uptake or bioaccumulation in the food web. The exceptions would be mercury and selenium, for which ambient WQGs for the protection of aquatic life consider the bioaccumulation pathway.

Project activities, including bridge construction, have the potential to result in changes in the physical or chemical composition of surface waters that could then affect aquatic resources. Indirect or direct deposition of concrete, concrete fines, and/or concrete wash or contact water in a watercourse, including cast-in-place and/or pre-cast concrete structures, have the potential to impact water quality parameters, such as water pH. Increased erosion and mobilization of fine-grained material in surface run-off can affect surface water and sediment quality by degrading water quality and aquatic habitat through increased suspended sediment and deposition.

Potential changes to water temperature from effluent discharge from the Mine Site have also been evaluated in Section 7.4.7.

7.9.4.4.3.2 QR Mill

Aquatic resources and fish health may be affected by changes in surface water and sediment quality related to the release of treated effluent to Rudy Creek during construction, operations, and closure. When water management structures are removed in post-closure, untreated water will be released from the Main Zone Pit into Creek#3. The potential for these effects to occur has been evaluated in Section 7.4.7. The COPC carried forward in the Surface Water Assessment (Section 7.4.7) are TSS, chloride, sulphate, nitrate, nitrite, ammonia, and metals. Most of the COPCs evaluated exert toxicity to aquatic life through ventilation/respiration of water rather than through dermal uptake or bioaccumulation in the food web. The exceptions would be mercury and selenium, for which ambient WQGs for the protection of aquatic life consider the bioaccumulation pathway.

7.9.4.4.3.3 Transmission Line

During transmission line construction, there is potential for increased mobilization of fine-grained materials in surface water runoff that could change water quality and aquatic habitat through increased suspended sediment and deposition.

In addition, changes in water temperature can occur by reducing riparian vegetation (shading). Changes in water temperature directly affect the physical and biological characteristics of the aquatic ecosystem. Increased temperatures can particularly affect trout species, such as Bull Trout, which are cold water fish. Bull Trout are sensitive to thermal changes and have more restrictive water quality guidelines due to these sensitivities, and the maximum daily temperature should not exceed 15°C for watercourses where these fish occur. Changes in water temperature can lead to direct mortality to fish and eggs. Each fish species has optimal temperature ranges according to specific life history stages.

Herbicide use may be used to control vegetation along the ROW during operations. Using herbicides may input toxins into nearby watercourses, which can affect fish.

During decommissioning of the transmission line, the land will be recontoured, which may disturb soils and cause erosion into streams. Riparian vegetation will be allowed to grow back, limiting potential effects to watercourses; therefore, anticipated effects during post-closure are likely negligible and are not carried forward.

Contact water is expected to be acidic and can contain sulphates and trace metals. The potential interaction with Freshwater Fish is described in more detail in the sections below.

7.9.4.4.4 Change in Water Quantity Resulting in Effects to Fish and Fish Habitat

7.9.4.4.4.1 Mine Site

During construction, instream works required to install the bridge over the Willow River have the potential to change the timing, duration, and frequency of flow. Inappropriately designed bridges and culverts can create velocity or vertical drop barriers. Direct effects to fish include changes in migration patterns or the displacement or stranding of fish. An increase in flow can displace fish from their habitat and create migration barriers. Also, instream works could potentially block the upstream and downstream passage of fish. These changes may interrupt critical spawning and overwintering migrations leading to reduced annual recruitment, lowering overwintering survival and spawning success. These effects can continue into operations and during closure when the bridge will be decommissioned.

The diversion and discharge of treated effluent to Jack of Clubs Lake also has the potential to alter flows into the Willow River and other watercourses during construction, operations, closure, and post-closure. Changes in flow during construction, operations, and closure can include alterations to fish habitat. Alteration or destruction of fish habitat may occur if increased flows cause erosion of banks and beds, which can cause suspended sediment to infill available spawning and rearing habitat when it settles. Changes in flow can lead to changes in water depth and velocities. These changes have the potential to alter the preferred rearing habitat for juvenile or small bodied fish that prefer lower flow velocities. Alternatively, lower flows can reduce pool areas which adults or large bodied fish use for refuge or overwintering habitat. The availability of suitable overwintering habitat is important for salmonids who use this habitat as refuges from high-velocity water and limit interactions with other fish. Velocity barriers can interrupt critical spawning and overwintering migrations leading to reduced annual recruitment, as well as lower overwintering survival and spawning success for fish.

7.9.4.4.4.2 QR Mill

During construction, the existing tailings storage facility (TSF) pond will be drawndown, treated, and discharged into the Rudy Creek watershed. An increase in flow can displace fish from their habitat and create migration barriers. Changes in flow may alter available habitat, and effects are similar to those identified at the Mine Site. Changes in flow may interrupt critical spawning and overwintering migrations and lead to reduced annual recruitment, lowering overwintering survival and spawning success.

7.9.4.4.4.3 Transmission Line

There are no expected changes to water quantity during construction, operations, closure, or post-closure of the transmission line.

For the access roads, existing watercourse crossings that require upgrades may have similar effects as identified at the Mine Site for instream works. Inappropriately designed bridges and culverts can create velocity or vertical drop barriers. Direct effects to effects to fish include changes in migration patterns or the displacement or stranding of fish.

7.9.5 Effects Management

7.9.5.1 Mitigation Approach

The approach to the identification of mitigation follows the mitigation hierarchy, which allows the Project to limit as much as possible the negative impacts on Freshwater Fish. This includes the Environmental Mitigation Policy for BC (ENV, 2014a) and DFO's policy for applying measures to offset adverse effects on fish and fish habitat under the *Fisheries Act* (DFO, 2020). The mitigation hierarchy approach is to avoid, minimize, restore on-site, and offset.

Each potential effect is reviewed below, and the appropriate mitigation measure identified based on site conditions, reliable technologies, technical and economic feasibility, and professional experience. Mitigation measures include those provided by best management practices, guidance documents, and management plans. Those mitigation measures that cannot completely reduce the potential effect to the Freshwater Fish VC are considered residual effects and may result in offsetting.

Mitigation measures can include design features that avoid fish and fish habitat, or reduce effects to fish and fish habitat, best management practices that are applicable, regulatory requirements, and adaptive management through monitoring.

Best Management Practices (BMPs) that are applicable to this Project for Freshwater Fish include:

- Best Management Practices for Linear Development Proposed within the Peace Region (ENV, 2018c);
- Requirements and Best Management Practices for Making Changes In and About a Stream in British Columbia (Government of BC, 2022);
- A Users' Guide for Changes In and About a Stream in British Columbia (Government of BC, 2022);
- Fish-stream Crossing Guidebook (FLNRORD, 2012);
- Terms and Conditions for Changes in and About a Stream Specified by ENV Habitat Offices, including Reduced Risk Work Windows for Fish within the Cariboo District (MWLAP, 2021); and
- DFO's Measures to protect fish and fish habitat (DFO, 2019) including:
    - Prevent the death of fish;
    - Maintain riparian vegetation;
    - Carry out works, undertakings and activities on land;
    - Maintain fish passage;
    - Ensure proper sediment control; and
    - Prevent entry of deleterious substances in water.

Management Plans to be developed for the Project that pertain to Freshwater Fish include:

- Wildlife Management Plan;
- Fuel Management and Spill Contingency Plan;
- Traffic Control Plan;
- Surface Erosion Prevention and Sediment Control Plan;
- Construction Environmental Management Plan;
- Water Management Plan;
- Discharge Management Plan;
- Vegetation Management Plan;
- Invasive Plant Management Plan; and
- Waste (Refuse and Emissions) Management Plan, including a Fugitive Dust Control Plan.

Monitoring applicable to Freshwater Fish (to be captured in Erosion and Sediment Control Plan and Environmental Monitoring Plan) includes:

- Erosion and Sediment Control (ESC) monitoring throughout various phases of the Project;
- Surface water, quantity, and turbidity monitoring implemented for effluent discharge sites affected by site contact water during all Project phases; and
- Event-based water quality monitoring in the event storms mobilize suspended sediments from disturbed areas.

Measures included in these guidelines and BMPs are generally effective at avoiding or reducing the death of fish and the alteration, disruption, or destruction of fish habitat if implemented correctly and adapted to the site conditions.

7.9.5.1.1 Mitigation Measures for Direct Mortality to Fish

Least risk timing windows are intended to identify periods of time when instream construction activities will result in the least impact to fish. Least risk timing windows by Project component and fish species are provided in Table 7.9-20.

Table 7.9-20 Regional Least Risk Timing Window

Project Component	Species	River or Watershed	District	Start Date	Completion Date
QR Mill and Transmission Line	Rainbow Trout (RB)	Quesnel River and watershed	Quesnel Forest District	July 15	July 31
QR Mill and Transmission Line	Chinook Salmon (CH)	Quesnel River and watershed	Quesnel Forest District	July 15	July 31
Mine Site and Transmission Line	Rainbow Trout (RB)	Willow River and watershed	Quesnel Forest District	July 15	July 25
Mine Site and Transmission Line	Bull Trout (BT)	Willow River and watershed	Quesnel Forest District	July 15	July 25
Mine Site and Transmission Line	Chinook Salmon (CH)	Willow River and watershed	Quesnel Forest District	July 15	July 25
Transmission Line	Rainbow Trout (RB)	Cottonwood/Swift River	Quesnel Forest District	No Reduced Timing Window	N/A
Transmission Line	Bull Trout (BT)	Cottonwood/Swift River	Quesnel Forest District	No Reduced Timing Window	N/A
Transmission Line	Chinook Salmon (CH)	Cottonwood/Swift River	Quesnel Forest District	No Reduced Timing Window	N/A
All components	Mountain Whitefish (MW) and other unmentioned species if present.	Other Fraser River Tributaries	Quesnel Forest District	July 15	July 31

Source: MWLAP, 2021
Notes: N/A = not applicable; QR Mill = QR Mill.

7.9.5.1.1.1 Mine Site

Direct mortality to fish during the Willow River Bridge construction will be avoided by constructing a clear-span bridge over the river, thereby avoiding instream works. It is anticipated that there will be no new culverts in watercourses required at the Mine Site. It is anticipated that upgrades on the B-road will not require changes to existing watercourse crossing structures. The installation of the diffuser pipeline and diffuser will follow best management practices for instream works. Specific mitigations for minimizing direct mortality to fish include the following:

- Conducting instream work during applicable timing windows to protect fish, unless otherwise approved by the applicable provincial or federal authority (Table 7.9-18);
- Conducting instream work in the dry or low flows or frozen; and
- Retaining a qualified environmental professional to conduct a fish salvage, if required.

Fishing will be prohibited for all employees and contractors on-site or while commuting to and from the Project sites. In addition, the use of off-road or recreational vehicles will be prohibited at ODV project sites unless with appropriate approvals.

Gates at all ODV properties will be locked when not operating unless circumstances for which this is not required are outlined in an appropriate Management Plan (e.g., in an emergency, identified in the Mine Emergency Response Plan).

During closure and post-closure, roads that are no longer required for ongoing activities will be closed to vehicular traffic, and obstructions will be placed on former road ROWs to deter human access. Roads will be revegetated to blend with surrounding ecosystems and culverts will be removed and fill material will be used to create irregular mounds and ridges consistent with the surrounding terrain.

It is anticipated that mitigation measures and BMPs will be effective. Therefore, effects on fish are not expected and are not carried forward.

7.9.5.1.1.2 QR Mill

Mitigation measures for direct mortality to fish from increased fishing pressure are the same as those identified at the Mine Site. Fishing will be prohibited at the Project sites.

It is anticipated that mitigation measures will be effective. Therefore, effects on fish are not expected and are not carried forward.

7.9.5.1.1.3 Transmission Line

Upgrades to access roads will have mitigation measures similar to those in the Mine Site, including working within timing windows, conducting work in the dry, during low flows, or during frozen conditions. If required, retain a qualified environmental professional to conduct a fish salvage. If required, open-bottom structures will be used at fish-bearing watercourse crossings.

As the transmission line is built next to existing access roads, it is not expected that the transmission line will offer more access to sport fishers than what is already available. There are 36 watercourses where both existing access roads and the proposed Transmission Line route cross. There is currently access to several watercourses, including the Tregillus Willow Recreational Trail, which encompasses the Willow River and Tregillus Creek and is accessed by Ketchum Beaver Passage Road. The Cottonwood River also has access via Highway 26. The additional employees and their families may use these access points where they occur on public lands.

There are 16 watercourse crossings that were assessed where sport-fish or large bodied fish are present, including the Cottonwood River and Willow River. Fishing spots identified include Lightning Creek or creeks and rivers that drain into the Bowron River or Cottonwood River (Appendix 7.9-3). The Willow River crossings are located on the Mine Site, and fishing will be prohibited on the Mine Site. Of these watercourses, 13 have existing access via roads, and the remaining three will have new access via the Transmission Line.

The most common fish species at these watercourse crossings are Rainbow Trout, which are ubiquitous in the RAA. Provincial guidelines, including sport fishing quotas for specific fish species, are in place for fishing in the Cariboo Region (Government of BC, 2021c), including Rainbow Trout. Bull Trout, Dolly Varden, Burbot, and whitefish all have daily quotas.

Due to the current existing access and fishing quotas enforced by BC, it is not expected that the Transmission Line will increase fishing pressure at those watercourse crossings that are fish-bearing. Those watercourse crossings that exist within the Mine Site will be subject to the no fishing policy. Therefore, effects on fish are not expected and are not carried forward.

7.9.5.1.2 Mitigation Measures for Instream Habitat and Riparian Habitat Loss and Alteration

7.9.5.1.2.1 Mine Site

Mining will be underground, which will result in no additional riparian vegetation clearing next to watercourses or waterbodies at the Mine Site. Mitigation measures to prevent instream or riparian habitat lost during construction and operations include:

- Riparian areas (for wetlands and waterways) will be managed according to the recommended management zone setbacks and work practices provided in the *Mines Act* (Government of BC, 1996c) and *Forest and Range Practices Act* (Government of BC, 2002b);
- Support the maintenance of riparian area function through the use of management area buffers around riparian areas in close proximity to, but not directly affected by, Project construction;
- Heavy equipment or vehicle crossings through watercourses, which include wetlands and ponds, is prohibited unless detailed under a special provision in a site-specific prescription or with specific regulatory agency approval; and
- Restrict debris from entering the high-water mark without specific regulatory agency approval.

Implementation of BMPs and management plans during construction and operations are expected to be effective at avoiding instream and riparian habitat at the Mine Site. Therefore, effects on fish and fish habitat are not expected and are not carried forward. This excludes the Willow River Bridge crossing and the diffuser and associated pipeline from the Mine Site into Jack of Clubs Lake.

The Willow River watercourse crossing that will be constructed for the new Mine Site road will be a clearspan bridge, which has no infrastructure in the watercourse, and has been designed to avoid impacts to instream fish habitat. Despite the design, habitat loss through the removal of riparian vegetation removal cannot be avoided or fully mitigated.

It is anticipated that there will be no upgrades to the bridge over Lowhee Creek along B-road. Upgrades over the unnamed tributary to Lowhee Creek are assumed to not change the existing footprint and that the design will allow for fish passage and not limit migration if the stream is fish-bearing. Construction will be done by following those BMPs for instream works or works in and around water, eliminating this pathway for effects to fish habitat and potential effect to fish, including migration. Therefore, effects on fish and fish habitat are not expected and are not carried forward.

New culverts may include culverts installed during construction where roads intersect drainage channels that divert contact water flow as part of the Water Management Plan at the Mine Site. There are no new culverts anticipated along any existing watercourses. The drainage channels that will be used to divert contact water flow under the Mine Site Water Management Plan may require culverts, but these crossings would not be part of any existing watercourses.

It is anticipated that the proposed diffuser pipeline and installation of the Jack of Clubs Lake diffuser and the Willow River contingency diffuser will follow standard mitigation measures and best management practices. The diffuser pipeline and diffuser have been designed to avoid sensitive fish and fish habitat along the shoreline and within the lake, as well as littoral areas and river habitat that support spawning or rearing fish. Further details regarding location design considerations of the diffuser are provided in Appendix 7.4-7 Diffuser Design Study for Jack of Clubs Lake and 7.4-11 for the Willow

River Diffuser. It is anticipated that standard mitigation measures and the design location will be effective, and effects to fish and fish habitat are not anticipated. Details regarding areas of impact and the design will be further developed in the Project's next engineering phase (detailed design), and any impacts identified may require offsetting during the permitting phase.

7.9.5.1.2.2 QR Mill

Mitigation measures at the QR Mill are the same as those described for the Mine Site. Therefore, effects on fish and fish habitat from loss of instream or riparian habitat are not expected and are not carried forward.

7.9.5.1.2.3 Transmission Line

The Transmission Line route was designed to minimize access road requirements by using existing roads, wherever possible. There are no new roads anticipated, thereby avoiding new instream works. Seven existing access roads may require upgrades, which may include culvert or bridge upgrades (Figure 7.9-7). It is assumed that these upgrades will be within the existing footprint and will not affect fish and fish habitat provided appropriate mitigation is implemented. All instream works will be conducted following BMPs for working in and around water. Mitigation measures for culvert maintenance and replacement include:

- Time the works for when the channel is dry or frozen to the bottom, or during the least risk windows to protect fish, unless otherwise approved by the applicable provincial and/ or federal authority;
- Controlling sediment and erosion downstream during the Construction and Operations Phases through the use of ESC measures such as riprap and silt fencing;
- Maintaining fish passage;
- Heavy equipment or vehicle crossings through watercourses, which include wetlands and ponds, is prohibited unless detailed under a special provision in a site-specific prescription or with specific regulatory agency approval; and
- Retaining a qualified environmental professional to conduct a fish salvage, if required.

Construction will be done by following those BMPs for instream works or works in and around water, eliminating this pathway for potential effects to fish habitat and potential effects to fish, including migration. Therefore, effects to fish and fish habitat from road crossing upgrades are not expected and are not carried forward.

During construction of the Transmission Line, the ROW will have to be cleared, including riparian vegetation, to ensure limits of approach for the line. There are no anticipated instream works. Mitigation measures used to reduce the effects to riparian habitat include:

- Fall trees directionally away from watercourse banks to the extent allowed by the need to maintain safe working clearances from the electrical system;
- Restrict debris from entering high-water mark without specific regulatory agency approval;
- Maintain groundcover and shrubs within 30 m of watercourses and waterbodies along the Transmission Line;

- Trees will not be removed in steep gulches, unless identified as necessary by a Qualified Professional and/or where safety is a concern if not removed;
- Clearly flag or delineate riparian management zones where vegetation clearing may be restricted, typically 15 m from watercourses or waterbodies;
- Conduct work during applicable timing windows to protect fish, unless otherwise approved by the applicable provincial and federal authority;
- Grubbing of stumps and roots in riparian habitat will not be conducted unless approved and under the guidance of a qualified professional; and
- Re-vegetate disturbed areas with native species.

After decommissioning of the Transmission Line, vegetation will be allowed to regenerate naturally. If there are bare areas or areas of sensitive soils or vegetation, site-specific revegetation plans will be developed and implemented by a Qualified Professional.

All mitigation measures identified are commonly used for transmission line construction, maintenance, and closure and are considered effective. Despite the design considerations, clearing the ROW will result in riparian vegetation alteration next to watercourses, and habitat alteration cannot be fully avoided or mitigated.

7.9.5.1.3 Mitigation Measures for Change in Water Quality resulting in Effects to Fish, Fish Habitat, and Aquatic Resources

Mitigation measures for water quality and sediment quality are provided in Section 7.4.5.

The primary mitigation measures for changes in water quality are discussed in Section 7.4 Surface Water.

7.9.5.1.3.1 Mine Site

The design of the WTP and diffuser has been planned to limit the impacts on the environment. Details concerning the design of the WTP and diffuser are provided in Section 7.4.5.1.2. Other Management Plans with regard to changes in water quality are outlined in Section 7.4.5.1.3 and 7.4.5.1.4. A site water management plan has been developed for the Mine Site that provides details of water management strategies and guidance on protecting natural waterways surrounding the Project to follow applicable BMPs, including references to water treatment, effluent discharge permits, and legislation.

As discussed in Section 7.4.7.3.4, effluent discharges and seepages are not expected to be acutely lethal to fish or *Daphnia magna* (vis-à-vis the MDMER) and receiving environment concentrations are expected to be lower than ambient water quality guidelines for the protection of aquatic life or applicable toxicological benchmarks. There is high confidence and low uncertainty in the predicted water quality and water quality guidelines as a result of conservative model assumptions and the relationship of exposure and toxicity modifying factors with water quality guidelines. Therefore, effects to aquatic life, including periphyton, plankton, benthic invertebrates, and fish, are not expected and are not carried forward.

The application of BMPs for bridge construction and culvert installation will reduce or eliminate pathways for effects to aquatic resources.

Other Management Plans with regard to changes in water quality are outlined in Section 7.4.5.1.3 and Section 7.4.5.1.4.

Additional mitigations measures are outlined in various management plans but include mitigation measures during construction, operations, and closure for:

- Controlling sediment and erosion through various means (ex, silt fences, detention swales, revegetation etc.);
- Storage of chemicals, fuel, and equipment, including refuelling, will be greater than 30 m away from watercourses and waterbodies;
- Implement spill response procedures;
- Implement dust control on roads;
- Use of salt for road traction; aggregate/sand will be prohibited. No application of salt or sand for de-icing measures will occur within 30 m of a watercourse crossing, unless required for safety reasons in specific instances;
- Implement progressive reclamation; and
- Clearly flag or delineate riparian management zones where use of herbicides may be restricted, usually 15 m from watercourses or waterbodies.

Post-closure active water management and treatment will continue until the water quality threshold objectives are met and water can be safely discharged back into the local receiving environment. This includes Jack of Clubs Lake at the Mine Site and Lowhee Creek, and Stouts Gulch at the Bonanza Ledge Site.

During reclamation, natural drainage patterns will be re-established through contouring and non-potentially acid generating rock will be applied as rock armour to drainage channels or areas expected to require additional erosion mitigation. The Reclamation Plan (Section 1.0-11) identifies additional mitigation measures for revegetation, control of erosion, and sedimentation.

The application of BMPs for bridge construction and culvert installation will reduce or eliminate pathways for effects to aquatic resources, fish, and fish habitat.

7.9.5.1.3.2 QR Mill

The design of the WTP at the QR Mill has been planned to limit impacts on the environment. The design is provided in Section 7.4.5.1.2. Other Management Plans with regard to changes in water quality are outlined in Sections 7.4.5.1.3 and 7.4.5.1.4. A site water management plan has been developed for the QR Mill that provides details of water management strategies and guidance on protecting natural waterways surrounding the Project to follow applicable BMPs, including references to water treatment, effluent discharge permits, and legislation.

As discussed in Section 7.4.7.3.6, effluent discharges and seepages are not expected to be acutely lethal to fish or *Daphnia magna* (vis-à-vis the MDMER) and receiving environment concentrations are expected to be lower than ambient water quality guidelines for the protection of aquatic life or applicable toxicological benchmarks. There is high confidence and low uncertainty in the predicted water quality and water quality guidelines as a result of conservative model assumptions and the relationship of exposure and toxicity modifying factors with water quality guidelines. Therefore, effects to aquatic life, including periphyton, plankton, benthic invertebrates, and fish, are not expected and are not carried forward.

7.9.5.1.3.3 Transmission Line

The application of erosion and sediment control measures will reduce or eliminate the pathway for effects to aquatic resources.

Mitigation measures to avoid or minimize changes to water quality that could adversely affect Freshwater Fish include those that prevent erosion and sedimentation and the release of deleterious substances. These mitigation measures include:

- Maintain groundcover and shrubs within 30 m of watercourses and waterbodies along the Transmission Line;
- Operate construction and maintenance equipment from land or top of bank in stable dry areas;
- Avoid storage of No fuels, oils, or other hazardous substances will be stored within 100 m of any waterbody;
- Clearly flag or delineate riparian management zones where use of herbicides may be restricted, usually 15 m from watercourses or waterbodies;
- Equipment will be properly maintained; mobile and stationary engines will be inspected and have regular servicing following manufacturer specifications;
- Heavy equipment or vehicle crossings through watercourses, which include wetlands and ponds, is prohibited unless detailed under a special provision in a site-specific prescription or with specific regulatory agency approval; and
- Avoid No equipment maintenance or re-fueling will be conducted within 100 m from any waterbody.

All mitigation measures for water quality identified are commonly used for transmission line construction, maintenance, and closure and are considered effective. The application of erosion and sediment control measures will reduce or eliminate the pathway for effects to fish and fish habitat. At decommissioning riparian vegetation will be allowed to grow back, limiting potential effects to watercourses; therefore, anticipated effects during post-closure are likely negligible and are not carried forward.

7.9.5.1.4 Mitigation Measures for Changes in Water Quantity that Result in Effects to Fish and Fish Habitat

The primary mitigation measures for changes in water quantity are discussed in Section 7.4.5.1 Surface Water.

7.9.5.1.4.1 Mine Site

The Willow River watercourse crossing that will be constructed for the new Mine Site road will be a clearspan bridge, which has no infrastructure in the watercourse and has been designed to avoid impacts to instream fish habitat. The bridge will be constructed by following BMPs for instream works or works in and around water, avoiding this pathway for effects to fish habitat and potential effects to fish, including migration. Therefore, effects on fish and fish habitat are not expected and are not carried forward.

Construction and operations of the Mine Site water management system (i.e., channels, ponds, sumps) have the potential to affect both the timing and magnitude of runoff reporting to existing surface water features. During construction, diversion and runoff are expected to result in residual effects on water quantity at the Mine Site. Therefore, effects on fish and fish habitat are anticipated as a result of changes in flow.

The discharge of treated effluent to Jack of Clubs Lake will result in an incremental increase in lake outflow and water level. The increased outflow will subsequently translate to an increase in streamflows in the downstream system. During operations, effluent discharge is expected to result in residual effects for water quantity at the Mine Site. Therefore, effects on fish and fish habitat are anticipated as a result of changes in flow.

The design of closure and post-closure landforms will minimize contact water production and restore natural water flow. Water management infrastructure will largely be decommissioned and removed during closure, including the breach of sedimentation pond dikes. Non-contact ditches to remain in place will be adjusted to meet the Project's closure water management plan criteria. Contact water ditches will be rehabilitated at the Bonanza Ledge Site as non-contact water ditches and remain in operation in perpetuity. They will be inspected by a qualified professional to ensure free-drainage. During closure and post-closure, residual effects from changes in flow at Stouts Gulch are not anticipated to result in erosion within the channel outside of its natural geomorphic regime. Streamflows in Stouts Gulch, Lowhee Creek, and the Willow River are expected to be maintained within the historical range of variability. Therefore, effects to fish and fish habitat are not anticipated as a result of changes in flow or are likely negligible and are not carried forward.

7.9.5.1.4.2 QR Mill

Similar to the Mine Site, diversion ditches will be designed to carry appropriate peak flows and to discharge without scouring.

The discharge of treated effluent to Rudy Creek during construction and operations will result in an incremental increase in stream flows in the downstream system. During operations, effluent discharge is expected to result in residual effects for water quantity at the QR Mill. Therefore, effects on fish and fish habitat are anticipated as a result of changes in flow.

At the QR Mill, the FSTSF collection ponds will be drained. Non-contact ditches will be upgraded to meet closure criteria. Both the South Seepage Collection Pond and North Seepage Collection Pond will be reclaimed as open water bodies with functional riparian areas. There are no anticipated changes to diversion and runoff at the QR Mill for the Construction, Operations, or Closure Phases. Therefore, effects on fish and fish habitat are not anticipated or are likely negligible and are not carried forward.

7.9.5.1.4.3 Transmission Line

Upgrades of culverts and bridges will be done by following those BMPs for instream works or works in and around water, eliminating this pathway for effects to fish habitat and potential effects to fish, including migration. Culverts and bridges will be designed to allow for fish passage where appropriate, including the use of open-bottom culverts at fish-bearing watercourses. Any upgrades to existing infrastructure will follow provincial and federal best management practices to reduce the likelihood of potential harmful alteration, disruption or destruction to fish habitat. Therefore, effects on fish and fish habitat are not expected and are not carried forward.

For the Transmission Line, surfaces will be recontoured for surface drainage as necessary to meet the Project's site drainage and water management plan requirements. Therefore, anticipated effects during post-closure are likely negligible and are not carried forward.

7.9.5.2 Effectiveness and Uncertainty of Mitigation

Mitigation measures are categorized for effectiveness in eliminating or reducing potential effects, following the methods described in Section 6.5.1.2 of Chapter 6.0. If a mitigation measure will eliminate a potential effect and no potential residual effect is identified, then the effect is not carried forward for further analysis. If a mitigation measure is not expected to eliminate an effect, a residual effect is identified and carried forward for further analysis (i.e., characterization of the negative effect). Adaptive management is a follow-up strategy employed to address uncertainties in a follow-up program by defining monitoring, auditing, and follow-up reporting and providing lessons learned on how to address uncertainties.

7.9.5.3 Mitigation Summary

The key measures proposed for mitigating potential effects on Freshwater Fish, along with mitigation effectiveness and uncertainty, are outlined in Table 7.9-21. Residual effects are identified and carried forward in assessing negative residual effects.

7.9.6 Assessing Positive Effects

Positive effects on fish, aquatic resources, and fish habitat are not expected as a result of the Project.

7.9.7 Assessing Negative Residual Effects

7.9.7.1 Summary of Residual Effects

The residual effects for Freshwater Fish after application of mitigation measures are:

- Loss or alteration of riparian habitat along the Transmission Line and at the Willow River bridge; and
- Change in water quantity at the Mine Site and QR Mill resulting in effects to fish and fish habitat.

7.9.7.2 Methods

The characterization of potential residual effects was based on several criteria: context, magnitude, extent, duration, reversibility, frequency, affected populations, and risk and uncertainty (likelihood and consequence). These criteria are defined for Freshwater Fish in Table 7.9-22.

Table 7.9-21 Proposed Mitigation Measures and Their Effectiveness – Freshwater Fish

Project Phase	VC Subcomponent	Project Effect	Mitigation	Effectiveness	Uncertainty	Residual Effect
Construction	Fish	Direct mortality to fish - Instream works related to watercourse crossings	• Installation of a clear-span bridge. • Conduct work during applicable timing windows to protect fish, unless otherwise approved by the applicable provincial and federal authority. • Conduct in-stream work in dry, low flows or frozen conditions. • Retain a qualified environmental professional to conduct a fish salvage if required. • Apply applicable BMPs for working in-stream works and working in and around water.	High	Low	No
Construction, Operations, Closure	Fish	Direct mortality to fish - Increased fishing pressure from access	• Fishing will be prohibited for all employees and contractors while working on-site or while commuting to and from the Project sites. • Use of recreational vehicles at the Project sites will be prohibited. • Gates at all ODV properties will be locked when not operating, unless circumstances for which this is not required are outlined in an appropriate Management Plan (e.g., in an emergency, identified in the Project Emergency Response Plan). • Close roads that are no longer required for ongoing activities and place obstructions on former roads ROWs to deter human access. • Revegetate roads and remove culverts and fill material to create irregular mounds and ridges consistent with the surrounding terrain.	Medium	Moderate	No
Construction, Operations, Closure, Post-Closure	Fish and Fish Habitat	Loss or alteration of instream or riparian habitat related to watercourse crossings, including Transmission Line ROW construction and maintenance	• Controlling sediment and erosion downstream during the Construction and Operations Phases through the use of erosion and sediment control (ESC) measures such as riprap and silt fencing. • Maintaining fish passage. • Riparian areas (for wetlands and waterways) will be managed according to the recommended management zone setbacks and work practices provided in the *Mines Act* (1996) and *Forest and Range Practices Act* (2002). • Installation of a clear-span bridge.	Medium to High	Low	Yes

Project Phase	VC Subcomponent	Project Effect	Mitigation	Effectiveness	Uncertainty	Residual Effect
			• Heavy equipment or vehicle crossings through watercourses, which include wetlands and ponds, is prohibited unless detailed under a special provision in a site-specific prescription or with specific regulatory agency approval. • Restrict debris from entering the high-water mark without specific regulatory agency approval. • Apply applicable BMPs for working in-stream works and working in and around water. • Time the works for when the channel is dry or frozen to the bottom or during the least risk windows to protect fish, unless otherwise approved by the applicable provincial and or federal authority. • Fall trees directionally away from watercourse banks to the extent allowed by the need to maintain safe working clearances from the electrical system. • Maintain groundcover and shrubs within 30 m of watercourses and waterbodies along the Transmission Line. • Trees will not be removed in steep gulches, unless identified as necessary by a Qualified Professional and/or where safety is a concern if not removed. • Clearly flag or delineate riparian management zones where the use of herbicides may be restricted, usually 15 m from watercourses or waterbodies. • Grubbing of stumps and roots in riparian habitat will not be conducted unless approved and under the guidance of a Qualified Professional. • Re-vegetate disturbed areas with native species.			

Project Phase	VC Subcomponent	Project Effect	Mitigation	Effectiveness	Uncertainty	Residual Effect
Closure	Fish and Fish Habitat	Loss or alteration of instream or riparian habitat from decommissioning of Transmission Line corridor.	• Vegetation will be allowed to naturally regenerate. If there are bare areas or areas of sensitive soils or vegetation, site specific revegetation plans will be developed and implemented by a qualified professional.	High	Low	No
Construction, Operations, Closure, Post-Closure	Fish, Fish Habitat, and Aquatic Resources	Change in Surface Water Quality resulting in effects to Fish, Fish Habitat and Aquatic Resources - discharge of effluent at the Mine Site and QR Mill	• Application of mitigation measures for water quality and sediment quality as outlined in Section 7.4.5. • Water Management Plan including diversion of contact water to sediment ponds and upgraded Water Treatment Plant prior to discharge into Jack of Clubs Lake or the Willow River. • Water Management Plan including diversion of contact water to sediment ponds and upgraded Water Treatment Plant prior to discharge into Rudy Creek. • Storage of chemicals, fuel, and equipment, including refueling will be greater than 30 m away from watercourses and waterbodies. • Implement spill response procedures. • Implement dust control on roads. • Use of salt for road traction aggregate/sand will be prohibited. No application of salt or sand de-icing measures will occur within 30 m of a watercourse crossing, unless unsafe to do so. • Implement progressive reclamation. • Implement avoidance or measures for the application of pesticides/herbicides near watercourses.	High	High	No

Project Phase	VC Subcomponent	Project Effect	Mitigation	Effectiveness	Uncertainty	Residual Effect
Construction, Operations, Closure	Fish, Fish Habitat, and Aquatic Resources	Change in Surface Water Quality resulting in effects to Fish, Fish Habitat, and Aquatic Resources - sedimentation and erosion along the Transmission Line	• Controlling sediment and erosion downstream during Construction and Operations Phases through the use of ESC measures such as riprap and silt fencing. • Maintain groundcover and shrubs within 30 m of watercourses and waterbodies along the Transmission Line. • Operate construction and maintenance equipment from land or top of the bank in stable dry areas. • No fuels, oils, or other hazardous substances will be stored within 100 m of any waterbody. • Clearly flag or delineate riparian management zones where use of herbicides may be restricted, usually 15 m from watercourses or waterbodies. • Equipment will be properly maintained; mobile and stationary engines will be inspected and have regular servicing following manufacturer specifications. • No equipment maintenance or re-fueling will be conducted within 100 m of any waterbody.	High	Low	No
Construction	Fish and Fish Habitat	Change in Surface Water Quantity resulting in effects to Fish and Fish Habitat - water management structures at the Mine Site	• Application of mitigation measures for water quantity and as outlined in Section 7.4.5. • Divert all non-contact water away from the Project site into existing drainages.	Medium	Low	Yes
Operations, Closure, Post-Closure (active care)	Fish and Fish Habitat	Change in Surface Water Quantity resulting in effects to Fish and Fish Habitat - water management structures at the Mine Site	• Application of mitigation measures for water quantity and as outlined in Section 7.4.5.	High	Low	No
Construction, Operations, Closure, Post-Closure (active care)	Fish and Fish Habitat	Change in Surface Water Quantity resulting in effects to Fish and Fish Habitat - discharge of effluent at the Mine Site and QR Mill.	• Application of mitigation measures for water quantity and as outlined in Section 7.4.5.	Medium	Low	Yes
Construction, Operations, Closure, Post-Closure (active care)	Fish and Fish Habitat	Change in Surface Water Quantity resulting in effects to Fish and Fish Habitat - water management structures at QR Mill	• Application of mitigation measures for water quantity and as outlined in Section 7.4.5. • At the QR Mill, the FSTSF collection ponds will be drained. Non-contact ditches will be upgraded to meet closure criteria. Both the South and North Seepage Collection Ponds will be reclaimed as open water bodies with vegetated riparian areas.	High	Low	No

Table 7.9-22 Residual Effects Criteria – Freshwater Fish

Criteria	Residual Effect Characterization
Context	**Low**: the receiving environment or population has a low resilience to imposed stresses and will not easily adapt to the potential residual effect **Neutral**: the receiving environment or population has a neutral resilience to imposed stresses and may be able to respond and adapt to the potential residual effect **High**: the receiving environment or population has a high natural resilience to imposed stresses and can respond and adapt to the potential residual effect
Magnitude	**Negligible**: no detectable change from existing conditions **Low**: the potential residual effect will slightly alter or change the fish habitat without changing its role or function **Medium**: the potential residual effect will alter or change the nature, role, or function of fish habitat but will not affect its integrity **High**: the potential residual effect will substantially alter or change the nature, role, or function of the fish habitat and may thus jeopardize the integrity of the fish
Extent	**Limited**: the potential residual effect is restricted to the Project Footprint **Local**: the potential residual effect will be within the local assessment area **Regional**: the potential residual effect will be within the regional assessment area **Beyond Regional**: the potential residual effect will be beyond the regional assessment area
Duration	**Short term**: the anticipated potential residual effect will be felt temporarily during the Project's Construction or Closure Phases only. Also applies to any effect that will occur for less than two years in operations **Medium-term**: the anticipated potential residual effect will be felt for a limited period of time greater than two years, generally corresponding to the Operations Phase and Closure Phase **Long-term**: the anticipated potential residual effect will be felt beyond the Closure Phase
Reversibility	**Fully reversible**: fish and fish habitat may fully recover and return to its pre-Project state **Partially reversible**: fish and fish habitat may partially recover from the Project changes **Irreversible**: fish and fish habitat will not recover and return to its pre-Project state
Frequency	**Once**: effect is confined to one discrete event (month) **Regular**: effect occurs at consistent intervals **Irregular**: effect occurs at sporadic intervals **Continuous**: effect occurs constantly
Affected Populations	**Even**: the potential effect is experienced by any and all sub-populations **Disproportionate**: the potential effect is experienced only by certain sub-populations or experienced more acutely by certain sub-populations

7.9.7.2.1 Analytical Assessment Techniques

Geographic information system modelling was used to estimate the area of riparian vegetation for the Transmission Line based on a 30 m riparian buffer from each side of the watercourse obtained from the Cariboo Chilcotin Land Use Plan for the ROW and a 5 m buffer from each side of the watercourse for the access roads. A smaller buffer was used for the access road upgrades as the road width is smaller than the ROW width, and clearing of riparian would have already occurred for the existing road. The buffer would account for any additional clearing that may be required for access road upgrades. Access road upgrades where culverts may exist were mapped compared to the BC Freshwater Atlas, and anywhere the two overlapped was considered to be a potential culvert upgrade location.

In addition, each watercourse crossing was compared to available imagery datasets to determine the landscape type of the riparian vegetation at the crossing location, if it was vegetated (forested) or non-vegetated (cleared, agriculture, developed), and to what extent the riparian vegetation at the crossing was non-vegetated within the Assessment Areas. Data used for the assessment included the following:

- 2019 Orthophoto provided by ODV that covers most of the transmission line (0.1 m resolution);
- 2021 drone imagery provided by ODV that covers part of the transmission line (0.1 m resolution); and
- 2021 Sentinel Satellite Data (ESA, 2021) to compare the above imagery to identify any new cutblocks in 2021 (10 m resolution).

All other modelling for water quality and water quantity are provided in Section 7.4.

7.9.7.2.2 Risk and Uncertainty

For the purposes of this assessment, the likelihood and consequences of a potential residual effect occurring are described as risk.

Likelihood is the probability of an event occurring and can be influenced by many factors. For the purposes of this assessment, likelihood is rated as low, moderate, or high, using the rating definitions provided in Section 6.7.1.8.

Consequence can be assessed as minor, moderate, or major (Chapter 6.0, Table 6.7-1) based on the combination of magnitude and extent of the residual effect.

Based on the results of the likelihood and consequence ratings for each residual effect, as described above, risk can be determined. A matrix of risk ratings using likelihood and consequence for the Project has been provided in Chapter 6.0, Table 6.7-2.

Many types of uncertainty are relevant to assessing whether an effect will occur and the implications of the effect. Uncertainty in the assessment is to be expected, particularly when predicting outcomes in complex physical, biological, and human systems. The assessment includes a characterization of uncertainty and level of confidence in the predicted potential residual effects. Confidence is a measure of how well potential residual effects are understood and the quality of the input data. It considers the level of uncertainty associated with the residual effects assessment.

The following are considered in the determination of confidence in the residual effects assessment for freshwater fish:

- Reliability of data inputs and analytical methods used to predict Project effects;
- Confidence regarding the effectiveness of mitigation measures;
- Certainty of the predicted outcome; and
- Confidence ratings and definitions as described in Section 6.7.1.8.

7.9.7.2.3 Importance

Importance of a residual effect refers to whether the effect or underlying issue has been previously identified as an interest and/or priority of potentially affected Indigenous nations, the public, local governments, provincial or federal government agencies, or stakeholders. For the purposes of the EA, importance is defined as described in Section 6.7.2.

7.9.7.3 Potential Residual Effects

7.9.7.3.1 Loss or Alteration of Riparian Habitat

Riparian habitat loss at the clearspan bridge is expected adjacent to the Willow River and cannot be avoided.

There is potential for riparian habitat alteration for the Transmission Line where the Transmission Line ROW intersects with the riparian vegetation that will be cleared at each watercourse crossing. To avoid loss of riparian function at these watercourse crossings, low-growing vegetation, including shrubs and grasses, will be allowed to grow and will be conserved during construction and operations. During closure and post-closure, the Transmission Line ROW will be allowed to revert to near existing conditions. There is no anticipated new loss of riparian or instream habitat for access roads for the Transmission Line as existing roads will be used and upgraded rather than disturbing new areas.

7.9.7.3.1.1 Residual Effect Analysis

The Willow River Bridge will retain some functions of riparian vegetation such as shading and cover, and beds and banks will be stabilized to prevent erosion. Potential adverse effects to fish from the Willow River Bridge construction to riparian vegetation are therefore expected to be negligible with the application of mitigation measures.

It is unlikely that riparian vegetation removal along the Transmission Line at larger watercourse crossing, including the Cottonwood River, will reduce fish habitat because small sections of riparian vegetation removal have little influence over temperature, instream habitat, or nutrient input availability in such a large river system. For smaller watercourses, it is unlikely that riparian vegetation removed for the Transmission Line will significantly impact nutrient inputs, temperature, or instream habitat. Large sections of cleared riparian vegetation (greater than 1 km) are more likely to have potential adverse effects on fish and fish habitat than small sections (less than 1 km) (Hetrick et al., 1998). Out of the 63 Transmission Line sites assessed, 51 sites are located in a forested area, while 12 are located next to or within a cleared area. Of these cleared areas, six are located in cutblocks where a small buffer has been left where a watercourse was present. Of these six sites, three are NCDs and have no fish habitat, and three have marginal habitat with low flows and steep gradients. Only one of these sites was in a cutblock that was 1 km long; however, this site was classified as a NCD (M-57580) and did not have fish habitat.

The remaining six sites are in small cleared areas due to anthropogenic activities, or the riparian area is next to a road. Of these sites, four are NCDs with no fish habitat. One site is the Lowhee Creek crossing; however, there is no concern for the Lowhee Creek Transmission Line site as the location is a BC database mapping error, and the watercourse is 200 m away and does not cross the proposed Transmission Line ROW. The sixth site is on Tregillus Creek, which has Important habitat, and there is a cleared area up to 40m long adjacent to the creek within the ROW. This site has already been cleared within the ROW and is not likely to be cleared again as part of construction activities.

The expected maintained ROW will be 30 m and is not likely to have adverse effects on Bull Trout, Rainbow Trout, or other species and their habitat. Potential effects to fish along the Transmission Line from the alteration of riparian vegetation are expected to be negligible with the application of mitigation measures.

7.9.7.3.1.2 Characterization of Residual Effect

The residual effect to Freshwater Fish from the loss or alteration of riparian habitat from watercourse crossings, including the Willow River Bridge and the Transmission Line ROW, are characterized in Table 7.9-23.

Table 7.9-23 Residual Effect Characterization for Loss or Alteration of Riparian Habitat

Criteria	Characterization	Rationale
Context	High	Fish populations are resilient to small changes.
Magnitude	Low	Low-lying riparian vegetation will be retained or is limited to a small area.
Extent	Limited	Only discrete sections within the footprint will be affected.
Duration	Medium-term	Riparian vegetation will be maintained until decommissioning during closure and post-closure.
Reversibility	Fully reversible	Riparian vegetation may fully recover and return to its pre-Project state when the Transmission Line and Willow River bridge are decommissioned.
Frequency	Regular	Change to riparian habitat will occur once during construction and maintained at consistent intervals (not every year) until decommissioning, when vegetation will be allowed to regrow.
Affected Populations	Even	The potential effect is experienced by any and all sub-populations.

7.9.7.3.1.3 Risk and Uncertainty

The likelihood of the event occurring is low as the chance of the effect to occur is small with the implementation of mitigation measures. Implications of linear developments on fish and riparian habitat are likely negligible to the overall functioning of a watercourse when BMPs are followed (Cott et al., 2015). The length of the riparian vegetation disrupted is also important. Large sections of cleared riparian area next to watercourses (greater than 1 km) are more likely to have potential adverse effects on fish and fish habitat than small sections (less than 1 km). For example, Hetrick et al. (1998) found that allochthonous input decreased following canopy removal but amounts of stored organic matter in the substrate did not differ significantly between the open and closed-canopy sections of relatively short reaches (40 m to 70 m long). Since some riparian vegetation will be maintained next to watercourses, these effects are expected to be further reduced.

The consequence is minor and the risk is low when the type of riparian and available habitat is still available, and the clearing is limited in extent (Table 7.9-24).

Table 7.9-24 Risk and Uncertainty Characterization for Loss or Alteration of Riparian Habitat

Criteria	Characterization	Rationale
Likelihood	Low	The likelihood of the effect occurring is low because some riparian vegetation will be retained within the Transmission Line ROW, and the access roads will be a limited disturbance.
Consequence	Minor	Extent is limited, and the magnitude is low.
Risk	Low	The consequence is minor, and the likelihood is low.
Confidence	Moderate	BMPs and mitigation measures are well understood, but existing conditions data is lacking for some watercourse crossings.

Notes: ROW = right-of-way; BMP = best management practice

The level of confidence associated with the predicted residual effect on fish and fish habitat is Moderate. Proposed mitigation measures and BMPs are highly effective for clearspan bridges and transmission line construction and maintenance. However, the Transmission Line route and associated access road designs have not yet been finalized, and some access road upgrade crossings have not been assessed; there is uncertainty associated with these areas and their contribution to fish and fish habitat. Once designs are completed, and each site is assessed, the confidence level is likely to increase as design and construction for these components will likely adhere to industry standards that are well known and tested.

7.9.7.3.1.4 Importance

Importance is Moderate as impacts to watercourse crossings have been identified as a concern along the Transmission Line corridor by participating Indigenous nations. Detailed design of the Transmission Line route and upgraded access roads is underway, and field studies and consultation are ongoing for this Project component, which may change the level of importance.

7.9.7.3.2 Changes in Water Quantity at the Mine Site and QR Mill that Result in Effects to Fish and Fish Habitat

7.9.7.3.2.1 Residual Effect Analysis

A summary of the water quantity changes at the Mine Site and QR Mill is presented here. Refer to Section 7.4 for further details.

7.9.7.3.2.2 Mine Site

A residual effect to fish and fish habitat from changes in streamflow due to diversion in Lowhee Creek and the Jack of Clubs Lake outlet is anticipated based on the predicted changes in flow at the Mine Site during the Construction and Operations Phases. Annual average flows at Lowhee Creek above Williams Creek and Jack of Clubs Lake at the outlet are predicted to decrease by 4% when runoff is being collected within the site water management system without discharge of effluent. Peak flows at the Jack of Clubs outlet are predicted to decrease by about 10%, and low flows will increase by about 25%. The changes in streamflow within the Jack of Clubs Lake and Lowhee Creek watersheds will propagate to downstream locations.

There will be no discharge to Lowhee Creek during the Operations Phase and flows are expected to be similar to the Construction Phase. Treated effluent discharged into Jack of Clubs Lake will cause changes in flows at the outlet into the Willow River. Annual average flows at Jack of Clubs Lake at the outlet are predicted to remain similar to existing conditions; however, a change in the seasonal distribution of flows is predicted during the Operations Phase. Peak flows at the Jack of Clubs Lake outlet are only marginally influenced by effluent discharge, with a predicted decrease of around 10%, similar to predictions for construction. Effluent discharge is predicted to increase low flows at the Jack of Clubs Lake outlet by up to 20%. It is assumed that these changes in streamflow are within the historical change of variability, and existing watercourses are able to convey flows.

The lower reaches of Lowhee Creek have important habitat, and Rainbow Trout have been captured in Reaches 1.1, 1.2, and 3 (Figure 7.9-11). Low flows into Lowhee Creek may affect fish habitat by reducing the availability of preferred habitat. Reduced flows are predicted during operations when the water is being diverted to the WTP for discharge into Jack of Clubs Lake. The lowest flows are predicted to occur in the winter (February) with a reduction of flow (0.012 m^3/s) compared to existing conditions (0.017 m^3/s) in Lowhee Creek. Only Reach 1.1 of Lowhee Creek has overwintering habitat rated as good, which may be affected by reduced flows.

Reach 5 and 6 of the Willow River are considered important habitat for fish with excellent habitat, but Reach 6 has no appropriate spawning gravels. Lake Chub spawning occurs at the outlet to Jack of Clubs Lake. Lake Chub spawn over gravel or around large rocks in shallow water, but spawning over other substrates (i.e., silt) has been observed (Roberge, 2002). Rainbow Trout and White Sucker also use Willow River Reach 5 for spawning, where suitable substrates (gravel) are found. Changes in low flows are not likely to affect spawning of Lake Chub at the outlet to Jack of Clubs Lake because the flow habitat requirements of spawning Lake Chub are less stringent relative to other stream fish species (McPhail, 2007), and the anticipated 0.1 m^3/s increase in flows is not expected to result in substantial habitat changes and is within the range of natural variability. Low flows may affect spawning for Rainbow Trout and White Sucker, depending on timing. Both Rainbow Trout and White Sucker spawn in spring. At the outlet, predicted monthly changes for spring increase in March, while the remaining spring months show a small reduction (<11%). These changes propagate to downstream locations. However, measurable changes are not predicted to streamflow in the Willow River downstream of Mosquito Creek or locations further downstream, with the exception of low flows, which will increase by up to 60% during Construction. Monthly predicted flows are less than the existing condition peak flows at the outlet downstream from Mosquito Creek for the 2-yr event. Therefore, effects to spawning habitat or the ability of Rainbow Trout and White Sucker to spawn is unlikely.

Low flows may limit overwintering habitat in the Willow River and Lowhee Creek, assuming that water does not freeze to the bottom. Jack of Clubs Lake likely provides the most overwintering habitat for fish.

7.9.7.3.2.3 Characterization of Residual Effect

The residual effect to Freshwater Fish from Water Quantity changes at the Mine Site is characterized in Table 7.9-25.

Table 7.9-25 Residual Effect Characterization for Water Quantity Changes at the Mine Site

Criteria	Characterization	Description
Context	High	Streamflows are expected to be maintained within the historical range of variability. Fish and fish habitat can recover from changes in flows within the historical range of variability.
Magnitude	Low	Streamflows are expected to be maintained within the historical range of variability.
Extent	Local	The effects are limited to the lower reaches of Lowhee Creek, the outlet of Jack of Clubs Lake, and upper reaches of the Willow River, and dissipate to existing conditions further downstream.
Duration	Medium-term	Changes in flow are expected to continue throughout operations.
Reversibility	Reversible	Changes in flow are expected to return to existing conditions once discharge ceases.
Frequency	Regular	Discharge of effluent will be regular, as required by site water management requirements, and discharge will be required through all Project phases.
Affected Populations	Even	The potential effect is experienced by any and all sub-populations.

7.9.7.3.2.4 Risk and Uncertainty

Changes in stream flow and how they affect fish and fish habitat are reasonably understood (Table 7.9-26). However, uncertainties exist in water quantity flow modelling, including predicted changes under climate change scenarios (See Section 7.4). There is also no modelling with regard to the Jack of Clubs lakeshore and changes in water levels or fish habitat as a result of increased flow; however, the highest densities and biomass of fish were observed at the south end of the lake, furthest from the diffuser location (See Appendix 7.9-4 Jack of Clubs Lake Fish Sampling Report). The diffuser is also located at the bottom of the lake with low fish biomass. Redside Shiner was observed swimming in proximity to the shoreline, and the diffuser has been placed away from the shoreline. Usable habitat areas for each life stage of fish under each flow scenario are not available or have been modelled in the Willow River, Stouts Gulch, or Lowhee Creek.

Table 7.9-26 Risk and Uncertainty Characterization for Water Quantity Changes at the Mine Site

Criteria	Characterization	Rationale
Likelihood	Low	Even though changes in flow are expected, they are within the range of natural variation, and fish can adapt.
Consequence	Minor	Extent is limited, and the magnitude is low.
Risk	Low	The consequence is minor, and the likelihood is low.
Confidence	High	Fish and use of habitat information is available for Jack of Clubs Lake, and the diffuser location takes this information into consideration.

The level of confidence associated with the predicted residual effect is high as there are fish and fish habitat data for Jack of Clubs Lake, and the diffuser location has been placed in a location to avoid or minimize interactions with fish and fish habitat. Overwintering habitat is assumed to occur in Jack of Clubs Lake; it is unknown if fish use Lowhee Creek or the Willow River for overwintering, and this can only be assumed based on the presence of suitable overwintering habitat.

7.9.7.3.2.5 Importance

Importance is high as water quantity and maintenance of stream flows at the Mine Site has been identified as a concern and of high interest, including by participating Indigenous nations, community members, the public, local governments, and/or provincial and federal government agencies. There are concerns with regard to water quantity and WTP to manage the capacity for storage during flooding and freshet events and the effects of climate change on these events.

7.9.7.3.2.6 QR Mill

A residual effect to fish and fish habitat from changes in streamflow in Rudy Creek is anticipated based on the predicted changes in flow at the QR Mill during the Construction and Operations Phases.

During construction, drawdown of the existing tailings storage facility will result in an increase in flows downstream into Rudy Creek. For the monthly distribution of flow changes, the largest percentage increase in flows happens during the drier fall months of September and October at upwards of 1,200%, and the smallest increase is in April at around 50%. The predicted 10-yr and 100-yr return period peak flows are predicted to increase in magnitude by 10% and 7%, respectively, under the condition during dewatering. This potential for an increase in peak flow magnitude may result in erosion beyond the active geomorphological process that the creek has evolved to; however, the likelihood of the occurrence of an extreme flow with the potential to meaningfully alter stream dimensions (e.g., 100-yr event or larger) is limited during the dewatering period of 10 months. The presence of Sandy Lake downstream of the dewatering discharge location will attenuate flows and reduce the relative increase in peak flows in the downstream system.

During the Operations Phase, an increase in flows downstream into Rudy Creek is predicted. For the monthly distribution of flow changes, the largest percentage increase in flows happens during the months of June, July, and October at upwards of 150%, and the smallest increase is in April at around 5%.

Rainbow Trout spawn in the spring (March to June) and prefer clear, silt-free cold-water streams. An increase in peak flow magnitude may result in erosion, which may affect Rainbow Trout spawning. The highest flows predicted in spring (0.125 m^3/s for construction and 0.0884 m^3/s for operations) are less than experienced during the existing conditions peak flows (0.19 m^3/s for a 2-yr return period), so the predicted flows are assumed to be within natural variation. Rainbow Trout fry rearing occurs in the summer to early fall. Fry prefer shallower water with slower water velocities, and an increase in flows may therefore affect fry rearing. Rainbow Trout adults prefer deeper and faster water, and an increase in flows may improve fish habitat for Rainbow Trout adults. There is limited overwintering habitat in Rudy Creek due to the lack of deep pools. Increased water quantity during winter months may provide and improve the availability of overwintering habitat for Rainbow Trout.

An increase in water during the drier months in fall may benefit Bull Trout, which spawn in fall, but there are no Bull Trout known to occur in Rudy Creek.

7.9.7.3.2.7 Characterization of Residual Effect

The residual effect to Freshwater Fish from Water Quantity changes at the QR Mill is characterized in Table 7.9-27.

Table 7.9-27 Residual Effect Characterization for Residual Water Quantity Changes at the QR Mill

Criteria	Characterization	Description
Context	High	Streamflows are expected to be maintained within the historical range of variability. Fish and fish habitat can recover from changes in flows within the historical range of variability.
Magnitude	Low	Streamflows are expected to be maintained within the historical range of variability.
Extent	Local	The effects are limited to upper Rudy Creek and dissipate further downstream.
Duration	Medium-term	Changes in water quantity will be during construction and operations.
Reversibility	Reversible	Change from effluent discharge will cease upon closure, and fish and fish habitat will recover.
Frequency	Regular	Discharge of effluent will be regular, as required by site water management requirements, and discharge will be required through all Project phases.
Affected Populations	Even	The potential effect is experienced by any and all sub-populations.

7.9.7.3.2.8 Risk and Uncertainty

Although effects to Rainbow Trout life stages may occur as a result of increased flows in Rudy Creek, the effect is localized and should have negligible change on the productivity of fish in the regional area (Table 7.9-28). Changes in stream flow and how they affect fish and fish habitat are reasonably understood. However, uncertainties exist in water quantity flow modelling, including predicted changes under climate change scenarios (See Section 7.4).

Table 7.9-28 Risk and Uncertainty Characterization for Water Quantity Changes at the QR Mill

Criteria	Characterization	Rationale
Likelihood	High	The likelihood of effects to fish and fish habitat from changes in stream flows is high.
Consequence	Minor	Magnitude is low, and extent is local.
Risk	Low	Consequence is minor, and likelihood is high.
Confidence	Low	There is low to moderate degree of uncertainty with data inputs and/or modelling techniques for water quantity changes.

The level of confidence associated with the predicted residual effect is Low. Fish and fish habitat information is available for upper Rudy Creek; however, there are some uncertainties regarding water quantity modelling. Predicted changes to fish habitat from water quantity are expected to be within the range of natural variability for Rudy Creek.

7.9.7.3.2.9 Importance

Importance is High as water quantity and maintenance of streamflows at the QR Mill has been identified as a concern and of high interest, including by participating Indigenous nations, community members, the public, local governments, and/or provincial and federal government agencies. There are concerns with regard to water quantity and the water treatment plant to manage the capacity for storage during flooding and freshet events and the effects of climate change on these events.

7.9.8 Characterization of Negative Residual Effects

Negative residual effects for Freshwater Fish are summarized in Table 7.9-29.

7.9.9 Cumulative Effects

Cumulative effects are changes to Freshwater Fish caused by the combined effects of past, present, and potential future human activities. The potential adverse residual effects identified for Freshwater Fish are carried forward, and those projects or activities that may affect Freshwater Fish are identified. Projects and activities include other mine projects in the area, as well as other activities, such as forestry, placer mining, transportation, and recreational activities.

7.9.9.1 Identified Residual Effects

The potential residual effects for Freshwater Fish after application of mitigation measures are:

- Effects on Fish Habitat from Riparian Habitat Loss or Alteration along the Transmission Line; and
- Effects on Freshwater Fish from Changes in Surface Water Quantity at the Mine Site and QR Mill.

7.9.9.2 Cumulative Effects Assessment Boundaries

The cumulative effects assessment boundaries are defined as the maximum spatial and temporal scales over which there is a potential for residual Project effects for Freshwater Fish to interact with the potential residual effects of other past, present, and reasonably foreseeable future projects and activities.

7.9.9.2.1 Spatial Boundaries

The spatial boundary for the cumulative effects includes an area within the same watersheds where the Project is reasonably expected to interact with Freshwater Fish (Figure 7.9-2). This area is the same as the defined RAA described for the Freshwater Fish Effects Assessment. For the Mine Site, this includes the Willow River Watershed upstream of the confluence with Stephanie Creek. For the QR Mill, this includes the Maud Creek Watershed and its confluence to the Quesnel River and the Quesnel River upstream from its confluence with Beaver Creek. The Transmission Line RAA is a 1 km area upstream and downstream from the Project Footprint and includes access roads that will require upgrades.

Table 7.9-29 Summary of Residual Effects for Freshwater Fish

Residual Effect	Context	Magnitude	Extent	Duration	Reversibility	Frequency	Affected Populations	Risk	Confidence	Importance
Loss of Riparian Habitat	High	Low	Limited	Medium-term	Fully reversible	Once	Even	Low	Moderate	Moderate
Change in Surface Water Quantity at the Mine Site resulting in changes to Fish and Fish Habitat	High	Low	Local	Medium-term	Reversible	Irregular	Even	Low	Low	High
Change in Surface Water Quantity at the QR Mill resulting in changes to Fish and Fish Habitat	High	Low	Local	Medium-term	Reversible	Irregular	Even	Low	Low	High

7.9.9.2.2 Temporal Boundaries

Temporal boundaries include:

- Present and Ongoing: initiated prior to 2021 but anticipated to carry on beyond the construction start date of the Project; and
- Planned/Reasonably Foreseeable Future: planned to start during mine life (construction – post-closure). Generally, the proposed end date for inclusion in the effects assessment is 2046, which represents the end of the Post-Closure (active care) Phase.

7.9.9.3 Interactions with Past, Present, or Reasonably Foreseeable Future Projects and Activities

Past, present, and reasonably foreseeable future projects and activities have been identified for inclusion in the cumulative effects assessment from various sources, including municipal, regional, provincial, and federal government agency and company websites. Those projects and activities that have the potential to interact with Freshwater Fish residual effects are present in Table 7.9-30.

Table 7.9-30 List of Projects and Activities with Potential to Interact with Freshwater Fish Residual Effects

Project / Activity	Temporal	Project Life	Location	Proponent
Bonanza Ledge Phase II Reclamation (outside the Project Footprint)	Reasonably Foreseeable Future	Proposed	4 km south of Wells	Osisko Development Corp.
Mosquito Creek Reclamation	Reasonably Foreseeable Future	Proposed	6 km northwest of Wells	Osisko Development Corp.
Mount Polley Copper Project	Present (certain)	Operating	56 km northeast of Williams Lake	Mount Polley Mining Corporation
Recreation Use	Present (certain)	Ongoing	Regional	Various
Fishing	Present (certain)	Ongoing	Regional	Various
Forestry	Present (certain)	Ongoing	Regional	Various
Mineral exploration	Present (certain)	Ongoing	Regional	Various
Placer mining	Present (certain)	Ongoing	Regional	Various
Transportation	Present (certain)	Ongoing	Regional	Various

Interactions with effects of past, present, and reasonably foreseeable projects and activities include those projects that directly interact within the same watercourse or within the same watershed, which can cause changes to surface water quality, water quantity, and riparian habitat (Table 7.9-31).

Additionally, natural disturbances, such as wildfire or pest infestations, have the potential to interact with freshwater fish; however, effects from these are difficult to quantify and therefore have a greater degree of uncertainty associated with them. Previous natural disturbances, including forest fires and pest infestations, are under various stages of regeneration, and forest fires may contribute to hydrological changes and stream inputs, but this is dependent on the type of fire and where it occurs. Effects of fire on fish populations are a function of both degree and duration of fire-caused changes in water quality and quantity, as well as the proportion of each inhabited stream network affected by burning (Cilimburg, 2005). Therefore, natural disturbances are not included in a way that would allow for meaningful assessment.

Table 7.9-31 Interactions with Effects of Past, Present, and Reasonably foreseeable Projects and Activities for Freshwater Fish Residual Effects

Potential Residual Effect	Bonanza Ledge Phase II Reclamation	Mosquito Creek Reclamation	Mount Polley Copper Project	Recreation Use	Fishing	Forestry	Mineral Exploration	Placer Mining	Transportation
Loss or alteration of riparian habitat	N	N	N	N	N	Y	Y	Y	Y
Change in surface water quantity	Y	Y	N	N	N	Y	Y	Y	Y

Notes: Y = Yes, interaction exists between the residual effect of the Project and the other past, current, or future project/activity.
N = No, interaction does not exist between the residual effect of the Project and the other past, current, or future project/activity.

7.9.9.4 Existing Conditions

Willow River Reach 1 was included as there is an existing facility (Mosquito Creek) located in Reach 1.

7.9.9.5 Potential Cumulative Effects

7.9.9.5.1 Loss or Alteration of Riparian Habitat

Forestry, placer mining, and transportation activities have the potential to cross watercourses through linear developments, which may increase the amount of riparian habitat lost or altered. If forestry cutblocks occur next to a ROW crossing, this may increase the amount of riparian vegetation altered adjacent to the creek, thereby increasing the likelihood of altering the watercourse and reducing riparian function at these crossing locations.

7.9.9.5.2 Change in Surface Water Quantity

The projects and activities outlined in Table 7.9-31 have the potential to interact with residual water quantity effects to fish and fish habitat because ongoing activities may result in increased flow changes to the hydrological regime in adjacent watercourses through recontouring of land during reclamation activities. Project-specific activities include:

- Changes in flow in the Lowhee Creek Watershed from Bonanza Ledge Phase II Project; and
- Changes in flow from the Mosquito Creek Watershed that flow into the Willow River from reclamation activities from the Mosquito Creek Reclamation Project.

There are no anticipated changes in flow from Mount Polley Mine activities as effluent is discharged into watercourses that enter the Quesnel Lake, and effects are expected to be localized to those systems.

7.9.9.6 Mitigation Measures

7.9.9.6.1 Mitigation Measures for Loss or Alteration to Riparian Habitat

This assessment is based on proponents of proposed development projects and activities adhering to their own mitigation plans and commitments during permitting, including mitigation measures for riparian setbacks and conserving riparian habitat, and the Cariboo Chilcotin Land Use Plan has identified these riparian management areas. The reclamation projects within the Mine Site will only improve riparian vegetation over time. All forests and range licensees, including roads, are governed by the *Forest and Range Practices Act*, which protect plants, animals, and ecosystems. Resource values identified under the *Forest and Range Practices Act* include fish and riparian and water quality. Riparian management areas are established for watercourses and wetlands based on riparian class and include riparian management areas from 20 to 100 m with reserve zones of 20 to 50 m for large watercourses. There are also old growth management areas that intersect the Transmission Line RAA where forestry development is prevented or constrained.

Currently, there are nine watercourse crossings located within old growth management areas. Based on the Cariboo Chilcotin Land Use Plan mapped riparian buffers, there is 10,021 ha of riparian area within the RAA. Of this area, 1,581 ha are within a cutblock, which accounts for up to 16% of riparian area in the RAA. The Transmission Line accounts for 1.3 ha of riparian area (six sites) that intersect a cutblock and accounts for up to 0.08% of riparian areas in the RAA. Of the six watercourse crossings

that occur in cutblocks, three sites had marginal quality habitat and three sites had no fish habitat. If a watercourse was present, a riparian buffer was also present within the cutblock, or the cutblock was located adjacent to the riparian area. Only one site had a cleared area that ran greater than 1 km along the length of the FWA stream; however, the watercourse was determined to be an NCD with no fish habitat during field assessments.

No new mitigations are proposed from those presented in Section 7.9.9.6 for residual effects mitigations. It is assumed that similar mitigations are in place for other projects in the RAA, which follow standard best practices and permitting requirements. Potential cumulative effects on Freshwater Fish from riparian alteration are not carried forward to a residual effects assessment.

7.9.9.6.2 Mitigation Measures for Changes in Surface Water Quantity

The Bonanza Ledge Phase II Project will improve drainages around existing and reclaimed infrastructure. Surface water runoff for the site will flow into natural drainages, whether that be Lowhee Creek or Stouts Gulch. Mitigation measures during Mosquito Creek Reclamation include the design of water management infrastructure and associated maintenance and operations. Therefore, potential cumulative effects for Freshwater Fish from changes in surface water quantity are not carried forward to a residual effects assessment.

7.9.9.7 Characterization of Potential Residual Adverse Cumulative Effects

No residual cumulative effects have been identified for the Freshwater Fish VC.

7.9.10 Follow-up Strategy

The follow-up strategy will evaluate the efficacy of proposed mitigation measures and the accuracy of the predicted potential effects to Freshwater Fish. Monitoring will be required to determine the effectiveness of mitigation measures and inform the adaptive management of potential changes or additional effects that may result from the Project.

An Aquatic Effects Monitoring Program (AEMP) will be used to compare existing conditions findings with the different Project phases. Key aspects of the AEMP will be to verify that prescribed mitigation measures are applied and functioning as intended and that effects within the mine area and downstream environments can be reliably detected. This program will include specific surveys that outline pathways of effects based on measurable effects indicators such as water quality monitoring, periphyton monitoring, phytoplankton monitoring, zooplankton monitoring, a benthic macroinvertebrates community survey and, if required, a fish population survey and/or fish tissue survey.

The AEMP monitoring programs will be designed to follow Environmental Effects Monitoring requirements under the MDMER or the federal *Fisheries Act*. Regular effluent characterization and water quality monitoring activities will be carried out at prescribed locations along with periodic biological sampling to determine if mining activities are affecting aquatic biota.

Adaptive management will be employed, as required, depending on the success of the management and mitigation efforts for minimizing adverse environmental impacts, and will take into consideration stakeholder reviews and recommendations, including Indigenous nations and government agencies, regulatory changes, or Project changes.

As part of ongoing consultation and engagement with interested parties (including community representatives, participating Indigenous nations, and local government representatives), ODV will confirm interest in receiving regular updates on monitoring results and preferred mechanisms for sharing data and information. These groups will also be engaged on strategies to be employed if predicted effects and mitigation effectiveness are not as expected.

Participating Indigenous nations will also be directly engaged regarding the design and implementation of the Freshwater Fish VC follow-up strategy.