BC EAO EAC Application – Tenas Project

Section 4.0 Environmental Effects Assessment
Chapter 3 Surface Water Valued Component

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Tenas Project

Section 4.0 Environmental Effects Assessment
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Abbreviations and Acronyms

Abbreviation or Acronym	Long Form of Abbreviation or Acronym
AGRA	AGRA Earth and Environmental Ltd.
AIR	Application Information Requirements
AQMP	Air Quality Management Plan (S13.0-C2)
BAT	best achievable technology
BC	British Columbia
BC AWQG	British Columbia Approved Water Quality Guidelines
BC EAO	British Columbia Environmental Assessment Office
BC WWQG	British Columbia Working Water Quality Guidelines
BC MECCS	British Columbia Ministry of Environment and Climate Change Strategy
BC MELP	British Columbia Ministry of Environment, Lands and Parks
BC MEM	British Columbia Ministry of Energy and Mines
BC MEMLI	British Columbia Ministry of Energy, Mines and Low Carbon Innovation
BC MFLNRO	British Columbia Ministry of Forests, Lands and Natural Resources Operations
BC MOE	British Columbia Ministry of Environment
BMPs	best management practices
C	Chapter
CCME	Canadian Council of Ministers of Environment
CEA	Cumulative Effects Assessment
CEMP	Construction Environmental Management Plan (S13.0-C4)
CMSTHP	Chemicals and Materials, Storage, Transfer, and Handling Plan (S13.0-C3)
CPP	Coal Processing Plant
DEM	Digital Elevation Model
DMP	Discharge Management Plan (S13.0-C5)
EAA	*Environmental Assessment Act,* SBC 2002, c 43 (Government of British Columbia [GovBC] 2002)
EAC	Environmental Assessment Certificate
ECCC	Environment and Climate Change Canada
EC	electrical conductivity
EDP	Effluent Discharge Permit
EMA	*Environmental Management Act,* SBC 2003, c. 53 (Government of British Columbia [GovBC] 2003)
EMP	Explosives Management Plan (S13.0-C6)
EMS	Environmental Management System (S13.0-C1)
FMSCP	Fuel Management and Spill Control Plan (S13.0-C7)

Abbreviation or Acronym	Long Form of Abbreviation or Acronym
GovBC	Government of British Columbia
GovCan	Government of Canada
ISO	International Standards Organization
LIDAR	Light Detection and Ranging
LOM	life-of-mine
LSA	Local Study Area
MA/EMA	*Mines Act*, RSBC 1996, c 293, and *Environmental Management Act*, SBC 2003, c 53
MAD	mean annual discharge
Manalta	Manalta Coal Ltd.
ML/ARD	metal leaching/acid rock drainage
ML/ARDMP	Metal Leaching (ML)/Acid Rock Drainage (ARD) Management Plan (S13.0-C12)
MWMP	Minesite Water Management Plan (S13.0-C11)
non-PAG	non-potentially acid generating
NSE	Nash-Sutcliffe Efficiency
OW	Office of the Wet'suwet'en
PAG	potentially acid generating
PAH	polycyclic aromatic hydrocarbons
PCIC	Pacific Climate Impact Consortium
Piteau	Piteau Engineering Ltd.
POC/COC	Parameters of Concern/Contaminants of Concern
POPC/COPC	Parameters of Potential Concern/Contaminants of Potential Concern
Project	Tenas Project
RCP	Reclamation and Closure Plan (S13.0-C15)
RSA	Regional Study Area
ROW	right-of-way
S	Section
SEPSCP	Surface Erosion Prevention and Sediment Control Plan (S13.0-C17)
SPO	site performance objective
TAC	Tenas Access Corridor
TARP	Trigger Action Response Plan
TCL	Telkwa Coal Limited
TDS	Total Dissolved Solids
TK	Traditional Knowledge
TSA	Timber Supply Area
TSS	total suspended solids

Abbreviation or Acronym	Long Form of Abbreviation or Acronym
UTM	Universal Transverse Mercator
VC	Valued Component
WMPRE	Waste Management Plan for Refuse and Emissions (S13.0-C20)
WQG	Water Quality Guideline
WQS	Water Quality Station
WSC	Water Survey of Canada

UNITS OF MEASURE

Abbreviation or Acronym	Long Form of Abbreviation or Acronym
ha	hectare
km	kilometre
km^2	square kilometre
kV	kilovolt
$L/s/km^2$	litre per second per square kilometre
m	metre
masl	metres above sea level
mg/L	milligram per litre
V	volt

EXECUTIVE SUMMARY

This chapter addresses the potential effects of the Tenas Project (Project) on the Surface Water Valued Component (VC). The purpose of this assessment is to analyse the potential changes to the surface water system because of the Project.

Surface Water was selected as a VC based on feedback from community stakeholders and Indigenous groups due to its intrinsic value, not only as a pathway or means of influencing other resources. The Project has the potential to interact with Surface Water Quantity and Surface Water Quality, which are considered as separate subcomponents for the effects assessment.

Baseline characterisation of the Surface Water VC within the Local Study Area (LSA) and Regional Study Area (RSA) were facilitated through monitoring programs for streamflow and water quality, and encompasses datasets from Project-specific networks, regional networks (Water Survey of Canada [WSC], Environment and Climate Change Canada (ECCC), and British Columbia Ministry of Environment and Climate Change Strategy [BC MECCS]) and technical reports from previous mining studies in the area.

A water and load balance model was developed to generate continuous time series of monthly flows and concentrations of water quality parameters for pre-mining and post-mining conditions and throughout the life-of-mine (LOM) through the Year 2100. See **Appendix 4.3-A Tenas Project Water and Load Balance Modeling Report.** Hydrologic components of the model were calibrated to regional and local streamflow datasets and encompassed interactions between surface water and groundwater. Streamflow was generated on a daily timestep based on precipitation and temperature datasets, which included orographic gradient adjustments developed and discussed in **Appendix1.0-R Tenas Project Hydrometeorological Report**. Both precipitation and temperature had additional adjustments to account for climate change through the Year 2100.

The load balance component was based on conservation of mass, assuming a fully-mixed scenario at each node and time step. Geochemical characterisation results were included to estimate mass of constituents released per mass of rock stored in various mine waste facilities. The in-stream water quality was calculated based on mixing of Project discharge with background loading, developed based on baseline monitoring of surface and groundwater quality. Baseline monitoring data and model results were screened against water quality guidelines and site performance objectives (SPOs).

Prediction nodes were selected to represent expected conditions in the downstream environment and were evaluated in relation to the baseline condition, which estimates streamflow and quality through the Year 2100 without influence of the proposed Project.

The residual effects for Surface Water Quantity and Surface Water Quality were developed based on effect Magnitude, Geographic Extent, Duration, Frequency, Reversibility, and Context, along with the Likelihood, Significance, and Level of Confidence. Residual effects on Surface Water Quantity were evaluated using the following indicators:

- change in mean annual discharge (MAD);
- change in seasonal flow distribution; and
- change in low and high flows.

While the Project is expected to change catchment areas and summer and winter streamflow from baseline conditions in sections of Four and Tenas creeks, the residual effects on Surface Water Quantity are limited to the LSA. The potentially affected watercourses represent 0.5 percent (%) of the RSA in the case of change in MAD, and 0.8% of the RSA in the case of both change in seasonal flow distribution and change in low and high flows. Based on the characterisation criteria, the Magnitude of all potential residual effects on Surface Water Quantity is Low, and residual effects are predicted to be **Not Significant** (i.e., not expected to result in a change within the RSA that will alter its integrity beyond an acceptable level).

Residual effects on Surface Water Quality were evaluated using the following indicators:

- change in parameter concentrations; and
- change in other measurable parameters.

Modelling results showed potential exceedances of water quality guidelines, and the conditions experienced in both Four and Tenas creeks' baseline monitoring data (greater than the 95^{th} percentile from baseline records) for total selenium, nitrite, dissolved cadmium, and sulphate, as well as increases in total dissolved solids concentrations and conductivity relative to baseline conditions. The site SPOs are not exceeded in any stream under expected conditions. The potentially affected area, in terms of exceedances of the water quality guidelines, is limited to within the watersheds of Four and Tenas creeks, occupying 2.0% of the RSA. Based on the characterisation criteria, the Magnitude of the potential residual effect on Surface Water Quality for both the change in parameter concentrations and the change in other measurable parameters are Low, and residual effects are predicted to be **Not Significant** (i.e., not expected to result in a change within the RSA that will alter its integrity beyond an acceptable level).

Considering the results of the assessment, the Project effects on the Surface Water VC are predicted to be **Not Significant** (i.e., not expected to result in a change in the RSA that will alter its integrity beyond an acceptable level).

The cumulative effects assessment (CEA) included review of potential effects on the Surface Water VC due to the Project's residual effects overlapping both spatially and temporally with the same residual effects resulting from other projects and activities. Projects included in the assessment for the cumulative effects on the Surface Water VC based on spatial and temporal interaction were proposed mining, forestry, agricultural and urban activities. Planned or current projects and activities are located outside the LSA but within the RSA in the watersheds of the Telkwa and Bulkley rivers. The proposed projects are expected to occupy a small portion of either watershed, and like the Project, their residual effects on the Telkwa and Bulkley rivers are expected to be minor. Additional mitigation measures beyond those considered in the assessment of Project-related effects are not expected to be necessary to avoid or minimize predicted cumulative effects on the Surface Water VC and its subcomponents; Surface Water Quantity; and Surface Water Quality.

Based on the available information supporting each reasonably foreseeable future project and current projects and activities, the Magnitude of the cumulative effects is expected be Low, since less than 5% of the RSA would be affected. Effects in the RSA would be expected to be of Short Duration and Infrequent, and are predicted to be **Not Significant** (i.e., not expected to result in a change in the RSA that will alter its integrity beyond an acceptable level).

Monitoring programs will be used to gauge the performance of the Project water management system and mitigation measures against model results and regulatory commitments. When changes relative to modelling results are observed, appropriate solutions will be developed using adaptive management and applied in a timely manner.

1. Introduction

This chapter presents the identification and assessment of the potential for residual effects of the Tenas Project (Project) and the cumulative effects on the Surface Water Valued Component (VC) in a thorough, rigorous, and concise manner. For this Environmental Assessment Certificate (EAC) Application, the Surface Water VC is represented by two (2) subcomponents: Surface Water Quantity and Surface Water Quality.

This assessment is comprised of the following steps:

- **Regulatory Context:** A description of the applicable legislation, policies, standards, and guidelines pertaining to the protection of the Surface Water VC;
- **Scope of the Assessment:** A description of the assessment scope including issues scoping, rationale for the selection of the Surface Water VC, subcomponents and indicators, and definition of the assessment boundaries;
- **Existing Conditions:** A description of the baseline studies undertaken for the Project, other relevant information, and descriptions of the Surface Water VC within the defined spatial boundaries;
- **Assessment of Project-related Effects:** A description of the potential interactions between the Project and the Surface Water VC, potential effects, proposed mitigation measures, an evaluation of potential residual effects that remain following implementation of the proposed mitigation measures, and an assessment of the significance of these potential residual effects;
- **Cumulative Effects Assessment (CEA):** A description of the residual effects of the Project in combination with the residual effects of past, present, and reasonably foreseeable future projects and activities, (if/where necessary) the development of additional mitigation measures to eliminate, reduce, or control cumulative effects and an assessment of the cumulative effects on the Surface Water VC and their significance; and
- **Follow-up Strategy:** A presentation of monitoring programs to verify assessment predictions and evaluate mitigation effectiveness, and a discussion of adaptive management program(s) to be implemented to address any unexpected Project effects on the Surface Water VC.

2. Regulatory Context

The Tenas Project Application Information Requirements (AIR) for the Project, approved by the British Columbia Environmental Assessment Office (BC EAO) in 2022, outlines the requirements of the Surface Water VC effects assessment to meet both requirements under the *Environmental Assessment Act,* SBC 2002, c 43 (Government of British Columbia [GovBC] 2002) (*EAA*).

Water use for the Project is expected to be subject to the provincial *Water Sustainability Act,* SBC 2014, c 15 (GovBC 2014) via a license for the use of surface or groundwater. The Project is expected to be subject to the federal *Fisheries Ac*t, RSC, c. F-14 (Government of Canada [GovCan] 1985b). through the future *Coal Mining Effluent Regulations* which are currently in development (GovCan 2021), as well as the provincial *Environmental Management Act,* SBC 2003, c. 53 (GovBC 2003) (*EMA*); via a Waste Discharge Authorization (permit).

In the British Columbia (BC) provincial jurisdiction, limits for discharge of treated or excess water to the environment may be specified in an Effluent Discharge Permit (EDP) issued by the British Columbia Ministry of Environment and Climate Change Strategy (BC MECCS) under the provincial *EMA,* in addition to established surface Water Quality Guidelines (WQG) for receiving environments. In advance of an EDP, the long-term average BC Approved Water Quality Guidelines or BC AWQG (BC MECCS 2019) and the British Columbia Working Water Quality Guidelines (BC WWQG) (BC MECCS 2021) for freshwater aquatic life were applied for the evaluation of results from the load balance. Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life (CCME WQG) (CCME 2014) are applied for parameters for which there is no BC AWQG or BC WWQG established, where appropriate.

The proposed Coal Mining Effluent Regulations (GovCan 2021) are expected to specify end-of-pipe limits for total suspended solids (TSS), nitrate, and selenium for new coal mines. In advance of the regulations, Project-specific end-of-pipe limits have been proposed to meet the in-stream WQG in the receiving environment.

Table 2-1 presents a summary of relevant provincial and federal statutory guidance documents and policies related to potential Project-related effects on the Surface Water VC.

Table 2-1: Surface Water Legislation, Regulation, Policy, Standards, and Guidelines

Name	Year	Description
British Columbia Field Sampling Manual (British Columbia Ministry of Environment [BC MOE] 2013a)	2013	Provides standard protocols for sampling quality control and assurance, procedures, and equipment that must be followed by permit holders for environmental monitoring and sample collection. Part E Water and Wastewater Sampling, Ambient Freshwater and Effluent Sampling provides specific details for water sampling, including location and frequency.
British Columbia Water Quality Guidelines (Approved and Working) (British Columbia Ministry of Environment and Climate Change Strategy (BC MECCS). 2019, 2021b)	2019, 2021	Water quality criteria are defined as maximum or minimum physical, chemical, or biological characteristics of water, biota, or sediment; and are applicable province wide. The guidelines are intended to prevent detrimental effects on water quality or aquatic life, under specified environmental conditions. Guidelines for drinking water supply and wildlife water supply.

Name	Year	Description
Water Sustainability Act , SBC 2014, c 15 (GovBC 2014)	2014	Regulates water rights and use in the province. Changes in and about a stream may be made only with an approval under section 11 of the *Act* and section 4 of the Water Sustainability Regulation, BC Reg 36/2016 (GovBC 2016), or through a notification, where applicable. The *Act* also provides special protection for designated sensitive streams in British Columbia (BC).
Canada Water Act, RSC 1985, c. C-11 (Government of Canada [GovCan] 1985a)	1985	Management of the water resources including research and the planning and implementation of programs relating to the conservation, development, and utilization of water resources.
Canadian Council of Ministers of Environment (CCME) Water Quality Guidelines (CCME 2014)	2014	Environmental quality guidelines are intended to protect, sustain, and enhance the quality of the Canadian environment. Each authority determines the degree to which it will adopt CCME recommendations and guidelines should not be regarded as blanket values for national environmental quality; users of guidelines consider local conditions and other supporting information during the implementation. Science-based site-specific criteria, guidelines and objectives or standards may differ from the Canadian guidelines.
Environmental Management Act SBC 2003, c. 53 (GovBC 2003) (*EMA*)	2003	Prohibits pollution of the environment and requires authorization to introduce waste into the environment or “prescribed” industry, trade, businesses, operations, and activities
Fisheries Act, RSC 1985, c. F-14 (GovCan 1985b)	1985	The Act prohibits causing serious harm to fish that are part of or support a commercial, recreational, or Aboriginal fishery (section 35); makes provisions for flow and passage (section 20 and 21); provides a framework for regulatory decision-making (section 6 and 6.1). Section 36(3) of the Act states that “no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish”.
Guidelines for Metal Leaching and Acid Rock Drainage in British Columbia (Price et al. 1998)	1998	Describes generic requirements and outlines common errors, omissions, and constraints. Assist mines in the development of comprehensive proposals that include the necessary documentation and consideration of risk for sound environmental management.
Manual of British Columbia Hydrometric Standards (British Columbia Ministry of Environment and Climate Change Strategy [BC MECCS] 2018)	2018	Defines a set of standards with detailed procedures for acquiring water quantity data, assessing the data, and qualifying and quantifying data grades.
Mines Act, RSBC 1996, c 293 (GovBC 1996b)	1996	The Act and the associated Health, Safety and Reclamation Code for Mines in British Columbia (British Columbia Ministry of Energy, Mines and Low Carbon Innovation [BC MEMLI] 2021) (Code) requires that mines have programs for the environmental protection of watercourses throughout mine life, including plans for prediction and prevention of metal leaching and acid rock drainage, and prevention of erosion and sediment

Name	Year	Description
		release. Watercourses are required to be reclaimed, and the Ministry has the authority to require monitoring and/or remediation programs to protect watercourses and water quality.
Policy for Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia (British Columbia Ministry of Energy and Mines [BC MEM] and British Columbia Ministry of Environment, Lands and Parks [BC MELP]))	1998	Outlines the process for determining the potential for metal leaching and acid rock drainage, and measures to prevent or reduce its occurrence to satisfy conditions of the *Mines Act*, RSBC 1996, c 293 (GovBC 1996b).
Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators (BC MOE 2012)	2012	Outline and define the baseline study requirements and information considerations necessary to propose a mineral development project in BC. Covers information requirements for surficial hydrology, water quality (physical and chemical parameters), aquatic sediments, tissue residues and aquatic life.
Water Protection Act. RSBC 1996, c 484 (GovBC 1996c)	1996	Under the Act the ownership of water is vested in the Crown; the Act provides statutes governing the allocation of water licenses and controls the use of freshwater in the BC. The Act also includes environmental protection for waters flowing in a stream, lake, or other surface water body.

The following sources were reviewed for applicability, but were determined to not contain the most recent/relevant information:

- *Canadian Environmental Protection Act,* S.C. 1999 (GovCan 1999); and
- British Columbia Environmental Laboratory Manual (British Columbia Ministry of Environment [BC MOE] 2020);

3. Scope of the Assessment

The assessment of Surface Water VC, including the assessment of Project-related effects and cumulative effects, was conducted according to the methods set out in **Section (S) 3.0 Assessment Methodology** of this **EAC Applicatio**n. The assessment boundaries specific to the Surface Water VC are provided in **3.2.4 Assessment Boundaries** and the characterisation criteria specific to the Surface Water VC are provided at the start of **5.4 Residual Effects and Significance of Residual Effects**.

This subsection outlines the scope of the assessment, including the rationale for the inclusion of Surface Water as a VC along with its subcomponents, the selection of indicators, and the definition of spatial and temporal boundaries. This assessment is organized into two (2) subcomponents: Surface Water Quantity and Surface Water Quality (**3.2.2 Subcomponents**).

The effects assessment focuses on characterising Project-related interactions on surface water systems, in terms of Water Quantity and Water Quality at the RSA level, supported by site-specific data and modelling. The assessment was informed by baseline studies and monitoring campaigns, as well as water and load balance modelling of expected Project conditions. The assessment was conducted according to the methods set out in **S3.0 Assessment Methodology** of the **EAC Application**. The scope was defined through the AIR as well as input from Indigenous groups, the public and government agencies through working groups and comment solicitation. The scope was developed by identifying indicators, spatial and temporal boundaries, and assessment cases to identify potential interactions between the Project and the VC, along with residual and cumulative effects.

3.1 Issues Scoping

Telkwa Coal Limited (TCL) has undertaken an engagement and consultation process to support the scoping of issues for the Project. Refer to **S11.0 Wet'suwet'en Rights and Interests Assessment** and **S12.0 Public Consultation** of this **EAC Application** for details on the consultation program). The consultation and engagement process has included technical working groups established with Indigenous groups and government departments, community meetings, one-on-one and small group meetings, regarding key themes of interest and discussion of candidate VCs to represent the themes of interest.

3.2 Rationale for Selection of Surface Water Valued Component (VC)

The Surface Water VC and associated subcomponents were selected during the pre-Application phase of the Project following the VC selection process set out in **3. Scope of the Assessment** and using the methodology provided in the Guideline for Selection of Valued Components and Assessment of Potential Effects (BC EAO 2013). The goal was to focus on relevant issues, concerns, and components of the natural and human environment that may be affected by the Project.

Surface water is a key component of the environment that was considered in the assessment for the Project, as it is linked to fish and aquatic habitat, as well as terrestrial resources and human health. Both Surface Water Quantity and Surface Water Quality were evaluated as part of the Surface Water VC.

To inform the assessment of the effects of the Project on the Surface Water VC, five (5) watercourses were considered:

1. Tenas Creek;
2. Four Creek;

3. Goathorn Creek;
4. Telkwa River; and
5. Bulkley River.

These watercourses were selected for their proximity to Project infrastructure and potential for Project interactions. Modelling incorporated the various nodes along each watercourse which were specifically selected to capture the Project effects.

The Tenas Access Corridor (TAC) will cross Helps Creek. The potential effects on Helps Creek are limited to road dust and are expected to be isolated and limited. For this reason, Helps Creek has not been evaluated for the purpose of the effects assessment as it relates to the Surface Water VC.

3.2.1 Valued Component (VC)

Surface Water was identified as a VC based on feedback from the Office of the Wet'suwet'en (OW) and other community stakeholders due to its intrinsic value, not only as a pathway or means for other resources**.** The Project will require that non-contact and/or contact water be diverted away from streams and discharged at controlled locations outside of the natural flow pathways for these streams, which may affect stream water quantity. Storage of water in reservoirs or excavation of open pits will affect the natural groundwater regime, which could also affect streamflow. Exposed material from open pit mining and material placement has the potential to alter the water quality of streams both directly by overland flow and/or indirectly via groundwater.

Surface water is dependent on and/or supports (i.e., is input to) on the assessment of several VCs:

- **Dependent on:**
  - **Atmospheric Environment VC** (**S4.0-C1**) – Atmospheric environment interacts with surface water through dust deposition and in distinguishing precipitation between rainfall and snowfall;
  - **Terrain and Soils VC (S1.0-C2)** – Terrain and soils interact with surface water by contributing to landscape form and function which influences infiltration and runoff rates; and
  - **Groundwater VC (S4.0-C4)** – Groundwater interacts with surface water by contributing to site drainage and discharge, moisture regimes, and water chemistry.
- **Supporting:**
  - **Aquatic Resources VC (S4.0-C5)** – Surface water contributes to ecosystem form and function that support aquatic resources (e.g., habitat area, flow characteristics, suitable water quality);
  - **Fish and Fish Habitat VC (S4.0-C6)** – Surface water contributes to ecosystem form and function that support fish and fish habitat (e.g., habitat area, flow characteristics, suitable water quality);
  - **Vegetation VC (S4.0-C3)** – Surface water interacts with vegetation by contributing to site drainage and discharge and moisture regimes, which influence the persistence of vegetation, ecosystems, and wetlands;
  - **Wildlife VC (S4.0-C8)** – Surface water is consumed by wildlife and is part of the exposure pathway from environment to wildlife;
  - **Avian Species VC (S4.0-C9)** – Surface water provides habitat for feeding, reproduction, rearing, and/or cover for avian species;
  - **Land and Resource Use VC (S6.0-C4) –** Surface water provides resource values such as recreation, fishing, and transportation; and

- **Human Health VC (S8.0-C1) –** Surface water can be consumed or in direct contact with humans and is part of the exposure pathway from environment to humans.

3.2.2 Subcomponents

During the VC scoping exercise two (2) subcomponents were selected to focus the Surface Water VC assessment on key themes of interest identified through consultation and engagement, and reviews of other information. The subcomponents of the Surface Water VC are:

- Surface Water Quantity: The Project will require that water be diverted away from streams and discharged at controlled locations outside of the natural flow pathways, which may affect stream water quantity. Storage of water in reservoirs or excavation of pits will affect the natural groundwater regime, which could also affect streamflow; and
- Surface Water Quality: .Exposed rock from open pit mining and waste placement has the potential to alter the water quality of streams.

Subcomponents and linkages are summarized in **Table 3.2-1**.

Table 3.2-1: Summary of Rationale for Selection of Surface Water Valued Component (VC) and Subcomponents and Their Linkages

Subcomponent	Rational for Inclusion	Source of Information	VC Linkages	
Surface Water Quantity	The Project has the potential to affect surface water quantity which could effect fish and fish habitat, aquatic resources, vegetation, land and resource use and wildlife.	▪ Issues scoping ▪ Government agency ▪ Traditional Knowledge (TK)	**Dependent on:** ▪ Atmospheric Environment ▪ Terrain and Soils ▪ Groundwater	**Supporting:** ▪ Aquatic Resources ▪ Fish and Fish Habitat ▪ Wildlife ▪ Vegetation ▪ Avian Species ▪ Land and Resource Use ▪ Human Health
Surface Water Quality	The Project has the potential to affect surface water quality which could affect fish and fish habitat, aquatic resources, human health, wildlife, vegetation, and avian species.			

Notes: *SC=subcomponent; Project=Tenas Project; VC=Valued Component*

3.2.3 Indicators

Indicators are quantitative or qualitative measures used to describe existing VC and/or VC subcomponents' conditions and trends, and to evaluate potential Project effects and cumulative effects on the VC.

The Surface Water VC effects assessment follows the structure indicated in the Project AIR (BC EAO 2022) and uses the indicators listed in **Table 3.2-2**.

Table 3.2-2: Indicators for Surface Water Valued Component (VC)

Indicator	Rationale for Selection
Surface Water Quantity	
Change in Mean Annual Discharge (MAD)	The Tenas Project (Project) has the potential to change the MAD of streams.
Change in seasonal flow distribution	The Project has the potential to change the flow distribution throughout the year (i.e., monthly average streamflow).
Change in low flows and high flows	The Project has the potential to change the magnitude of low flows and high flows.
Surface Water Quality	
Change in modelled parameter concentrations	The Project may result in a change in parameter concentrations based on model results. Total and dissolved elements, anion/nutrients and hardness are all measured based on concentrations.
Change in other measurable water quality parameters.	The Project may result in other water quality parameters beyond those modelled, including a change in temperature, turbidity, TSS, alkalinity and acidity based on pH, PAHs, and conductivity relative to baseline conditions.

3.2.3.1 Water Quality Guidelines (WQG) and Site Performance Objectives (SPOs)

The long-term average British Columbia Approved Water Quality Guidelines (BC AWQG) (BC MECCS 2019) and the British Columbia Working Water Quality Guidelines(BC WWQG) (BC MECCS 2021b) for freshwater aquatic life were considered during the evaluation of effects of Project-discharge in the receiving environment. Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME WQG) (CCME 2014) are applied for parameters for which there is no BC AWQG or BC WWQG established.

Long-term average water quality guidelines for the protection of freshwater aquatic life as described above are herein referred to as the Guidelines, are summarized in **Table 3.2-3** for each selected watercourse. Note that the guidelines for various parameters depend on the water quality in the receiving environment, and for this reason, different guidelines are established for different potential receiving environments, based on the median values (50th percentile) presented in the background datasets (refer to **4.2.4 Surface Water Quality Baseline Conditions**).

Table 3.2-3: Long-term (30-day average) Water Quality Guidelines for Freshwater Aquatic Life in Receiving Environments

Parameter	Units	Water Quality Guideline by Stream (mg/L)				
		Tenas Creek	Four Creek	Goathorn Creek	Telkwa River	Bulkley River
Total Suspended Solids	mg/L	35	35	35	35	35
Chloride	mg/L	150	150	150	150	150
Fluoride	mg/L	0.12	0.12	0.12	0.12	0.12
Ammonia, total*	mg-N/L	1.2	0.95	1.5	1.7	1.7
Nitrate	mg-N/L	3	3	3	3	3

Parameter	Units	Water Quality Guideline by Stream (mg/L)				
		Tenas Creek	Four Creek	Goathorn Creek	Telkwa River	Bulkley River
Nitrite*	mg-N/L	0.02	0.02	0.02	0.02	0.02
Sulfate*	mg/L	218	309	218	218	128
Aluminum, total*	mg/L	0.1	0.1	0.1	0.1	0.1
Aluminum, dissolved*	mg/L	0.05	0.05	0.05	0.05	0.05
Antimony, total	mg/L	0.009	0.009	0.009	0.009	0.009
Arsenic, total	mg/L	0.005	0.005	0.005	0.005	0.005
Barium, total	mg/L	1	1	1	1	1
Beryllium, total	mg/L	0.00013	0.00013	0.00013	0.00013	0.00013
Boron, total	mg/L	1.2	1.2	1.2	1.2	1.2
Cadmium, dissolved*	mg/L	0.00017	0.00024	0.00016	0.00011	0.00008
Chromium, total	mg/L	Cr(III): 0.0089	Cr(III): 0.0089	Cr(III): 0.0089	Cr(III): 0.0089	Cr(III): 0.0089
		Cr(VI): 0.001	Cr(VI): 0.001	Cr(VI): 0.001	Cr(VI): 0.001	Cr(VI): 0.001
Cobalt, total	mg/L	0.004	0.004	0.004	0.004	0.004
Copper, total*	mg/L	0.003	0.0047	0.0028	0.002	0.002
Iron, total	mg/L	0.3	0.3	0.3	0.3	0.3
Iron, dissolved	mg/L	0.35	0.35	0.35	0.35	0.35
Lead, total*	mg/L	0.0055	0.0072	0.0054	0.0044	0.0040
Manganese, total*	mg/L	0.94	1.1	0.92	0.79	0.73
Mercury, total***	mg/L	0.00001	0.00001	0.00001	0.00001	0.00001
Molybdenum, total	mg/L	0.073	0.073	0.073	0.073	0.073
Nickel, total*	mg/L	0.11	0.11	0.11	0.025	0.025
Selenium, total	mg/L	0.002	0.002	0.002	0.002	0.002
Silver, total*	mg/L	0.00005	0.0015	0.00005	0.00005	0.00005
Thallium, total	mg/L	0.0008	0.0008	0.0008	0.0008	0.0008
Uranium, total	mg/L	0.0085	0.0085	0.0085	0.0085	0.0085
Zinc, total*	mg/L	0.0075	0.029	0.0075	0.0075	0.0075

Notes: *mg/L=milligram per litre; mg-N/L=milligram of nitrogen as nitrate or nitrite or ammonia per litre*

Guidelines (BC MECCS 2019, 2021b, CCME 2014) determined by baseline receiving water quality, presented in* ***Table 4.2 6* *to account for hardness and other parameters which modify the guidelines for site specific conditions.*

***Assuming methyl mercury is ≤ 0.5% of total mercury. The guideline for total mercury is dependent on the methyl mercury concentrations of the receiving environment, which is not measured in the baseline data. The mid-range guideline was selected, which assumes a concentration of MeHg that is 1.% of total mercury. Since the lowest limit is below the detection limit of the baseline monitoring data.*

A site performance objective (SPO) is a 'predictive' site-specific water quality objective for a quantifiable receiving environment parameter or attribute, developed by a qualified professional, using a rigorous scientific process (e.g., CCME 2002; BC MECCS 2021; BC MECCS 2016a; British Columbia Ministry of Environment [BC MOE] 2013b), with the intent to guide management decisions and mitigation actions for a regulated activity at a specific location (e.g., compliance with an effluent limit at a final discharge point).

SPOs are an effects assessment tool developed to support water management aspects of the aquatic effects assessment for a specific effluent discharge decision (BC MECCS 2016a). Development of SPOs will include consultation with Indigenous groups, regulators, and stakeholders, as appropriate.

Per the scientific approaches, SPOs for the Project were developed considering:

- that they must not result in exceedance of the provincial drinking water guidelines for human health;
- that they must not result in the creation of a contaminated site as defined under the Contaminated Sites Regulation, BC Reg 375/96 (GovBC 1996); and
- the use of an adaptive management approach in a manner that ensures ongoing monitoring and protection of key values and interests related to water quality.

SPOs were developed for total and dissolved cobalt, nitrite, aluminum, selenium, thallium, and dissolved cadmium to inform the assessment and are presented in **Table 3.2-4**. Two (2) SPOs were developed for total and dissolved selenium, described as a Tier 1 value of 0.008 milligram per litre (mg/L) and a Tier 2 value that is dependent on the sulphate concentrations of the receiving environment. **Table 3.2-4** presents the Tier 1 selenium SPO, which is used for preliminary screening. The Tier 2 SPO was also evaluated and is discussed in **5.2.2 Surface Water Quality Subcomponent**. Note that the SPO for dissolved cadmium varies based on hardness. Like the guidelines, the 50th percentile hardness from baseline monitoring was used for each stream to select the dissolved cadmium SPO.

Table 3.2-4: Site Performance Objectives (SPOs) and Corresponding Guidelines for each Watercourse

Parameter	Site Performance Objective (SPO) for Watercourses (Guideline* Value) (mg/L)				
	Tenas Creek	Four Creek	Goathorn Creek	Telkwa River	Bulkley River
Total Aluminum	0.236 (0.10)	0.236 (0.10)	0.236 (0.10)	0.236 (0.10)	0.236 (0.10)
Dissolved Cadmium (1)	0.000193 (0.00017)	0.000263 (0.00024)	0.000185 (0.00016)	0.000117 (0.00011)	0.000093 (0.00008)
Total Cobalt	0.0174 (0.004)	0.0174 (0.004)	0.0174 (0.004)	0.0174 (0.004)	0.0174 (0.004)
Nitrite	0.0524 (0.02)	0.0524 (0.02)	0.0524 (0.02)	0.0524 (0.02)	0.0524 (0.02)
Total Selenium 3	0.008 (0.002)	0.008 (0.002)	0.008 (0.002)	0.008 (0.002)	0.008 (0.002)
Total Thallium	0.0022 (0.0008)	0.0022 (0.0008)	0.0022 (0.0008)	0.0022 (0.0008)	0.0022 (0.0008)

Notes: *mg/L=milligrams per litre*
Guidelines (BC MECCS 2019, 2021b, CCME 2014) determined by baseline receiving water quality, presented in **Table 4.2 6 to account for hardness and other parameters which modify the guidelines for site specific conditions.*
1. *Dissolved Cadmium SPO developed based on median hardness concentration from available baseline data, see **Table 4.2-6**.*
2. *SPO rationale are described in Borealis 2021a through 2021e and in **Appendix 4.3-A Tenas Project Water and Load Balance Modeling Report**.*
3. *Total selenium SPO represents the Tier 1 value. A Tier 2 total selenium SPO was also developed and is dependent on the sulphate concentrations in the receiving environment.*
4. *Coal Mine Effluent Regulations are currently under development by the Federal Government which may specify end-of-pipe limits for Selenium at 0.010 mg/L*

3.2.4 Assessment Boundaries

This subsection identifies the spatial and temporal boundaries established for the assessment of the Surface Water VC. These boundaries were delineated to encompass the area within, and times during which, the Project is expected to interact with the Surface Water VC.

3.2.4.1 Spatial Boundaries

Three (3) spatial boundaries were delineated for the Surface Water VC assessment: the Project Area, the Local Study Area (LSA) and the Regional Study Area (RSA) (**Table 3.2-5**) and **Figure 3.2-1**.

The Project Area covers 18.6 square kilometres (km^2) and refers to the maximum area within which the Project will be constructed and operated, including the Minesite and access routes. The Project Area is described in detail in **S3.0-Chapter (C) 1-3 Assessment of Boundaries**. The Project Area is a conservative spatial estimate of the area of direct Project effects on the Surface Water VC to inform this assessment.

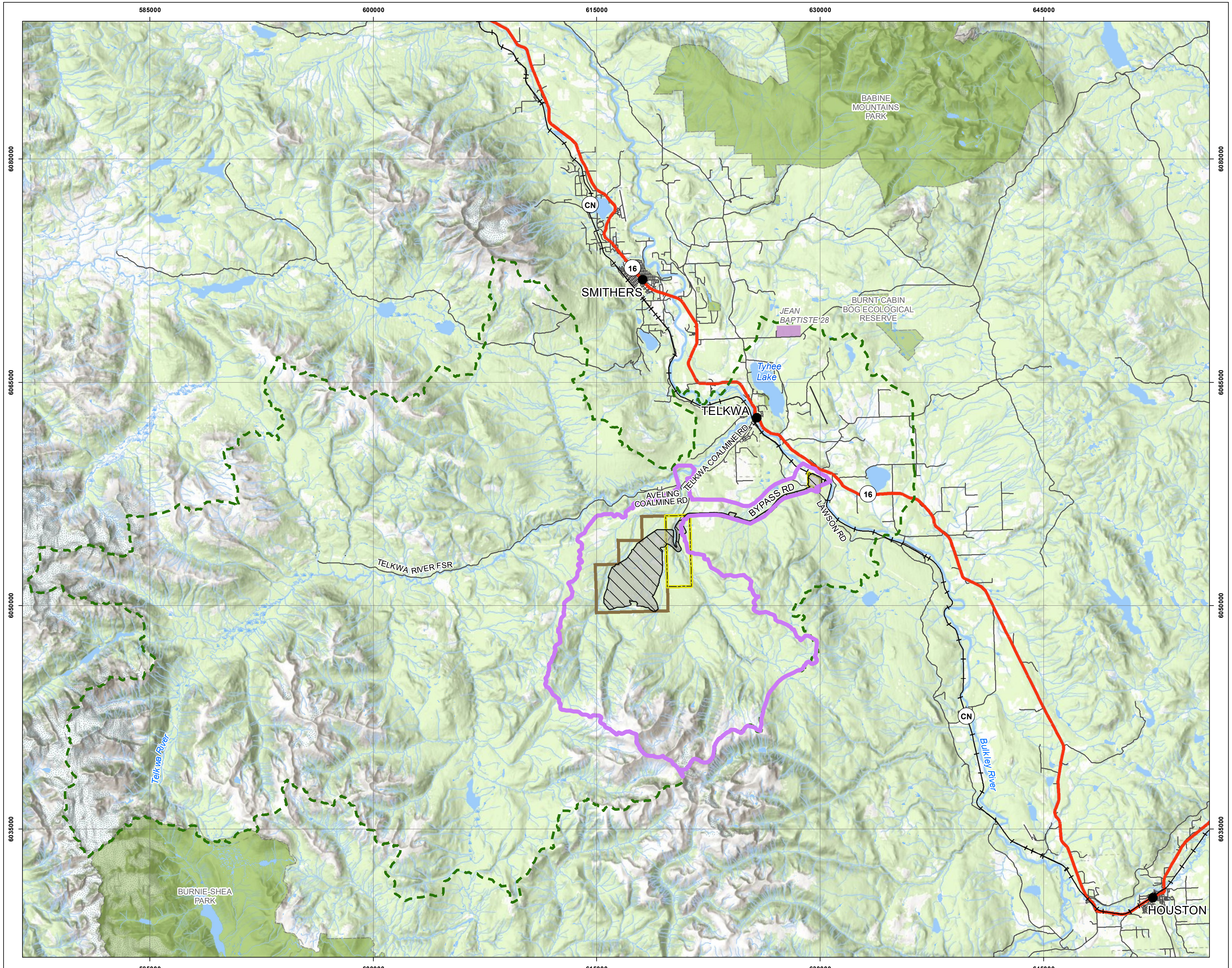
The Surface Water LSA is defined as the area where direct discharges occur to watercourses within the vicinity of the Minesite (e.g., Tenas Creek, Four Creek, and Goathorn Creek) to the edge of the mixing zone in the Telkwa River, and the Bulkley River downstream of the Rail Loadout. The LSA is 208.3 km^2 in area and incorporates the Project Area.

The Surface Water RSA was confirmed through modelling and extends approximately 2 kilometres (km) downstream of the Bulkley River confluence with the Telkwa River which captures Water Quality Station (WQS) monitoring location WQS12. The RSA is 1,430 km^2 in area and includes the Telkwa River catchment area to be consistent with other VC boundaries. The RSA continues upstream of the confluence of the Telkwa River to the Bulkley River at Quick Water Survey of Canada (WSC) station (08EE004), which captures conditions upstream of the Rail Infrastructure Area. The Bulkley River catchment area upstream of the WSC station Bulkley River at Quick was not included as part of the RSA. This decision was based on the relative difference between the size of the Bulkley River catchment area (approximately 7,340 km^2 at the Bulkley River at Quick WSC hydrometric station) relative to the Project Area.

The spatial boundaries delineated for the Surface Water VC are described in **Table 3.2-5** and shown in **Figure 3.2-1.**

Table 3.2-5: Spatial Boundary Definitions for Surface Water Valued Component (VC)

Spatial Boundary	Description of Study Area
Project Area	Maximum disturbance area within which the Tenas Project (Project) will be constructed and operated
Local Study Area (LSA)	A 208.3 square kilometre (km^2) area delineated by the watersheds of the Tenas Creek, and Goathorn Creek, including the Project Area.
Regional Study Area (RSA)	A 1,430 km^2 area defined based on the Telkwa River watershed and in the tributaries to the Bulkley River crossed by the haul road.



Tenas Project

Local and Regional Study Areas for Surface Water Valued Component

Legend

- City/Town
- Rail Line
- Highway
- Road
- Discharge Path
- Watercourse
- LSA Boundary
- RSA Boundary
- Wetland
- Waterbody
- Park or Protected Area
- First Nation Reserve
- Tenas Coal Licenses
- Telkwa Coal Limited Private Property

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Project Area: Allegiance Coal, April 21, 2021
- Basedata: Government of British Columbia
- Basemap: World Topo Base

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Kilometres

NAD 1983 UTM Zone 9N

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3.2.4.2 Temporal Boundaries

The assessment includes analyses for the Construction, Operation, Decommissioning and Reclamation and Post-closure phases of the Project, as described in **S1.0 Overview of Project Proponent Description** of the **EAC Application**. The relevant time periods used for the Surface Water effects assessment are presented in **Table 3.2-6**.

The modeling to inform the assessment for surface water extends to the Year 2100, which is the current projection extent of global climate change models. Monitoring through the Post-closure Phase is not anticipated to be required through the Year 2100; however, model results in terms of potential effects are presented for this period.

Table 3.2-6: Temporal Boundaries for the Tenas Project

Phase	Year	Duration (years)	Description of Activities
Construction	-0.5 to 0	1.5	Site clearing, soil salvage, open pit development, building construction, service and haul road development, Rail Infrastructure construction, bridge construction and development of onsite utilities and services. Development of mine rock, and overburden storage piles, stockpiling of reclamation material such as soil, overburden and other materials suitable for reclamation. Development of water management systems and management ponds for storage of potentially acid generating (PAG) materials.
Operation	1 to 21	21	Development of the open pit through drilling, blasting, loading, and hauling functions. Development of mine rock, and overburden storage piles, stockpiling of reclamation material such as soil, overburden, and other materials suitable for reclamation. Development of water management systems and management ponds for PAG storage. Conducting coal processing, stockpiling of raw coal prior to processing, and stockpiling of processed coal prior to shipping. Progressive reclamation will be accomplished during operation including, where available, reclamation activities such as sloping, topsoil placement and revegetation.
Decommissioning and Reclamation	22 to 25	4	Tear-down of infrastructure onsite plus reclamation activities, including sloping of storage piles, backfill materials, and placement of reclamation materials including growth media, overburden and non-PAG rock for management pond covers and revegetating surfaces that are planned to be reclaimed.
Post-closure	26 to 50	10	Active: This involves the filling of the open pit with water, monitoring of vegetation growth and water quality for both groundwater and surface water and wildlife. Control and sedimentation ponds may still be needed for settling of total suspended solid levels. The management ponds are left as dry land reclamation except for portions that will be left as open water.
		15	Passive: This stage is when the control and sedimentation ponds are no longer required for settling of total suspended solid (TSS) levels and the management ponds are left as dry land reclamation except for portions that will be left as open water. Telkwa Coal Limited (TCL) is now simply monitoring the site.

3.2.4.3 Administrative Boundaries

No administrative boundaries are relevant to the Surface Water VC effects assessment.

3.2.4.4 Technical Boundaries

No technical boundaries were identified to the Surface Water VC effects assessment.

4. Existing Conditions

The information in this subsection establishes the context for the assessment of effects of the Project on the Surface Water VC, including regulatory context, Traditional Knowledge (TK), and baseline studies undertaken for the Project.

4.1 Background Information and Studies

This subsection describes the contribution of Traditional Knowledge (TK) to the description of the existing conditions, the availability of existing information, and the studies conducted for the Project.

4.1.1 Traditional Knowledge (TK)

The Surface Water LSA and RSA are within the Wet'suwet'en Traditional Territory. TK for the Project was obtained through a review of publicly available information as well as the Cultural Use Study (CUS). The **CUS** is **Appendix 7.1-B** of **7.0 Heritage Effects Assessment** of the **EAC Application** and presents a completed baseline inventory of cultural hereditary resources pertaining to the Wet'suwet'en communities by examining pre-existing cultural, social, historic, and economic data.

Water is important to the Wet'suwet'en culture and history. Physical environment features can be understood within the context of TK by recognizing the connection between the environment and the types and settings of Indigenous cultural values. The health of watersheds and waterways is just as important to Wet'suwet'en culture as the health of dry land. Both land and water are integral to the feast system, which in turn is integral to the Wet'suwet'en culture and collective identify. Given their preference for salmon, some culturally important waterways in the RSA are the Bulkley and Telkwa rivers.

The importance of surface water to the Wet'suwet'en culture, and its links to other environmental components (e.g., fish and fish habitat), supported its selection as a VC and informed the effects assessment. This includes the identification of potential residual effects, the development of mitigation measures proposed, the characterisation of the predicted residual effects, and the determination of significance of those residual effects on the Surface Water VC (i.e., TK was considered throughout the assessment).

4.1.2 Scientific and Other Information

The following information was consulted to support the assessment:

- Regional streamflow datasets:
  - Telkwa River Below Tsai Creek, Station 08EE020 (WSC 2020);
  - Bulkley River at Quick, Station 08EE004 (WSC 2020);
  - Bulkley River Near Smithers, Station 08EE005 (WSC 2020);
  - Goathorn Creek near Telkwa, Station 08EE008 (WSC 2020);
- Digital Elevation Model (DEM) from a Light Detection and Ranging (LIDAR) survey conducted in August 2017 on behalf of TCL;
- Climate data (Environment and Climate Change Canada [ECCC] 2020):
  - ECCC meteorological stations, namely Smithers A (Climate Identifier 1076638) and Smithers Airport Auto (Climate Identifier 1077501);

    - Automated Snow Weather Station network operated by the BC MECCS, BC Hydro, and others, namely Tsai Creek (Station Identified 4B17P);
    - ERA-5 Reanalysis data from European Centre for Medium-Range Weather Forecast, providing gridded climate data from 1980 to present;
    - PRISM Reanalysis data from the Pacific Climate Impact Consortium (PCIC), providing gridded climate data from 1950 to 2007;
- Technical reports reviewed in support of the Project Surface Water conditions include:
    - Davidson Project Meteorology and Hydrology Baseline report 2006-2008 (Rescan Environmental Services Ltd 2009);
    - Application for Environmental Assessment Certificate (Blue Pearl Mining Inc. 2008);
    - Drinking Water Source Quality Monitoring 2002-03; Bulkley Valley Surface Water Sources: Smithers Lakes, Kirby Lake, Chicago Creek, Bulkley River, Tobaggan Creek, and Thompson Creek (BC MECCS 2006);
    - Telkwa Coal Project 1999 Baseline Surface Flow and Water Quality Final Data Report (AGRA Earth and Environmental Ltd. [AGRA] 2000);
    - Telkwa Coal Mine Surface Water Monitoring Program 1998 (AGRA 1999);
    - Report to Stephen Day: BC Research Selenium Results (Frontier 1999);
    - Water Management for the Telkwa Coal Project (Piteau Engineering Ltd. [Piteau] 1998);
    - Final Project Report Specifications for Manalta Coal Ltd.'s Proposed Telkwa Coal Project (Telkwa Coal Project Committee 1997);
    - Telkwa Coal Project: Application for a Project Approval Certificate – Volumes I-V (Manalta Coal Ltd. [Manalta] 1997);
    - Summary of Fisheries, Aquatic Habitat and Water Quality Information for the Telkwa Project Area: A Literature Review (SRK Consulting (Canada) Inc. [SRK] 1996);
    - Baseline Data, Surface Water and Groundwater, Telkwa Coal Project (Piteau 1994);
    - Suspended Sediment: Telkwa River Watershed (Beaudry, P.G., J.W. Schwab and D. September 1991);
    - Water Quality Summaries for Eight Rivers in the Skeena River Drainage, 1983 – 1987: the Bulkley, Upper Bulkley, Morice, Telkwa, Kispiox, Skeena, Lakelse, and Kitimat Rivers (Wilkes, B. and R. Lloyd 1990);
    - Ambient Water Quality Objectives for the Bulkley River Basin: Overview Report. B.C. Ministry of Environment (Nijman 1986a);
    - Ambient Water Quality Objectives for the Bulkley River Basin: Technical Appendix. B.C. Ministry of Environment (Nijman 1986b);
    - Skeena-Nass Area Bulkley River Basin Water Quality Assessment and Objectives (BC MOE 1986);
    - Water Quality Investigation: Telkwa Coal Project (MacLaren 1985); and
    - Telkwa Project: Stage I Application (Crows Nest Resources 1983).

4.1.3 Baseline Studies

Baseline studies were completed between 1997 and 1999 in support of the former Manalta Coal Project property and were reinitiated in 2017 through 2020 for the Project. Methods to characterize surface water conditions are summarized as follows:

- local hydrometric station installation and manual discharge measurements; and

- annual water quality monitoring programs.

Table 4.1-1 lists the relevant field programs related to the Surface Water VC. Additional descriptions of the available data are summarized in **Appendix 4.1-C Tenas Project 2017 to 2019 Baseline Report**.

Table 4.1-1: Summary of Desktop and Field Studies Related to the Surface Water Valued Component (VC)

Study Name	Study Purpose, Duration and Spatial Boundaries
Tenas Project 2017-2019 Baseline Report (ERM 2020)	▪ Summary of hydrometric station installations, continuous water level readings, manual streamflow measurements, development of rating curves, and resultant continuous streamflow time series ▪ Summary of surface water quality monitoring data ▪ Summary of local meteorological data ▪ Developed in support of the Tenas Project (Project) effects assessment ▪ Presented in **Appendix 4.1-C Tenas Project 2017 to 2019 Baseline Report of S4.0-C1 Atmospheric Environment Valued Component (VC)** of the **EAC Application**,
Telkwa Coal Project 1999 Baseline Surface Flow and Water Quality Final Data Report AGRA Earth & Environmental [AGRA 2000)	▪ Water quality, water level and streamflow monitoring in support of the Telkwa Coal Project: Application for Project Approval Certificate by Manalta Coal Ltd (Manalta) (1997). Water quality measured in Telkwa River, Tenas Creek, Bulkley River, Goathorn Creek and Four Creek ▪ Continuous water level measurements collected in Four Creek in 1997 (October to November) and in 1998 (June to November). Converted to streamflow in support of 1999 baseline studies (AGRA 1999)
Telkwa Coal Mine Surface Water Monitoring Program (AGRA 1999)	▪ Summary of water monitoring data, including water levels, streamflow, and water quality, in support of Telkwa Coal Project Application for Project Approval Certificate by Manalta ▪ Data within the LSA and RSA
Baseline Data for Surface Water and Groundwater, Telkwa Coal Project (Piteau 1994)	▪ Prepared for Manalta. Summary of surface water quality measurements in Telkwa River, Bulkley River and Goathorn Creek, in addition to the meteorological data collection at the local weather station

Additional documents supporting the Surface Water VC effects assessment that are provided in the EAC Application include:

- **Tenas Project Water and Load Balance Modeling Report (Appendix 4.3-A)**;
- **Tenas Project Hydrometeorological Report (Appendix 1.0-R)**;
- **Tenas Project Water Management Design Technical Report (Appendix 1.0-F)**;
- **Minesite Water Management Plan (S13.0-C11) (MWMP)**;
- **Tenas Project Supplemental Geochemical Characterisation (Appendix 1.0-M)**;
- **Groundwater Technical Report for the Tenas Coal Project, Telkwa (Appendix 1.0-U)**; and
- Description of Proposed Project in **S1.0 Overview of Project Proponent Description** of the **EAC Application**.

4.1.3.1 Surface Water Quantity Methods

Surface water quantity was characterised through installation of local hydrometric stations along with compilation of data from regional stations. **Figure 4.4-1** presents the four (4) local hydrometric stations and their associated catchment areas in relation to the regional stations.

Local hydrometric monitoring stations were set up at Tenas Creek, Four Creek, Goathorn Creek, and Telkwa River. At each station, pressure transducers were installed as deep in the channel as possible to allow for continuous monitoring of water levels for all ranges of flows. Pressure transducers continuously recorded the water level at a 10-minute interval. Manual flow measurements were completed during each site visit during the 2017 to 2020 monitoring period to obtain a range of measured discharges under various conditions.

To provide a continuous record of the discharge at hydrometric monitoring sites, empirical relationships between measured stage and discharge (i.e., rating curves) were developed (as per International Standards Organization [ISO] 2010). Once the rating curve was established for a monitoring site, continuous stage data were converted into continuous discharge data by applying the rating curve equation to the recorded stage values. Data were then presented as discharge hydrographs.

Annual hydrographs, presented as mean daily discharge, were generated for each hydrometric monitoring station. To develop hydrologic indices, including mean annual runoff, seasonal runoff distribution and peak and low flow conditions, each local hydrometric station was extended to develop long-term synthetic streamflow records. The regression approach selected to develop regressions between measured, Project hydrometric records and regional analogues was chosen based on:

- the simplicity of the regression;
- the Nash-Sutcliffe Efficiency (NSE) between the estimated flows and the measured flows for the period of overlap; and
- the ability of the regression to approximate both high and low flows based on flow duration curves.

The regressions were then used to generate synthetic flow records for each Project hydrometric station using the long-term, regional records from WSC as a foundation. The time series generated from the developed regression equations for each hydrometric station were compared to the measured unit discharges at each station, and hydrologic indices were prepared.

Table 4.1-2 summarizes the hydrometric stations installed for the most recent baseline data collection. Rating curves and continuous discharge were developed for each hydrometric station by ERM (2020). Additional details on the instrumentation and rating curve development are summarized in the **Tenas Project 2017-2019 Baseline Report (Appendix 4.1-C** of the **EAC Application)**. The Tenas-Hydro station was relocated approximately 200 metres (m) upstream in 2018 after a flood event eroded the channel bank and rendered the former monitoring location unsuitable for anchoring instrumentation. Additional monitoring, rating curve development and analysis for 2019 hydrometric data were completed by ERM.

The Four-Hydro station was installed in April 2020 and a rating curve was developed based on six (6) discharge measurements with two (2) additional measurements completed in late 2020. Monitoring of other local hydrometric stations in 2020 was not completed due to access restrictions during the COVID-19 pandemic. A discharge measurement was completed at Four-Hydro in February 2021 to gather information on low flows at this hydrometric station.

Table 4.1-2: Project Specific Hydrometric Monitoring Network

Hydrometric Station	Location	Easting[4]	Northing[4]	Drainage Area (km^2)	Median Elevation (masl)	Period of Operation
Tenas-Hydro[1]	Tenas Creek	616914	6053490	47.6	1181	May 2017-November 2019
Tenas-Hydro B[2]				46.8		
Four-Hydro[3]	Four Creek	620096	6054096	11.0	985	Established 30 April 2020
Goathorn-Hydro[1]	Goathorn Creek	621100	6057441	123.5	1243	May 2017-November 2019
Telkwa-Hydro[1]	Telkwa River	54.65	617940	6057866	1243	May 2017-November 2019

Notes: *km^2=square kilometre; masl=metres above sea level*
1. Goathorn-Hydro, Telkwa-Hydro and Tenas-Hydro stations were installed May 2017, collecting continuous water level data through the open-water season. Rating curves were established through manual measurements in 2017 through 2019, and continuous streamflow records developed accordingly. Instrumentation was not re-installed in 2020.
2. Tenas-Hydro station relocated in 2018 approximately 200 m downstream from original location, renamed Tenas-Hydro B.
3. Four-Hydro station was installed April 2020 (ERM) with continuous water level data collected through October 2020 and winter spot flows in November, December 2020, and February 2021. Rating curve established through manual measurements 2020 only.
4. Northing and Easting based on UTM Zone 9N, datum WGS84.

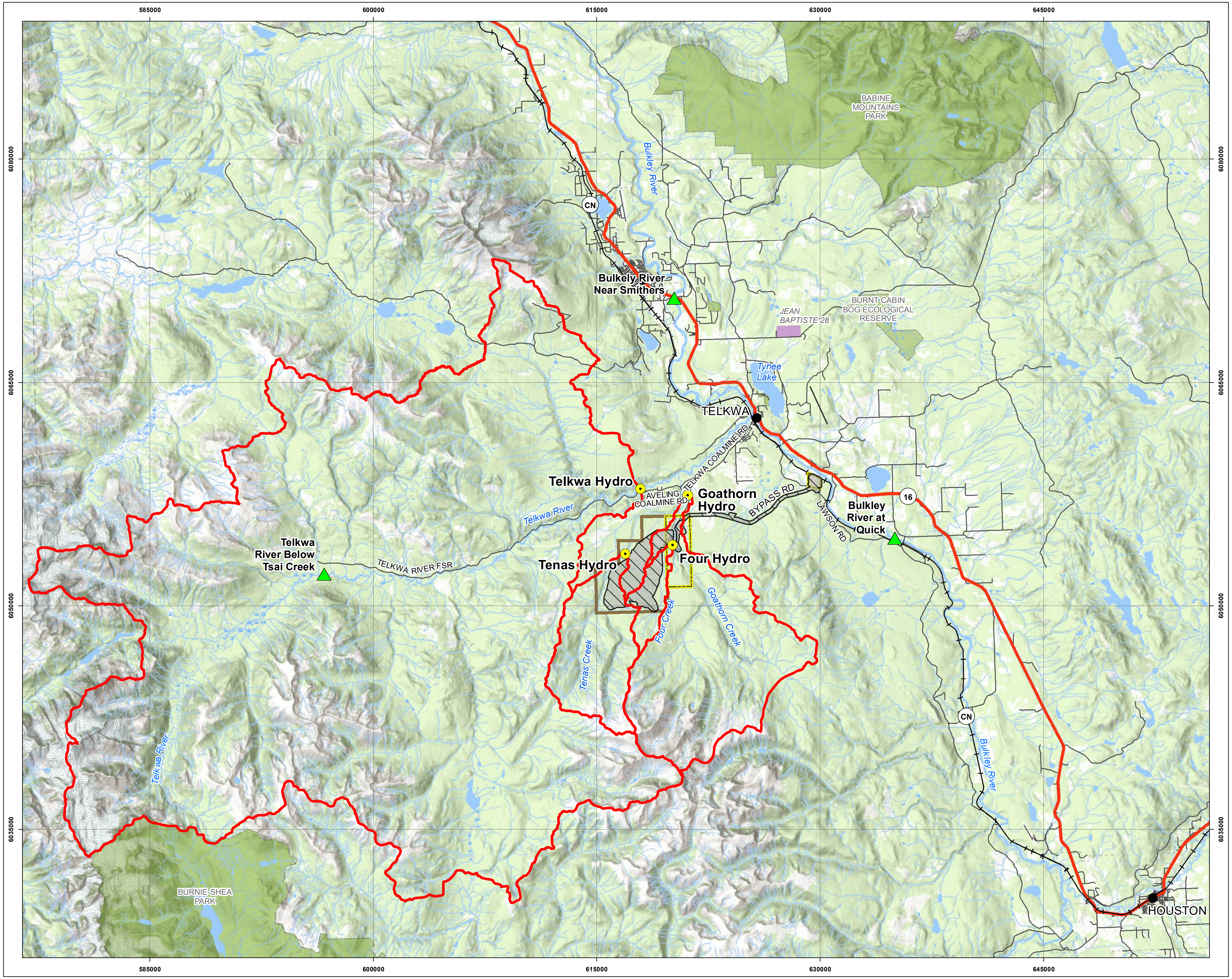
The WSC is the national authority responsible for the collection, interpretation, and dissemination of standardized water resource data in Canada. Stations within the same BC hydrological zone were evaluated and additional selection criteria were subsequently applied.

Figure 4.1-1 illustrates the four (4) regional WSC stations selected based on proximity to the Project hydrometric stations, as well as for having similar flow regimes, whereby the Goathorn Creek near Telkwa station (08EE008) is at the same location as Goathorn-Hydro. These stations have more than 10 years of data and catchment areas ranging between 125 km^2 to 8,940 km^2. **Table 4.1-3** summarizes the metadata for these stations and the length of published historical record. Additional provisional data were downloaded from the WSC website if the archived record did not extend to 2020. The provisional data records may change slightly as WSC evaluates data and adjusts rating curves to address any changes that may have occurred between years.

Table 4.1-3: Regional Hydrometric Monitoring Network

Station ID	Station Name	Easting[2]	Northing[2]	Drainage Area (km^2)	Period of Operation	
					First Year	Last Year
08EE008[1]	Goathorn Creek near Telkwa	621100	6057441	125	1960	2017
08EE020[1]	Telkwa River below Tsai Creek	596710	6052132	367	1975	2018
08EE004[1]	Bulkley River at Quick	635022	6054566	7340	1930	2018
08EE005[1]	Bulkley River near Smithers	620206	-6070667	8940	1945	2018

Notes: *km^2=square kilometres*
1. Streamflow records downloaded from WSC databases (WSG 2020) and consist of daily average flows along with annual peak instantaneous flows.
2. Northing and Easting based on UTM Zone 9N, datum WGS84



Tenas Project

Monitoring Map for Baseline Characterisation of Surface Water Quantity

Legend

- City/Town
- Project Hydrometric Stations
- Regional Hydrometric Stations (WSC)
- Rail Line
- Highway
- Road
- Discharge Path
- Watercourse
- Project Hydrometric Station Watersheds
- Wetland
- Waterbody
- Park or Protected Area
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- Tenas Coal Licenses
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Notes

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Kilometres

NAD 1983 UTM Zone 9N

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4.1.3.2 Surface Water Quality Methods

Water quality samples were collected from streams within the LSA and RSA in support of the Project, including Tenas Creek, Four Creek, Goathorn Creek, Telkwa River and Bulkley River. Samples were also collected at Helps Creek, located east of the Project, as it is crossed by the TAC. Samples were analyzed by ALS Environmental Laboratories. **Table 4.1-4** presents the station information and rationale. Data collection occurs throughout 2017 and 2019, predominantly in the open water season. Sample locations are shown in **Figure 8.1-1** of **Appendix 4.1-C** of the **EAC Application**.

Table 4.1-4: Surface Water Quality Baseline Sites, Tenas Project, 2017 to 2019

Site	Waterbody	Water Quality		Location and Rationale
		Easting[1]	Northing[1]	
WQS01	Tenas Creek	615171	6050438	Upstream reference for proposed Project infrastructure
WQS02	Tenas Creek	616914	6053490	Near-field downstream of deposits and proposed Project infrastructure
WQS04	Tenas Creek	620499	6057020	Mid-field downstream of deposits and proposed Project infrastructure
WQS04B	Tenas Creek	620676	6057950	Mid-field downstream of deposits and proposed Project infrastructure
E242646	Tenas Creek	-	-	Unknown point in Tenas Creek (EMS UTM not in stream)
WQS03	Four Creek	619235	6049989	Upstream reference for proposed Project infrastructure
WQS03-DS	Four Creek	620034	6054076	Downstream of proposed Project infrastructure, potentially influenced by historical workings
WQS15	Goathorn Creek	620942	6047172	Far upstream site sampled once. Sampled at the request of the Office of the Wet'suwet'en
WQS14	Goathorn Creek	620476	6047262	Far upstream site sampled once. Sampled at the request of the Office of the Wet'suwet'en (OW)
WQS13	Goathorn Creek	621664	6051778	Upstream reference site on Goathorn Creek. Upstream of historical workings
WQS06-US	Goathorn Creek	620587	6053711	Upstream of WQS06 and the confluence with Four Creek. Potentially influenced by historical workings
WQS06	Goathorn Creek	621100	6057441	Downstream of Project discharge, above the confluence with Tenas Creek
E242647	Goathorn Creek	-	-	Unknown point on Goathorn Creek (EMS UTM not in stream); description states that it is above the confluence with Tenas Creek
WQS05	Goathorn Creek	620615	6058133	Mid-field downstream of the confluence with Tenas Creek
WQS16	Helps Creek	625906	6055851	Upstream of proposed Tenas Bypass Road
WQS17	Helps Creek	625801	6055979	Upstream of proposed Tenas Bypass Road

Site	Waterbody	Water Quality		Location and Rationale
		Easting[1]	Northing[1]	
WQS08	Telkwa River	617964	6057860	Upstream reference; above the confluence with Goathorn Creek
WQS09	Telkwa River	621394	6058998	Mid-field downstream of the confluence with Goathorn Creek
WQS10	Telkwa River	624269	6061725	Far-field downstream before the confluence with the Bulkley River
400187	Telkwa River	625481	6062592	At the mouth of the Telkwa River at Village of Telkwa
WQS11-US	Bulkley River	630472	6056723	Upstream reference for the proposed Rail Infrastructure
WQS11	Bulkley River	629601	6059221	Near-field downstream of the proposed Rail Infrastructure
E246125	Bulkley River	625477	6062748	Immediately downstream of the Telkwa River confluence, at water intake for Telkwa
WQS12	Bulkley River	625021	6063831	Mid-field downstream of the proposed rail loadout and confluence with the Telkwa River
400434	Bulkley River	618410	6074024	Far-field downstream of the Project; downstream of Smithers and upstream of Smithers sewage discharge
400435	Bulkley River	617870	6074979	Far-field downstream of the Project; downstream of Smithers and downstream of Smithers sewage discharge

Notes: EMS=environmental monitoring system; Project=Tenas Project; UTM**=**Universal Transverse Mercator; WQS=Water Quality Station
1. Northing and Easting based on UTM Zone 9N, datum WGS84

Water-quality parameters were compared to their respective BC MECCS and CCME water quality guidelines for the protection of freshwater aquatic life.

4.2 Description of Existing Conditions

This subsection describes the existing (or baseline) surface water conditions in the context of the LSA and RSA. Details on surface water data, as well as data location maps and analyses, are provided in the **Tenas Project Hydrometeorological Report** in **Appendix 1.0-R** of the **EAC Application**.

4.2.1 Surface Water in the Context of the Regional Study Area (RSA)

The Project is located within the Telkwa River Watershed, a tributary of the Bulkley River and the Skeena River, which discharges into the Pacific Ocean, approximately 180 km west of the Project. The Project is situated between Goathorn Creek to the east, along with its tributary, Four Creek, and Tenas Creek to the west and north. Tenas Creek joins Goathorn Creek north of the Project, which in turn flows into the Telkwa River. The Telkwa River flows northwest approximately six (6) km from the confluence with Goathorn Creek before discharging into the Bulkley River (**Figure 4.1-1**).

The streamflow regime is nival (snowmelt-dominated) with the majority of runoff occurring in the spring and early summer due to melting winter snowpack. Following the snowmelt-driven high flow, there is typically a period of low flow throughout the late summer and early fall when inputs from snow have diminished. Throughout the fall period, short duration high intensity rain events may produce substantial high flow events with naturally elevated concentrations of suspended particles. Annual low flows occur during the winter months when air temperatures remain below freezing and snow that falls is typically stored in the snowpack until spring. During the winter low flow period, most streams retain baseflow from groundwater discharge. Some streams in the region have glacial inputs, but this is less prominent in the Project Area, as most of the substantial glacier coverage is west of the Project in the upper Telkwa River Watershed.

The RSA includes the Telkwa River catchment and a portion of the Bulkley River catchment between the Rail Infrastructure and downstream of the Telkwa River confluence. The RSA is characterised by mountainous terrain (i.e., Telkwa range and Bulkley range) with peak elevations ranging between 2,300 and 2,500 metres above sea level (masl) and elevations at Telkwa of about 500 masl.

The Telkwa River has a catchment area of approximately 1,000 km^2 upstream of the confluence with Goathorn Creek, which contributes an additional catchment of 200 km^2 below the confluence. The Telkwa River catchment increases to nearly 1,200 km^2 at the confluence with the Bulkley River, and the Bulkley River catchment upstream of the Telkwa River is close to 7,400 km^2.

Tenas Creek encompasses 35 percent (%) of the Goathorn Creek’s catchment area, and approximately 6% of the Telkwa River’s catchment at its confluence with the Bulkley River. Four Creek encompasses an even smaller portion of these catchments, representing 6% and 1% of the total Goathorn Creek and Telkwa River catchments, respectively.

Streams in the RSA exhibit naturally elevated concentrations of iron, copper and aluminum based on baseline monitoring data (ERM 2020). The Telkwa River and Bulkley River have historically exceeded the water quality guideline for total and dissolved aluminum, total iron, and total copper. Goathorn Creek and Tenas Creek have historically exceeded the water quality guideline for total and dissolved aluminum, total iron, and total copper, while Four Creek data exhibited exceedances for dissolved and total aluminum and dissolved and total iron.

4.2.2 Past and Current Human Activities

Within the RSA, small-scale underground and surface mining began in 1918 and continued sporadically until 1985, resulting in the recovery of over 400,000 tonnes of coal, about 3.6 km north and northwest of the Project. Currently, human activities within the LSA include mining exploration and forestry. Agriculture and forestry are concentrated in the area surrounding the village of Telkwa and along roads, trails, and rail tracks within the RSA.

Historic forest fires and forestry activities are expected to have had a temporary influence on sediment loads in the streams and may have resulted in increased flows by reducing infiltration losses to the soils. Similarly, small-scale quarry operations would be expected to have increased sediment load or the occurrence of elevated metals in the nearby receiving water quality.

4.2.3 Surface Water Quantity Baseline Conditions

To inform the assessment of the Project effects on the Surface Water VC, representative drainages were selected: Tenas Creek; Four Creek; Goathorn Creek; Telkwa River; and Bulkley River. Helps Creek and some of its tributaries will be crossed by the TAC however the potential effects on Surface Water Quantity and Quality are expected to be negligible. This is based on the use of a clear span bridges, best management practices (BMPs) for road construction in and around surface water streams and the use of surficial materials and approved gravel sources for the construction and maintenance of this structures. For this reason, Helps Creek has not been evaluated for the purpose of the effects assessment as it relates to the Surface Water VC.

The following subsections summarize the characteristics of each stream, including data source and quality, typical hydrologic indices (**Table 4.2-1**) and commentary on the methodology for record extension with regional datasets. Detailed discussion of station quality and modeling are presented in **Appendix 1.0-R Tenas Project Hydrometeorological Report**.

Table 4.2-1: Summary of Hydrologic Indices for Local Hydrometric Stations in the Regional Study Area (RSA) from 2017-2020

Hydrometric Station (stream)	Year	Total Annual Runoff (mm)	Peak Annual Unit Flow (L/s/km²)	June-September Unit Low Flow (L/s/km²)	
			Daily	Seven-day	Daily
Tenas-Hydro (Tenas Creek)	2017	452	117	3.7	3.7
	2018	399	133	1.4	1.3
	2019	353	71	2.9	2.6
Four-Hydro[1] (Four Creek)	2020	104	33	0.24	0.18
Goathorn-Hydro (Goathorn Creek)	2017	457	355	7.1	6.8
	2018	442	129	7.6	7.5
	2019	459	55	6.2	5.8
Telkwa-Hydro (Telkwa River)	2017	981	399	18.8	16.1
	2018	864	238	19.2	18.8
	2019	860	136	17.6	15.6
Bulkley River at Quick[2] (Bulkley River)	2017	7,980	95	0.068	0.066
Total for 4 water bodies	2018	6,430	110	0.027	0.025
Total for 4 waterbodies	2019	6,040	56	0.054	0.050

Notes: *L/s/km²=litres per second per square kilometre; mm=millimetre*
Four-Hydro was the only local station monitored in 2020
Bulkley River data based on WSC 08EE004 Bulkley River at Quick

4.2.3.1 Tenas Creek

Tenas Creek is a 20 km long tributary of Goathorn Creek and a portion of the stream flows past the western and northern extents of the Project Area.

Streamflow in Tenas Creek was characterised by data collected by the Tenas-Hydro station (renamed Tenas-Hydro B from 2018 onwards after being moved approximately 200 m upstream). Monitoring of Tenas-Hydro consists of open-water season continuous water level measurements which are converted to streamflow based on a rating curve established from manual flow measurements. Winter flows are estimated based on regression with WSC stations and available manual measurements.

The Tenas watershed ranges from 2,000 masl at its upper-most extent to 670 masl at the confluence with Goathorn Creek. The catchment area at Tenas-Hydro is 47.6 km^2, while the catchment area at the confluence with Goathorn Creek is approximately 70 km^2.

The Tenas-Hydro record was extended using regression analysis with Goathorn Creek near Telkwa WSC station (08EE008), resulting in a continuous flow record from 1960 through 2020. The regression model provided similar monthly and annual discharges as those measured at Tenas-Hydro but was found to overestimate higher exceedance probability flows (i.e., low flows).

The mean annual runoff for Tenas Creek was calculated to be 338 millimetre (mm), with a typical peak runoff occurring in May and June. This mean runoff depth is lower than the runoff rates measured at the Tenas-Hydro station between 2017 and 2019, which suggest these years presented higher than average runoff rates. The unit peak flows in Tenas Creek are higher than the unit peak flows at Goathorn Creek for a given return period, which can be attributed to its steeper terrain and shorter response time. Baseflow rates to Tenas Creek are lower per unit area than Goathorn Creek, with lowest flows occurring over the winter months between December and March.

4.2.3.2 Four Creek

Four Creek is a 6 km long tributary of Goathorn Creek and a portion flows along the eastern edges of the Project Area.

The Four Creek watershed ranges from 1,300 masl at its headwaters to 700 masl at the confluence with Goathorn Creek. The watershed area at Four-Hydro is 11 km^2, which is located near the confluence with Goathorn Creek.

Streamflow in Four Creek was characterised by the Four-Hydro station, installed in April 2020, and removed in October 2020. There are three (3) low flow measurements in Four Creek that span November 2020 to February 2021 and produced a unit discharge from 5.1 litres per second per square kilometre ($L/s/km^2$)to 0.72 $L/s/km^2$ as well as a single flow measurement in July with a unit discharge 0.33 $L/s/km^2$. These measurements form the basis of assumptions made to characterise baseflows at Four-Hydro. Additionally, low flow measurements collected in February 2021 spanned several locations along Four Creek and showed that baseflows have natural variability.

The Four-Hydro station record was compared against Goathorn Creek (08EE008); however, insufficient data were available to develop a strong regression and record extension. Four-Hydro measurements in 2020 indicate a faster snowmelt peak than at Goathorn Creek, which recedes to a low flow period that produces minimal response to rainfall events in drier summer months. Additional monitoring at the Four-Hydro is recommended throughout the Construction Phase to validate or update the hydrologic models.

Monitoring results from 1997 and 1998 (AGRA 1999) were reviewed, which showed that Four Creek presented a similar hydrological response as Goathorn Creek throughout the available overlapping records at that time. In the case of 2020, the regressions could not reproduce the peak hydrological events and patterns. Ongoing monitoring and regression model development for Four Creek will be completed to improve the creek's characterisation during the Construction Phase of the Project.

4.2.3.3 Goathorn Creek

Goathorn Creek is a 20 km long tributary of Telkwa River that flows along the eastern and northern edges of the Project Area. Goathorn Creek is a moderately wide, extensively braided creek. The TAC will cross the Goathorn Creek downstream of the confluence with Four Creek and upstream of the confluence with Tenas Creek.

Streamflow in Goathorn Creek is characterised by the Goathorn-Hydro station, which is located close to the WSC station on Goathorn Creek near Telkwa (08EE008). Monitoring of Goathorn-Hydro consists of open-water season continuous water level measurements which are converted to streamflow based on a rating curve established from manual flow measurements. Winter flows are estimated based on regression with WSC stations and available manual measurements.

The Goathorn watershed ranges from 2,000 masl at its upper-most extents to 570 masl at the confluence with Telkwa River. The catchment area at Goathorn-Hydro is 123.5 km^2, while the catchment area at the confluence with Telkwa River is approximately 195 km^2.

The Goathorn-Hydro record was extended using regression analysis with Goathorn Creek near the Telkwa WSC station (08EE008), resulting in a continuous flow record from 1960 through 2020. The regression model provided similar monthly and annual discharges to those measured at Goathorn-Hydro, with slight overestimation in 2017 and 2018 and some underestimation in 2019.

The mean annual runoff for Goathorn Creek was calculated to be 413 mm based on the extended record using WSC 08EE008, with a typical peak runoff occurring in May and June coinciding with spring freshet. Baseflow rates to Goathorn Creek are lower per unit area than Telkwa River, with the lowest flows occurring over the winter months between December and March.

4.2.3.4 Telkwa River

Telkwa River is a major watercourse, with a length of approximately 60 km and a watershed that encompasses glacier-capped mountains to the west. Where Goathorn Creek meets the Telkwa River, north of the Project, the slope of the river is approximately 1% with a floodplain width of approximately 500 m. The Telkwa River meets the Bulkley River in the Village of Telkwa, approximately six (6) km downstream of the confluence with Goathorn Creek.

Streamflow in Telkwa River was characterised by the Telkwa-Hydro station, located 2.6 km upstream of the confluence with Goathorn Creek and 22 km downstream of the WSC station Telkwa River below Tsai Creek (08EE020). Monitoring at Telkwa-Hydro consists of open-water season continuous water level measurements which were converted to streamflow based on a rating curve established from manual flow measurements. Winter flows were estimated based on regression with WSC stations and available manual measurements.

The Telkwa Watershed ranges from 2,100 masl at its upper-most extents to 500 masl at the confluence with Telkwa River. The watershed area at Telkwa-Hydro is 997 km^2, while the watershed area at the confluence with Bulkley River is approximately 1,200 km^2.

The Telkwa-Hydro record was extended using regression analysis with Telkwa River below Tsai Creek WSC station (08EE020), resulting in a continuous flow record from 1975 through 2020. The regression model provided similar monthly and annual discharges as those measured at Telkwa-Hydro, with slight underestimation in 2017 but comparable results for 2018 and 2019.

The mean annual runoff for Telkwa River was calculated to be 892 mm based on the extended record using WSC 08EE020, with a typical peak runoff occurring in May and June. The unit peak flows in Telkwa River are like Goathorn Creek, and greater than Bulkley River, for a given return period. Baseflow rates to the

Telkwa River are higher per unit area than its tributaries, with lowest flows occurring over the winter months between December and March.

4.2.3.5 Bulkley River

Bulkley River is a major watercourse, with a length of approximately 267 km and draining a total of 12,400 km^2 towards the Skeena River. The Bulkley River flows through the communities of Quick, Telkwa and Smithers, from south to north, and eventually discharges to the Skeena River near Hazelton.

Streamflow in the Bulkley River is characterised by two (2) WSC stations, Bulkley River at Quick (08EE004) and Bulkley River near Smithers (08EE005), located upstream and downstream of the confluence with the Telkwa River, respectively. Gaps in station 08EE005 exist from 1952 through 2008. For this reason, the baseline characterisation relied more on the 08EE004 records.

The Bulkley River Watershed ranges from 2,200 masl at its upper-most extents to 480 masl at the Town of Smithers. The watershed area at 08EE004 is 7,340 km^2.

The mean annual runoff for the Bulkley River was calculated to be 599 mm based on the WSC 08EE004 record, with a typical peak runoff occurring in May and June. The unit peak flows in the Bulkley River are lower than the Telkwa River or the smaller tributaries, for a given return period. Baseflow rates to the Bulkley River are higher per unit area than the smaller tributaries of Goathorn, Tenas or Four Creek, but lower than baseflows expected in the Telkwa River. Baseline Surface Water Quantity summaries are presented for each stream based on regional and local hydrometric datasets. Results include the monthly runoff rates at representative regional monitoring stations (**Figure 4.2-1**), monthly runoff distributions from the local hydrometric stations **(Figure 4.2-2**), modelled unit runoff rates (**Table 4.2-2)**, modelled unit seven (7)-day low flows (**Table 4.2-3**) and modelled unit peak flows (**Table 4.2-4**).

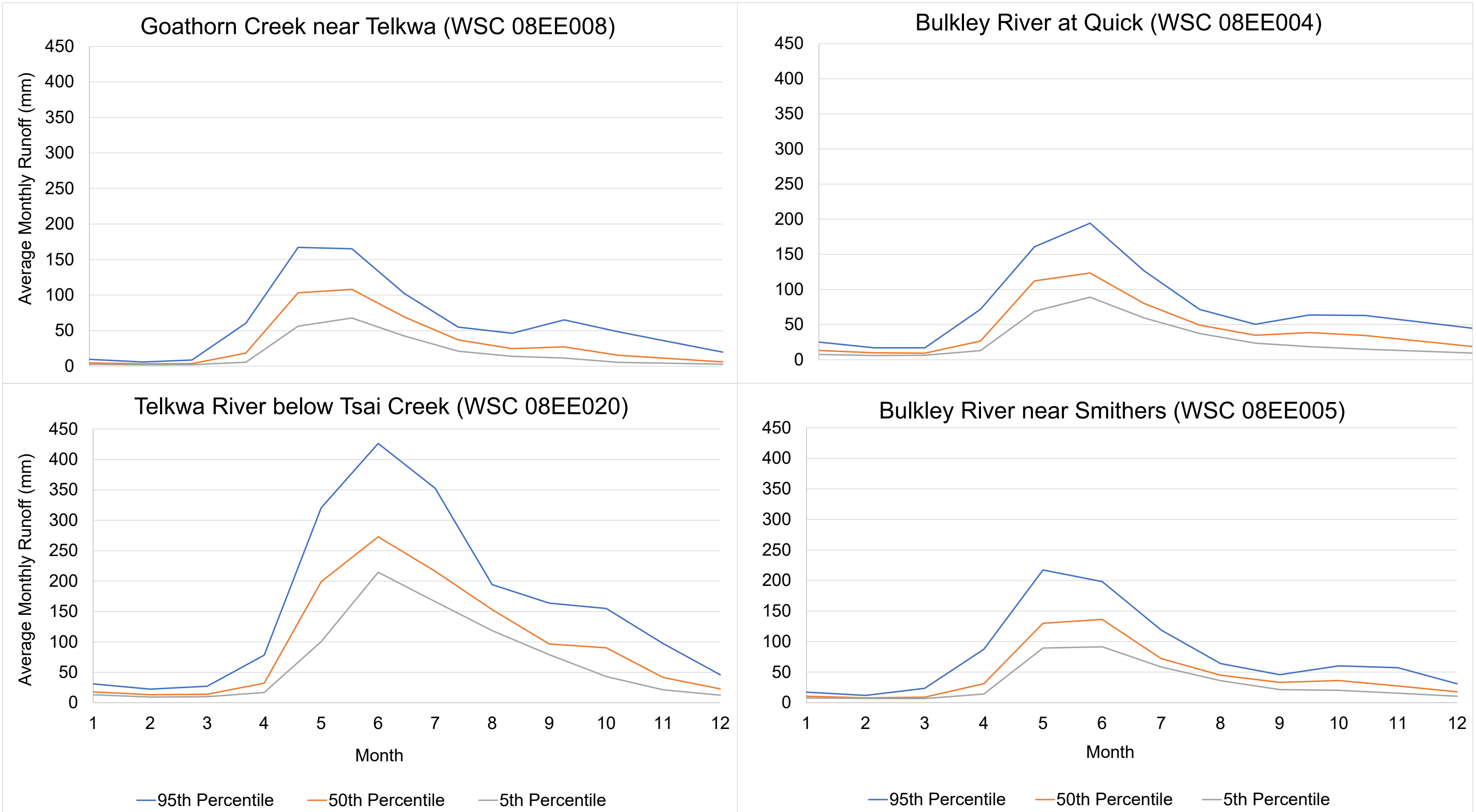


Figure 4.2-1: Monthly Runoff Rates (millimetre [mm]) at Representative Regional Monitoring Stations (WSC) for Various Percentile Flow Conditions, including 5th (Grey), 50th (Orange) and 95th (Blue) Monthly Runoff Percentiles

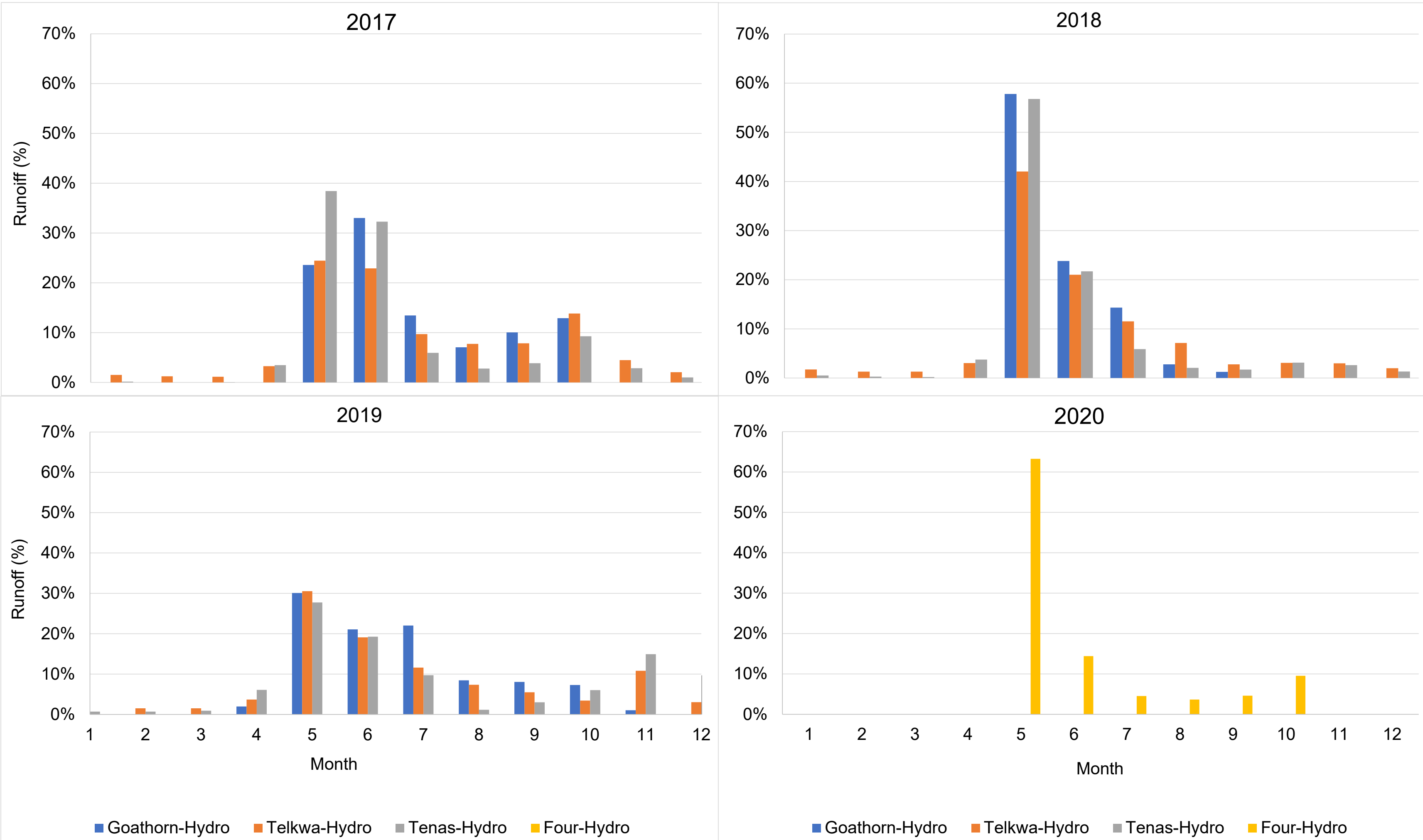


Figure 4.2-2: Monthly Runoff Distribution for Local Hydrometric Stations based on Measured Data from 2017 to 2020, including Tenas-Hydro (Grey), Goathorn-Hydro (Blue), Telkwa-Hydro (Orange), and Four-Hydro (Yellow)

Table 4.2-2: Modelled Monthly Average Runoff Depth [mm] for Tenas Project Watercourses

Watercourse	Unit Runoff Depth (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Tenas Creek[1]	1.6	1.0	1.3	22	105	104	32	16	12	27	17	3.4	338
Four Creek[2]	0.72	0.65	0.72	16	12	3.0	5.0	2.0	6.4	2.4	0.86	0.72	50
Goathorn Creek[3]	7.7	6.3	7.2	24	97	96	63	34	26	29	19	11	413
Telkwa River[4]	18	13	15	44	205	220	130	73	54	68	35	21	892
Bulkley River[5]	13	10	9	27	112	123	80	49	35	39	35	19	551

Table 4.2-3: Modelled Seven (7)-Day Unit Low Flows (L/s/km^2) for Tenas Project Watercourses

Watercourse	7-Day Unit Low Flow (L/s/km^2) Recurrence (Years)					
	2	5	10	20	50	100
Tenas Creek[1]	0.21	0.11	0.08	0.06	0.05	0.048
Four Creek[2,6]	0.21	0.11	0.08	0.06	0.05	0.048
Goathorn Creek[3]	2.2	1.9	1.8	1.7	1.6	1.5
Telkwa River[4]	4.2	3.7	3.4	3.2	2.9	2.8
Bulkley River[5]	3.1	2.4	2.1	1.8	1.6	1.5

Table 4.2-4: Modelled Annual Unit Peak Flows (L/s/km^2) for Tenas Project Watercourses

Watercourse	Unit Peak Flow (L/s/km^2) Recurrence (Years)					
	2	5	10	20	50	100
Tenas Creek[1]	103	142	175	213	274	330
Four Creek[2,6]	103	142	175	213	274	330
Goathorn Creek[3]	98	140	172	205	248	280
Telkwa River[4]	198	260	313	376	478	574
Bulkley River[5]	91	111	122	130	140	147

Notes for Tables 4.2-2, 4.2-3, 4.2-4: *L/s/km^2=litres per second per square kilometre; mm=millimetre*
1. Tenas Creek results calculated based on regression with Tenas-Hydro with Goathorn Creek near Telkwa (WSC 08EE008)
2. Four Creek results calculated based on precipitation-runoff model calibrated for 2020 monitoring data at Four-Hydro. Calibrated model results appear to underestimate freshet (May) runoff by 50%. Results to be refined when additional monitoring data become available
3. Goathorn Creek results calculated based on regression with Goathorn-Hydro with Goathorn Creek near Telkwa (WSC 08EE008)
4. Telkwa River results calculated based on regression with Telkwa River below Tsai Creek (WSC 08EE020)
5. Bulkley River results calculated based on Bulkley River at Quick (WSC 08EE004)
6. Sufficient data were not available at Four Creek to calculate low and high flow conditions. Modelling assumes Tenas Creek metrics for low and high conditions are applicable to Four Creek for the purpose of effects assessment.

4.2.4 Surface Water Quality Baseline Conditions

Table 4.2-5 presents the number of measurements collected within each watercourse selected to inform the assessment, over the sampling campaign in 2017 through 2019. Percentiles were developed from year-round monitoring data. The 50th and 95th percentile water quality results from the available datasets in each stream are presented in **Table 4.2-6**. Furthermore, five (5) measurements over a 30-day timeframe were also completed as per regulatory guidelines for most of the watercourses in the Project Area with only Four Creek being missed. TCL is currently completing these measurements for Four Creek and will be provided during the EA process. Note that only parameters with an associated guideline, as described in **3.2.3.1 Water Quality Guidelines (WQG) and Site Performance Objectives (SPOs)**, are presented in the summary tables. Complete baseline data compilation can be found in **Appendix 4.1-C Tenas Project 2017 to 2019 Baseline Report** of **S4.0-C1 Atmospheric Environment VC** of the **EAC Application**. In processing the receiving water quality data, values presented as less than the method detection limit were assumed to be equal to the method detection limit to be conservative. Where reporting parameters were different between historical and current baseline data sets, but where the same species was measured, the data were combined into a single parameter (done for: fluoride, sulfate, ammonia, nitrate, and nitrite).

Table 4.2-5: Number of Samples Collected Throughout Surface Water Quality Baseline Sampling Program, 2017 to 2019

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017												
Tenas Creek[2]	-	-	-	-	4	3	3	3	3	4	4	4
Four Creek[1]	-	-	-	-	1	1	1	1	1	1	1	1
Goathorn Creek[3]	-	-	-	-	2	2	2	2	2	3	3	3
Telkwa River[4]	-	-	-	-	4	4	4	4	4	3	3	3
Bulkley River[5]	-	-	-	-	2	2	2	2	3	2	3	3
2018												
Tenas Creek[2]	4	5	3	4	7	8	4	4	3	10	3	4
Four Creek[1]	1	1	1	1	2	2	2	2	2	2	2	2
Goathorn Creek[3]	3	2	2	3	5	6	3	4	6	9	6	4
Telkwa River[4]	3	3	5	3	5	9	4	3	4	9	3	3
Bulkley River[5]	-	-	1	1	4	7	3	3	4	11	3	4
2019												
Tenas Creek[2]	3	3	3	3	-	-	-	3	-	-	3	-
Four Creek[1]	2	2	2	2	-	-	-	-	-	2	2	-
Goathorn Creek[3]	5	5	5	4	-	-	-	2	-	3	3	-
Telkwa River[4]	4	4	3	2	-	-	-	2	-	-	2	-
Bulkley River[5]	3	3	4	3	-	-	-	2	-	-	4	-

Notes:
1. Four Creek numbers include data collected from stations WQS03, WQS03-DS, WQS18.
2. Tenas Creek numbers include data collected from stations WQS02, WQS01, WQS04B, WQS04.
3. Goathorn Creek numbers include data collected from stations WQS05, WQS06, WQS06-US, WQS07, WQS13, WQS14, WQS15
4. Telkwa River numbers include data collected from stations WQS08, WQS09, WQS10
5. Bulkley River numbers include data collected from stations WQS11, WQS11-US and WQS12

Table 4.2-6: Surface Water Quality Summary Statistics by Stream, 2017 to 2019 (milligrams per litre [mg/L]) where Parameters Exceeding the Water Quality Guidelines (WQG) are Highlighted in Red

Parameter[1]	Units	Receiving Water Quality																								
		Four Creek					Goathorn Creek					Tenas Creek					Telkwa River					Bulkley River				
		Average	P50	P95	Count	WQG	Average	P50	P95	Count	WQG	Average	P50	P95	Count	WQG	Average	P50	P95	Count	WQG	Average	P50	P95	Count	WQG
Total Dissolved Solids	mg/L	150	150	220	26		110	110	140	63		98	100	130	53		64	66	88	73		49	47	68	56	
Conductivity	µS/cm	220	240	330	26		150	160	210	85		150	160	210	76		90	87	130	138		60	56	77	89	
pH		8.2	8.3	8.5	26		7.9	7.9	8.2	85		8.1	8.1	8.3	76		7.8	7.8	8.1	136		7.6	7.7	7.8	116	
Total Suspended Solids	mg/L	9.1	1.5	23	26	35	6.5	3.7	19	63	35	7.7	1.5	**41**	53	35	11	5.3	**40**	73	35	14	4	**50**	56	35
Hardness	mg-$CaCO_3$/L	110	110	170	28		70	69	110	92		75	73	110	82		42	37	66	109		29	27	37	76	
Chloride	mg/L	0.3	0.25	0.5	28	150	0.34	0.25	0.5	92	150	0.35	0.25	0.5	82	150	0.34	0.25	0.5	108	150	0.43	0.25	0.86	66	150
Fluoride	mg/L	0.053	0.059	0.068	28	0.12	0.033	0.032	0.041	78	0.12	0.033	0.031	0.045	69	0.12	0.029	0.029	0.038	94	0.12	0.022	0.023	0.035	60	0.12
Nitrate	mg-N/L	0.021	0.013	0.058	28	3	0.044	0.041	0.076	80	3	0.019	0.005	0.06	71	3	0.024	0.013	0.076	99	3	0.018	0.013	0.041	75	3
Nitrite	mg-N/L	0.00057	0.0005	0.001	28	0.02	0.00079	0.0005	0.002	80	0.02	0.0015	0.0005	0.002	71	0.02	0.0011	0.0005	0.005	99	0.02	0.0028	0.002	0.005	134	0.02
Sulfate	mg/L	5.9	1.9	28	28	309	24	24	37	92	218	3.1	2.6	7.4	82	218	5.6	5.6	9	107	218	4.1	4	5	64	128
Aluminum, total	mg/L	**0.32**	0.099	**1.2**	28	0.1	**0.21**	0.092	**0.75**	92	0.1	**0.31**	0.056	**1.8**	82	0.1	**0.39**	**0.17**	**1.7**	103	0.1	**0.34**	**0.13**	**1.3**	68	0.1
Aluminum, dissolved	mg/L	**0.12**	0.032	**0.49**	28	0.05	0.036	0.014	**0.13**	78	0.05	0.036	0.016	**0.14**	70	0.05	0.039	0.027	**0.088**	94	0.05	**0.075**	0.017	**0.13**	60	0.05
Antimony, total	mg/L	0.000063	0.00005	0.00012	28	0.009	0.00008	0.000073	0.00014	92	0.009	0.00013	0.00013	0.00024	82	0.009	0.000049	0.00005	0.00005	103	0.009	0.000075	0.00005	0.00011	68	0.009
Arsenic, total	mg/L	0.00075	0.00074	0.0011	28	0.005	0.00029	0.00023	0.00068	92	0.005	0.00051	0.00048	0.0009	82	0.005	0.00027	0.00024	0.00055	103	0.005	0.00033	0.00024	0.0007	68	0.005
Barium, total	mg/L	0.084	0.071	0.13	28	1	0.058	0.058	0.072	92	1	0.035	0.034	0.047	82	1	0.041	0.04	0.049	103	1	0.028	0.026	0.038	68	1
Beryllium, total	mg/L	0.000059	0.00005	0.0001	28	0.00013	0.000044	0.00005	0.0001	92	0.00013	0.000044	0.00005	0.0001	82	0.00013	0.000044	0.00005	0.00005	103	0.00013	0.000056	0.00005	0.0001	68	0.00013
Boron, total	mg/L	0.012	0.012	0.02	28	1.2	0.011	0.005	0.05	92	1.2	0.017	0.015	0.05	82	1.2	0.01	0.005	0.05	103	1.2	0.0078	0.005	0.01	65	1.2
Cadmium, total	mg/L	0.0000083	0.0000063	0.000019	28	0.000009	0.000015	0.00001	0.000049	92	0.000009	0.0000069	0.000005	0.000021	82	0.000009	0.000016	0.000011	0.000036	103	0.000009	0.0000087	0.0000079	0.000021	68	0.000009
Cadmium, dissolved	mg/L	0.0000056	0.0000052	0.000012	28	0.000024	0.000012	0.0000081	0.000036	78	0.000016	0.0000032	0.0000025	0.0000058	70	0.000017	0.000006	0.0000063	0.0000099	94	0.000011	0.0000037	0.0000025	0.0000065	60	0.000008
Calcium, total	mg/L	23	24	34	28		22	21	30	91		22	22	31	79		13	12	20	102		9.3	8.8	11	74	
Chromium, total	mg/L	0.00051	0.00026	0.0016	28	0.0089	0.00032	0.0002	0.00091	92	0.0089	0.00055	0.00032	0.0018	82	0.0089	0.00036	0.0002	0.001	103	0.0089	0.00043	0.00025	0.0012	68	0.0089
Cobalt, total	mg/L	0.00016	0.00005	0.00047	28	0.004	0.00015	0.00005	0.00055	92	0.004	0.0002	0.00005	0.00099	82	0.004	0.00019	0.00005	0.00088	103	0.004	0.00021	0.00005	0.00068	68	0.004
Copper, total	mg/L	0.0018	0.0014	0.0044	28	0.0047	0.0021	0.0015	**0.0054**	92	0.0028	0.0018	0.0011	**0.005**	82	0.003	0.0015	0.0011	**0.0042**	103	0.002	0.0013	0.0009	**0.0029**	68	0.002
Iron, total	mg/L	0.29	0.095	**1.1**	28	0.3	0.22	0.085	**0.78**	92	0.3	0.26	0.048	**1.2**	82	0.3	**0.49**	**0.31**	**1.5**	103	0.3	**0.39**	0.18	**1.3**	71	0.3
Iron, dissolved	mg/L	0.093	0.015	**0.41**	28	0.3	0.041	0.015	0.13	79	0.3	0.038	0.015	0.14	71	0.3	0.11	0.076	0.27	95	0.3	0.09	0.024	0.16	62	0.3
Lead, total	mg/L	0.000084	0.000025	0.00028	28	0.005	0.000076	0.000025	0.00023	92	0.005	0.00008	0.000025	0.00039	82	0.005	0.00037	0.00014	0.0014	103	0.0044	0.00017	0.000095	0.00051	68	0.004
Magnesium, total	mg/L	13	14	19	28		4	3.9	6.5	91		4.3	4.2	6.3	79		2.2	2.1	3.5	102		1.4	1.4	2.5	74	
Manganese, total	mg/L	0.0065	0.0025	0.024	28	0.12	0.0098	0.0059	0.033	92	0.12	0.012	0.005	0.058	82	0.12	0.027	0.02	0.078	103	0.12	0.023	0.016	0.059	68	0.12
Mercury, total	mg/L	0.0000061	0.0000025	**0.000013**	28	0.00001	0.0000031	0.0000025	0.0000064	67	0.00001	0.0000038	0.0000025	0.0000089	58	0.00001	0.0000034	0.0000025	0.000007	81	0.00001	0.0000032	0.0000025	0.0000055	60	0.00001

Parameter[1]	Units	Receiving Water Quality																								
		Four Creek					Goathorn Creek					Tenas Creek					Telkwa River					Bulkley River				
		Average	P50	P95	Count	WQG	Average	P50	P95	Count	WQG	Average	P50	P95	Count	WQG	Average	P50	P95	Count	WQG	Average	P50	P95	Count	WQG
Molybdenum, total	mg/L	0.00023	0.00023	0.00038	28	0.073	0.00046	0.00047	0.00062	92	0.073	0.00013	0.00012	0.00019	82	0.073	0.00053	0.00053	0.00073	103	0.073	0.00039	0.00037	0.00055	68	0.073
Nickel, total	mg/L	0.00071	0.00025	0.0018	28	0.08	0.00044	0.00025	0.0011	92	0.08	0.00049	0.00025	0.0017	82	0.08	0.00037	0.00025	0.0011	103	0.025	0.00055	0.00025	0.0014	68	0.025
Selenium, total	mg/L	0.000047	0.000025	0.000095	28	0.002	0.00011	0.000086	0.0002	92	0.002	0.000073	0.000051	0.0002	82	0.002	0.00009	0.00008	0.0002	103	0.002	0.000051	0.000025	0.0002	68	0.002
Strontium, total	mg/L	0.15	0.17	0.24	28	7	0.078	0.076	0.11	92	7	0.1	0.11	0.13	82	7	0.063	0.062	0.087	103	7	0.042	0.04	0.061	68	7
Silver, total	mg/L	0.000008	0.000005	0.000022	28	0.00005	0.000008	0.000005	0.00002	92	0.00005	0.0000081	0.000005	0.00002	82	0.00005	0.0000086	0.000005	0.00002	103	0.00005	0.0000077	0.000005	0.00002	68	0.00005
Uranium, total	mg/L	0.0001	0.000078	0.00025	28	0.0085	0.00006	0.000054	0.00014	92	0.0085	0.00012	0.00011	0.00025	82	0.0085	0.000058	0.000056	0.000092	103	0.0085	0.00004	0.000036	0.000094	68	0.0085
Zinc, total	mg/L	0.0026	0.0015	0.0059	28	0.023	0.0035	0.0015	0.0061	92	0.0075	0.0017	0.0015	0.006	82	0.0075	0.0024	0.0015	0.0072	103	0.0075	0.0025	0.0015	0.0055	68	0.0075

Notes: *µS/cm=microSiemens per centimetre; mg-$CaCO_3$/L=milligrams of calcium carbonate per litre; mg-N/L=milligrams nitrate per litre; mg/L=milligrams per litre; P50=50th percentile; P95=95th percentile*

1. List includes all parameters with an associated guideline value. Complete list of baseline water quality statistics presented in ERM 2020 and SRK 2021b.

Watercourses monitored during baseline studies within the RSA have historically had elevated concentrations of iron, copper, and aluminum when compared to the BC ALG as summarized by **Table 4.2-6** above. The Telkwa River and Bulkley River have historically exceeded the guideline for total aluminum based on the 50th percentile of baseline water quality data. The Telkwa River also exceeded the guideline for total iron in 50th percentile of results. Both rivers have also exceeded the guidelines for total copper and dissolved aluminum in up to the 95th percentile of baseline records. Goathorn Creek and Tenas Creek have historically exceeded the guideline for total and dissolved aluminum, total iron, and total copper in the 95th percentile of baseline data, while Four Creek data shows a similar pattern but for dissolved and total aluminum and dissolved and total iron. Exceedances in Four Creek are also observed in the upstream reaches, with total and dissolved aluminum, total copper, and total iron exceeding the guideline in the 95th percentile of baseline data. The upstream reaches of Goathorn Creek show a similar pattern but for total cadmium and total copper.

5. ASSESSMENT OF PROJECT-RELATED EFFECTS

A water and load balance model was developed to evaluate the change between pre-mining conditions and post-mining conditions in surface water to inform the assessment. Inputs to the model include groundwater modelling results, historical and modelled climate and hydrology datasets, performance and operations of mining elements, water management infrastructure, catchment areas, geochemical source terms and baseline water quality data. The model is intended to provide expected and reasonable worst-case conditions before, during and after mining is complete and includes sensitivity analyses to understand the range of expected conditions. Where applicable, model results were calibrated using baseline information. Modelling methods, assumptions and detailed results are presented in **Appendix 4.3-A Tenas Project Water and Load Balance Modeling Report**. Results are summarized in terms of effects during the Construction, Operation, Decommissioning and Reclamation, and Post-closure phases.

Modelled nodes were selected within each stream in the receiving environment to characterise potential Project-related effects. Results of the modelling for the nodes were used to determine the location, extent, and timing of change in Surface Water Quantity and Surface Water Quality subcomponents based on thresholds selected for each indicator, as described in **Table 5-1**. The catchment area reporting to nodes that were classified as affected by the Project were compared with the total catchment area available within the RSA. This was to determine if the Project's effect on the Surface Water VC compromised the sustainability or its contributions to ecological function or other water uses (agriculture, drinking water, recreation, wildlife) at the regional level.

Table 5-1: Definition of Affected Areas by Surface Water Valued Component (VC) Indicators

Indicator	Definition of Affected Area
Surface Water Quantity	
Change in Mean Annual Discharge (MAD)	Catchment area for nodes where modelling results show an increase of more than 30 percent (%) or reduction of more than 10% to pre-mining MAD in any year.
Change in seasonal flow distribution	Catchment area for nodes where modelling results show an increase of more than 30% or reduction of more than 10% to pre-mining monthly average discharge in any year.
Change in low flows and high flows	Catchment area for nodes where modelling results show a reduction of more than 10% to pre-mining low flows (7Q10) or increase of more than 30% to pre-mining high flows (100-year wet).
Surface Water Quality	
Change in parameter concentrations	Catchment area for nodes where modeling results show an exceedance of Site Performance Objective (SPO) values or guidelines where SPOs where not developed, for any parameter while also exceeding the 95th percentile from baseline monitoring data.
Change in other measurable water quality parameters.	Catchment area for nodes where modeling results show an exceedance of guideline for any parameter while also exceeding the 95th percentile from baseline monitoring data

The water quantity thresholds were selected based on the Environmental Flow Needs Policy (British Columbia Ministry of Forests, Lands and Natural Resources Operations [BC MFLNRO] and BC MOE 2016) and environmental risk management framework, which uses a 10% reduction or withdrawal from streamflow as an indicator of stream sensitivity for fish habitat. Water quality thresholds incorporate SPOs when applicable, and are otherwise based on the guidelines, while accounting for natural variability each stream could be expected to experience based on baseline monitoring (95th percentile). Several assessment cases were selected to understand the range of potential effects from the Project throughout the life of the mine. Cases incorporate variability in hydrologic conditions, groundwater conditions and geochemical source terms.

The effects assessment described in this report describes the Project Case, which incorporates Project design mitigation measures and expected inputs for geochemical source terms and average hydrology. The results were used to inform the assessment of the Project effects on the Surface Water VC at the RSA level. Alternative assessment cases are discussed in **Appendix 4.3-A Tenas Project Water and Load Balance Modeling Report**.

This subsection presents:

- identification of potential Project-related interactions with the Surface Water VC;
- description of potential Project-related effects on the Surface Water VC;
- identification of mitigation measures; and
- characteristics of Project residual effects and determination of Significance on the Surface Water VC.

5.1 Potential Project-related Interactions

This subsection focuses the assessment on those Project components and activities expected to interact with the Surface Water VC and may cause a potential effect on surface water, in terms of both quantity and quality. The potential interactions were identified based on professional experience with other mining projects in BC and through multi-disciplinary consultation with consultants working on behalf of TCL. Interactions are defined as either No Interaction, or Interaction, as outlined in **Table 5.1-1**.

Table 5.1-1: Potential for an Interaction between Surface Water Valued Component (VC) or Subcomponent and the Tenas Project (Project)

Term	Definition
No Interaction	Tenas Project (Project) activity will not interact with the Surface Water Valued Component (VC), no effect is expected; no further consideration is warranted.
Interaction	Interaction between the Project activity and the Surface Water VC may have a substantive influence on the short- or long-term integrity of the VC (i.e., measurable, or detectable using the identified indicator). The potential effect(s) of the interaction is considered further in the effects assessment.

The evaluation of the interaction matrix (**Table 5.1-2**) led to identification of potential interactions between Project components or activities and Surface Water VC subcomponents, which are those that warrant further assessment as they have potential to result in residual effects or to be of greater concern to Indigenous groups, government, or the public. Where an interaction is possible, the anticipated potential effect(s) is identified and carried forward in the assessment (**5.2 Potential Project-related Effects**).

Where no interaction between the Project and a subcomponent is anticipated, the interaction is not considered further in the assessment for one (1) or both of the following reasons:

- They are known to have no or negligible effects (i.e., not expected to have an influence on the integrity of surface water; effect would not be measurable or detectable using the indicators identified for the surface water VC); or
- They are already well regulated and/or managed under another regulatory process.

Table 5.1-2: Interactions between Surface Water Valued Component (VC) and the Tenas Project

Project Activities	Surface Water Subcomponent	
	Surface Water Quantity	Surface Water Quality
Construction		
Transportation of equipment, materials, and personnel	X	X
Site clearing (surveying, clearing, grubbing, soil salvaging)	X	X
Construction of Surface Water Management Infrastructure, including channels and ponds (sedimentation, control, management, storage)	X	X
Construction of Bypass Road and quarries from the Minesite to the Rail Infrastructure	X	X
Improvements to existing private road and Forest Service Roads	X	X
Construction of haul roads and service roads within the Minesite		X
Construction of the permanent Goathorn Bridge Crossing over Goathorn Creek	X	X
Construction of the Coal Processing Plant	X	X
Construction of fuel and lubricant storage facilities and distribution network		X
Construction of administration buildings (first aid, maintenance, mine dry, warehouse, laboratory, parking, and vehicle wash facilities)		
Construction of a 25 kilovolt (kV) power line and a 600 volt (V) substation adjacent to the Coal Processing Plant		X
Construction of Rail Infrastructure including Rail Loop and Loadout connecting to the existing main Canadian National Railway line	X	X
Installation of water supply wells, storage, and distribution system		
Construction of the water discharge infrastructure		X
Construction of storage piles for overburden, rock separated from coal in Coal Processing Plant, and stockpiles for topsoil and vegetation management	X	X
Construction of material handling systems for Minesite, including run-of-mine coal, processed coal, process rock conveyors, and stockpiles	X	X
Construction of solid waste management systems including recycling and composting facilities		
Construction of Explosives Magazine (storage building)	X	X
Employment and labour		
Operation		
Mining the open pit (soil salvaging, drilling and blasting, excavation of material, dewatering, loading, hauling, unloading)	X	X

Project Activities	Surface Water Subcomponent	
	Surface Water Quantity	Surface Water Quality
Operation of Surface Water Management Infrastructure including channels and ponds (sedimentation, control, management, storage)	X	X
Maintain and use Bypass Road and quarries from the Minesite to the Rail Infrastructure		
Maintain improved private and Forest Service Roads		
Maintain haul roads within the Minesite, including service roads		
Maintain permanent bridge over Goathorn Creek		
Operate Coal Preparation Plant		
Maintain fuel and lubricant storage facilities		
Maintain administration buildings (first aid, maintenance, mine dry, warehouse, laboratory, and vehicle wash facilities)		
Maintain 25 kV power line and a 600 V substation adjacent to the Coal Processing Plant		
Transportation of equipment, materials, and personnel		
Maintain and use Rail Infrastructure including Rail Loop and Loadout connecting to the existing main Canadian National Railway line		X
Operate water supply wells, storage, and distribution system	X	
Operate the water discharge infrastructure	X	X
Maintain storage piles for overburden, rock separated from coal in Coal Processing Plant, and stockpiles for topsoil and vegetation management	X	X
Operate material handling systems for Minesite, including run-of-mine coal, processed coal, process rock conveyors, and stockpiles	X	X
Operate solid waste management systems including recycling and composting facilities		X
Maintain Explosives Magazine (storage facilities)		
Progressive reclamation		
Employment and labour		
Decommissioning and Reclamation		
Dismantle and remove mining equipment and facilities (including powerline, Rail Infrastructure)		X
Transportation of equipment, materials, and personnel		
Reclamation and closure activities at Minesite	X	X

Project Activities	Surface Water Subcomponent	
	Surface Water Quantity	Surface Water Quality
Reclamation and closure of Bypass Road and haul roads, including quarries	X	X
Reclamation and closure of permanent bridge over Goathorn Creek		
Reclamation and closure of powerlines		
Reclamation and closure of Rail Infrastructure	X	X
Implement post-mining systems and monitoring	X	X
Employment and labour		
Post-closure		
Maintain post-mining systems and ongoing monitoring	X	X
Transportation of equipment, materials, and personnel		
Employment and labour		

Notes:
Interaction (X): Interaction between the Project activity and the VC may have a substantive influence on the short- or long-term integrity of the VC (i.e., measurable, or detectable using the identified indicator). The potential effect(s) of the interaction is considered further in the effects assessment.
No interaction (Blank): Project activity will not interact with the VC; no adverse effect is expected; no further consideration is warranted.

5.2 Potential Project-related Effects

This subsection considers the potential Project-related effects on the Surface Water VC arising from potential interactions identified in **Table 5.1-2**, and in relation to the indicators listed in **Table 3.3-2**. Mitigation measures for each potential effect are described in **5.3.**

5.2.1 Surface Water Quantity Subcomponent

Surface water runoff is collected within the Project footprint to meet various water needs and discharged into the receiving environment when excess water is accumulated. The following sections summarize the potential Project-related effects on Surface Water Quantity in terms of the assessment indicators.

5.2.1.1 Change in Mean Annual Discharge (MAD)

Changes to the streams' catchment areas throughout the life of the Project has the potential to affect the MAD. Where catchment areas are reduced or increased over baseline conditions, a similar change in MAD is expected.

5.2.1.2 Change in Seasonal Flow Distribution

Runoff generated within the Project footprint will be discharged, as needed, to Goathorn Creek. The Project will include several ponds and other changes to land use, which will affect the rate of precipitation losses, including evaporation and infiltration rates, and increasing the rate of runoff in relation to a natural, vegetated catchment. Runoff more than water demand will be discharged from the Project into a tributary to Goathorn Creek, which is expected to affect the seasonal distribution of flows in Goathorn relative to natural conditions.

Changes to the water table have the potential to alter streamflow. The water table will be reduced in proximity to the open pit, which is expected to influence groundwater recharge rates in Four Creek and Tenas Creek. The management ponds are expected to increase the water table levels, which would result in a net gain to groundwater recharge further downstream in Four, Tenas and Goathorn creeks. Both changes affect the shape of the annual hydrograph in relation to baseline conditions.

5.2.1.3 Change in Low Flows and High Flows

The water table is expected to fluctuate throughout the life of the mine, based on open pit mining and mounding of water in raised management ponds. This change is expected to have an effect (i.e., change in flows) that is expected to be most prominent during low flow conditions in Four and Tenas creeks.

Where catchment areas are expected to increase relative to baseline conditions, such as in select reaches within Four Creek and in Goathorn Creek downstream of the Project discharge, the Project may influence high flows. These changes are expected to be similar in magnitude as the increase in catchment relative to baseline conditions.

5.2.2 Surface Water Quality Subcomponent

Surface Water Quality has the potential to be affected because of mining operations. The primary pathways for effects on water quality include seepage from water storage facilities and direct discharge to surface water streams, as well as minor pathways related to inadvertent spills or leaks of hydrocarbons.

5.2.2.1 Change in Modelled Parameter Concentrations

Water in contact with previously buried rock, whether non-potentially acid generating (non-PAG) or potentially-acid generating (PAG), may result in release of naturally-occurring metals, including selenium, cadmium, sulphate, and aluminum, through metal leaching and/or acid rock drainage (ML/ARD).

Recently blasted rock from active mining may also contain residual compounds from incomplete detonation of explosives materials, resulting in elevated levels of nitrite, nitrate, and ammonia. These blasting residuals can also be released through water in contact with blasted rock.

As a result, water captured within the Project footprints that may be in contact with mine rock may produce elevated concentrations of metals and other water quality parameters.

Project discharge is expected to occur because of surplus runoff and precipitation within storage facilities such as the management, sedimentation ponds and will be directed to Goathorn Creek or Tenas Creek via the Tenas Control Pond. Discharge will occur throughout Construction, Operation, Decommissioning and Reclamation, as well as Post-closure Phases. During Construction, Operation, Decommissioning and Reclamation, and part of the Post-closure Phase, discharge will be through the Tenas Control Pond, while in the later part of the Post-closure phase discharge will be from the North Management Pond.

Seepage from the Project may occur because of increased head in the water table versus baseline conditions. The timing of seepage being observed in the downstream environment is tied to soil characteristics, which suggest that the effect will not be immediate, but will occur primarily near the end of Operation Phase, and during the Post-closure Phase. Seepage effects are not expected to be observed during the Construction Phase.

Effects are evaluated in relation to the in-stream water quality guidelines (**3.2.3.1**).

5.2.2.2 Change in Other Measurable Water Quality Parameters

Any disturbance to natural ground may result in an increase in suspended sediment (i.e., TSS) and dissolved solids (TDS) which in turn may increase turbidity and electrical conductivity (EC). Elevated concentrations of metals in water storage facilities may also change the conductivity of the water.

Unexpected, incidental spills or leaks due to operating machinery could result in elevated concentrations of hydrocarbons.

No changes are expected for polycyclic aromatic hydrocarbons (PAHs) from baseline conditions so the effect from PAHs was not carried forward into the effects assessment stage, however PAHs will be included as a monitored parameter as part of the **Minesite Water Monitoring Program (Appendix 13.11-E** of the **MWMP)**.

5.2.3 Summary of Potential Project-related Effects

5.2.3.1 Construction Phase

The following bullet points summarize potential Project-related effects on the Surface Water VC during the Construction Phase, including effects on both Water Quantity and Water Quality subcomponents:

- Removal of vegetation and topsoil during land clearing has the potential to result in increased erosion rates, resulting in sediment migration to downstream creeks and rivers (i.e., change in water quality parameters);

- Changes to site drainage patterns, resulting in reduction or increases to pre-mining catchment areas, have the potential to reduce or enhance streamflow (i.e., change in MAD, seasonal distribution, low flows, and high flows); and
- Construction of Project facilities has the potential to result in accidental spills/leaks or release of sediment to the downstream creeks and rivers (i.e., change in water quality parameters, change in other measurable parameters).

5.2.3.2 Operation Phase

The following bullet points summarize potential Project-related effects on the Surface Water VC during the Operation, and Decommissioning and Reclamation phases, including effects on both Water Quantity and Water Quality subcomponents:

- As the Project footprint expands over-time, streamflow in both Tenas and Four creeks is expected to decrease in relation to the reduced catchment area (i.e., change in mean annual discharge, low flows, and high flows);
- Open pit mining is anticipated to result in a drawdown of the groundwater table, which could have an effect on the baseflow contributions in the adjacent creeks and rivers (i.e., change in low flows);
- Water in contact with blasted rock during open pit mining has the potential to mobilize blasting residuals including nitrate, nitrite, and ammonia, which could have an effect on water quality (i.e., change in modelled water quality parameters);
- Management ponds and the Tenas Control Pond are anticipated to increase the water table level, which could increase the baseflow contributions in the adjacent creeks and rivers (i.e., change in low flows);
- Exposure of mine waste to oxygen has the potential to produce ML/ARD, resulting in potential degradation of water quality in the downstream creeks and rivers. ML/ARD has the potential to travel in both subsurface flows through groundwater pathways and in surface water via direct discharge from Project infrastructure (i.e., change in modelled water quality parameters, change in other measurable parameters);
- Use of road crossings (i.e., vehicle traffic) has the potential to release dust and sediment into creeks and rivers (i.e., change in modelled water quality parameters, change in other measurable parameters);
- Operation of the Coal Processing Plant (CPP) and other industrial activities have the potential to release contaminants, into downstream creeks and rivers (i.e., change in modelled water quality parameters, change in other measurable parameters); and
- Water storage facilities, including the larger management ponds and the Tenas Control Pond, as well as smaller sedimentation ponds, have the potential to breach, resulting in uncontrolled discharge of water and mine waste to the environment (i.e., change in modelled water quality parameters, high flows).

5.2.3.3 Post-closure Phase

The following bullet points summarize potential Project-related effects on the Surface Water VC during the Post-closure phase, including effects on both Water Quantity and Water Quality subcomponents:

- Dewatering of the Tenas Control Pond to the tributary of Goathorn Creek has the potential to result in increased erosion and elevated concentrations of water quality parameters (i.e., change in high flows and modelled water quality parameters, change in other measurable parameters);
- Release of ML/ARD may contribute to water quality exceedances in downstream creeks and rivers (i.e., change in modelled water quality parameters, change in other measurable parameters);
- Flooding of the open pit in development of pit lakes may reduce Project discharge for approximately 12 years (i.e., change in MAD, seasonal flow distribution); and
- Permanent changes to site drainage may reduce streamflow in Four Creek and Tenas Creek (i.e., change in MAD, seasonal flow distribution, low flows, and high flows).

5.3 Mitigation Measures

This subsection describes the mitigation measures that have been considered within the Project design and mitigations to alleviate potential Project-related effects (changes in MAD, seasonal flow distribution, low flows, high flows, etc.) in all Project phases. These mitigations include practical means or measures taken to avoid or reduce potential effects of the Project on the Surface Water VC. Mitigation measures include applicable standards, guidelines and BMPs supported by guidance documents and are based on proven, accepted mitigation used on other similar projects in BC.

TCL has incorporated several mitigation measures in the Project's design and/or operational procedures to reduce the magnitude, duration, and extent of effects due to the Project. These Project mitigation measures are outlined in **S1.0 Overview of Project Proponent Description** of the **EAC Application** and include Project design aspects such as site selection, selection of best available technology (BAT) to-date for Project infrastructure and mining equipment, and a commitment to progressive reclamation. Project mitigation measures that are relevant to minimizing potential Project-related effects on the Surface Water VC are described in **5.3.1** to **5.3.10** below. As not all effects can be addressed through design, additional mitigation measures specific to the Surface Water VC and tailored to Project features are described in **5.3.11** and **5.3.12.**

Several environmental management plans will define the standard operating procedures, the BMPs, the adherence to existing environmental regulations, and the use of appropriate design criteria. Environmental management plans will define the purpose and objectives, scope, the BMPs, the adherence to existing environmental regulations, Minesite employee roles and responsibilities, and the use of appropriate design criteria. Project operations are governed by an overarching **Environmental Management System (S13.0-C1) (EMS)** of the **EAC Application**, of which all management plans are a part. The following is a list of the management plans (**S13.0 Management Plans**) with potential linkages to the Surface Water VC:

- **EMS;**
- **Air Quality Management Plan (S13.0-C2) (AQMP);**
- **Chemicals and Materials, Storage, Transfer, and Handling Plan (S13.0-C3) (CMSTHP);**
- **Construction Environmental Management Plan (S13.0-C4) (CEMP);**
- **Discharge Management Plan (S13.0-C5) (DMP);**
- **Explosives Management Plan (S13.0-C6) (EMP);**
- **Fuel Management and Spill Control Plan (S13.0-C7) (FMSCP);**
- **MWMP;**

- **ML/ARD Management Plan (S13.0-C12) (ML/ARDMP);**
- **Reclamation and Closure Plan (S13.0-C15) (RCP);**
- **Surface Erosion Prevention and Sediment Control Plan (S13.0-C17) (SEPSCP);** and
- **Waste Management Plan for Refuse and Emissions (S13.0-C20) (WMPRE).**

The management plans provide further direction on sequencing, monitoring and adaptive management, and the mitigation measures outlined in each plan are expected to be timely and effective following implementation.

Mitigation measures are commitments that TCL has applied through mine design and to the operating principals through the life cycle of the Project. All mitigation measures for the Surface water VC are described in detail in the following subsections and summarized in **Table 5.3-1.**

5.3.1 Avoid Sensitive Environments

The Project has been designed to:

- avoid known wetlands and sensitive ecosystems (such as riparian areas); and
- avoid activities within watercourses.

5.3.2 Limit Project Footprint and Project Area

To limit the Project footprint and Project Area the Project has been designed to:

- Cluster Project components, including the open pit, stockpiles for run-of-mine (ROM) coal, processed coal and processed rock, CPP, management ponds, and ancillary facilities such as the Maintenance Facility and Administration Building;
- Align linear Project features (such as powerlines, roads, water distribution) into a common ROW;
- Place Project features within existing or planned Project component footprints to limit the clearing of vegetation and the salvage of reclamation materials (surface soil, woody debris, and overburden). For example, the Minesite buildings will be built in areas previously cleared by forestry activity;
- Place reclamation material (surface soil and woody debris) stockpiles within development areas such as the open pit and haul roads to avoid disturbance, while overburden is directly placed on Project components for future reclamation activities;
- Limit the Tenas Access Corridor (TAC) to a single lane width for long distances and utilize existing Forest Service Roads (FSRs) or private roads where appropriate;
- Backfill approximately 50 percent (%) of non-coal material back into the open pit; and
- Place processed rock from the CPP within the management ponds versus a separate permanent pile to avoid any potential ARD from this material and reduce the Project Footprint.

5.3.3 Reclamation Measures

The following reclamation measures have been incorporated into the mine design:

- Use progressive reclamation techniques to limit the amount of disturbance at any given time by sequencing the open pit and stockpiles to the extent feasible, backfilling of open pit where possible, directly reclamation materials, and placing excavated materials on previously disturbed areas;

- Salvage reclamation materials (surface soil, woody debris, and overburden), for later use in accordance with the **RCP**;
- Vegetate all temporary surface soil and overburden stockpiles to minimize the potential for erosion and sediment generation, to prevent subsequent potential effects on water quality, and to prevent losses of surface soils;
- Implement progressive reclamation on embankments, buttresses, backfills, TAC cut and fill slopes, and other Project components, where possible to minimize fugitive dust emissions and reduce erosion and sediment generation;
- PAG material deposited in the management ponds will be flooded to prevent acid mine drainage but will also be covered with an engineered cover consisting of non-PAG rock, overburden, and surface soils to allow for terrestrial revegetation; and
- Majority of open pit features (e.g., highwalls and footwalls) are covered/resurfaced/recontoured with non-potentially acid generating (PAG) rock and overburden.

5.3.4 Management of Metal Leaching/Acid Rock Drainage (ML/ARD)

The following mitigation measures apply to preventing potential ARD:

- Identify and segregate PAG material while mining the open pit, and place PAG material in management ponds and submerge PAG material under a minimum of one (1) m of water within an average of six (6) months after excavation but no longer than 12 months and under at least two (2) m of water once the management pond has met its PAG material storage requirements (North Management Pond is completed first, followed by the East Management Pond and finally the West Management Pond) to prevent potential ARD and subsequent effects on surface water quality;
- Place approximately a one (1) to two (2) m layer of non-PAG rock on top of the submerged PAG material below the active water level of the respective management pond, followed by approximately one (1) to three (3) m layer of overburden to create a dry landform above water, followed by an approximately 30 centimetre (cm) layer of reclamation materials (surface soil) to reduce evaporative losses from the management ponds and provide a landscape more similar to pre-Project development;
- No PAG material will be used in construction of any external piles, pads, roads, embankments, buttresses, or for backfilling the open pit, to prevent potential ARD and subsequent effects on surface water quality;
- Open pit walls will be covered by non-PAG material to limit oxygen and water ingress into the open pit walls and provide a neutralizing effect on the open pit wall material below;
- Some of the open pit walls will be flooded with water to further reduce the likelihood of ARD from the covered open pit walls;
- Establish a material geochemical testing program for future Project exploration drillholes and Operation Phase blast holes as part of the blasting program to verify PAG versus non-PAG materials. Maintain a PAG geological model while the open pit is being mined to reflect any changes observed;
- Maintain a database of geochemical testing results and material placement to avoid the incorrect placement of PAG material and potential ARD with subsequent effects on surface water quality;
- Establish a material tracking system to document the location and type of material being excavated and hauled to avoid misplacement of material and/or remediate any misplacement that may occur;

- Controlled open pit wall blasting will be conducted on both the highwall and footwall to limit the amount of damage to the open pit wall to minimize the potential for particle size reduction and provide pathways for water and oxygen to enter the open walls prior to them being covered;
- Majority of material near the open pit footwall will not be blasted again to minimize the potential of water and oxygen accessing this material; and
- Progressive reclamation will be undertaken to reduce the infiltration of water and oxygen into the open pit walls by placing non-PAG rock and overburden on the open pit walls once mining is completed for an open pit wall section in question and people operating equipment have moved at least 100 m away from proposed backfilling operation. Furthermore, this non-PAG material is expected to provide a permanent high neutralization potential (NP) water source to prevent ARD generation from PAG material present in the open pit walls.

The following mitigation measures apply for minimizing potential metal leaching (ML):

- Progressive reclamation will be undertaken to reduce the infiltration of water and oxygen into the non-PAG backfills, buttresses, and embankments;
- Non-PAG rock will be covered with overburden as much as material constraints allow to reduce the infiltration of water and oxygen;
- Place some non-PAG rock into management ponds that are characterized as PAG because of the mine planning process using a neutralization potential ratio (NPR) value of 2NP (neutralizing potential):1AP (acid potential [AP]) to classify non-PAG material from PAG material versus the geochemistry NPR value of 1.2NP:1AP used for classifying non-PAG material from PAG material; and
- In the Post-closure Phase, approximately half of non-PAG material will be flooded with water in the open pit to prevent oxygen ingress and further oxidization of this material resulting in a reduction of ML once this occurs.

5.3.5 Transport Measures

The following mitigation measures refer to transport measures:

- Build, maintain, and use the TAC for hauling processed coal to the Rail Infrastructure for the duration of all Project phases after the Construction Phase to minimize traffic on existing, residential roads;
- Build, maintain, and use the TAC for transport of personnel, goods, and services for the duration of all Project phases after the Construction Phase to minimize traffic on existing, residential roads;
- Repair and/or replace and/or upgrade existing FSRs or private roads that will be used as part of the TAC;
- Repair and replace new and existing culverts as required for all Project related transport corridors including the TAC;
- Design and build a permanent clear span bridge over Goathorn Creek and Helps Creek and its tributaries to provide vehicular access to the Project that will be controlled by TCL;
- Use buses and/or vans for employees and contractors as much as practical to reduce the risk of traffic incidents, and to reduce noise and fugitive dust emissions generated by the Project. Bussing options to Witset and/or Houston to be provided (if requested and based on sufficient employees in these locations) to facilitate potential employees accessing employment opportunities with the Project;

- Use dust supressing agents on the rail cars to reduce fugitive dust emissions;
- Cover super B-train trucks when hauling processed coal from CPP to Rail Infrastructure to reduce fugitive dust emissions from trucks;
- Use water and chemical agents on the TAC to reduce fugitive dust emissions, where and when appropriate; and
- Use water and chemical agents, as required, on processed coal and ROM coal stockpiles to reduce fugitive dust emissions resulting from storage and handling.

5.3.6 Blasting Measures

The following mitigation measures apply to blasting:

- Use best management stemming techniques (e.g., type of material, size consistency, loading method, and thickness) that will minimize effects of noise and fugitive dust from blast patterns and assist in the complete detonation of drill holes to reduce the introduction of nitrogen species into the surrounding rock per the **EMP**;
- Correctly time blast to minimize effects of noise, vibration, and fugitive dust from blast patterns;
- Keep blast patterns small to minimize effects of noise, vibration, and fugitive dust and to reduce the time that patterns need to sleep or wait until they are blasted which reduces the introduction of nitrogen species into the surrounding rock;
- Monitor actual blast results and implement improvements as required as per the adaptive management process to reduce effects of noise, vibration, fugitive dust and reduce the introduction of nitrogen species into the surrounding rock; and
- Use electronic detonators to minimize effects of noise, vibration, and fugitive dust from blast patterns and manage misfires to reduce the introduction of nitrogen species into the surrounding environment.

5.3.7 Seepage Management Measures

Mitigation measures associated with seepage management:

- Use overburden bentonite liners for management ponds to reduce the amount of groundwater seepage and potential effects on surface and groundwater quality;
- Use liners in the Tenas Control Pond, Wastewater Storage Pond, Soil Treatment Facility, Potable Water Storage Pond, and sedimentation pond at the CPP site to minimize the risk of seepage to groundwater and potential effects on surface water and groundwater quality;
- Monitor seepage, groundwater, and surface water levels, and quality/quantity downstream and upstream of the Project as per the monitoring programs set up in the **MWMP**; and
- Establish trigger levels that require the implementation of contingency mitigations measures described in the **DMP** to protect surface water and groundwater quality and maintain minimum flow levels downstream of the Project.

5.3.8 Water Capture Measures

The designs of the management ponds, sedimentation ponds, collection and diversion channels, and all other water management structures are documented in **S1.0-1.22 Management Ponds (Tailings Storage**

Facility) and Control Pond Aspects, Appendix 1.0-G Tenas Project Water Management Technical Design Report, and the **MWMP**. The following mitigation measures apply to water capture:

- Construct diversion channels, where practical, to prevent non-contact water from entering the Project Area and remain as non-contact water;
- Sedimentation and control ponds will have sufficient storage capacity to allow fine sediments to settle out for 1 in 10-year storm events and will be designed to structurally withstand a 1 in 200-year storm event; total suspended solids (TSS) and/or turbidity will be monitored prior to release;
- Establish flocculent addition systems for sedimentation and/or control ponds that will discharge directly to surface waters to provide additional sedimentation control to reduce potential effects on surface water quality;
- If monitoring indicates, construct wetlands within or downstream of sedimentation and/or control ponds to reduce potential effects on surface water quality;
- Include a control structure on the outflow from the C02 diversion channel south of the East Management Pond to control high flow events discharging into the upstream portion of Four Creek by enabling overflow to the East Management Pond directly in the Post-closure Phase or to a channel going into the Tenas Control Pond in the Operation, and Decommissioning and Reclamation phases;
- Maintain sufficient capacity in the Tenas Control Pond to store up to a 1 in 10-year storm event and to control discharge;
- Monitor and control water discharges from Tenas Control Pond to a tributary of Goathorn Creek based on downstream water flow rates and water quality to meet in-stream guidelines and flow requirements during the Operation, and Decommissioning and Reclamation phases; and
- Develop the open pit in a manner that will allow it to collect water in the Decommissioning and Reclamation, Post-closure Phases to provide additional sedimentation control.

5.3.9 Project Use of Water

The following mitigation measures apply to water use:

- Maximize the use of contact water for all Project water needs (i.e., use contact water for process water for the CPP and equipment washbays before withdrawing additional water from streams);
- Incorporate a contingency water supply from of 2.5 % of Goathorn Creek's mean annual monthly flow which was part of the effects assessment (effect is included in the flow rate of Goathorn Creek downstream of intake location) but this contingency is not incorporated into water cover simulations or the overall Project water balance;
- Use dewatered fine processed rock in the CPP to reduce Project water consumption;
- Direct water from the Maintenance Facility to the CPP to reduce Project water consumption;
- Use process water from the Tenas Control Pond, management ponds, and CPP sedimentation pond for the CPP to limit water consumption;
- Design of the CPP allows for the introduction of additional equipment to be installed within 18 months to further reduce water consumption in the Operation Phase if required;
- Use process water from the Tenas Control Pond for toilets in the Minesite Administration Building to reduce potable water consumption; and

- Construct engineered covers for the management ponds in the Operation, and Decommissioning and Reclamation, and Post-closure phases to limit the consumption of water through evaporation losses.

5.3.10 Water Quality Monitoring and Reporting Measures

The following refer to surface water quality and monitoring measures:

- Provide results of water quality sampling and quantity monitoring per the **MWMP** via the BC MECCS website, as was completed for baseline sampling activities, in addition to annual reporting required as part of regulatory permits. Annual reports regarding *Mines Act,* RSBC 1996, c 293, and *Environmental Management Act,* SBC 2003, c 53 (*MA/EMA)* permits will be sent to Indigenous groups and the public based on final permit conditions.

5.3.11 Erosion and Sediment Control

- Sediment and erosion control measures will be implemented in accordance with the **SEPSCP** and **CEMP**; and
- Areas prone to instability and areas in proximity to water bodies and drainages will be further reinforced/stabilized via construction of abutments and permanent erosion controls, if specified. Hydrological connectivity will be maintained by providing unobstructed passage of water in existing drainage channels through fill materials (i.e., using free-span bridges or culverts at water crossings) in accordance with the **MWMP**.

5.3.12 Hazardous Materials and Refueling

- Hydrocarbon storage and refueling stations will be located at least 30 m from waterbodies and on level ground. Double-walled hydrocarbon (fuel, glycol, and lubricant) tanks will be used at most locations in addition to other spill controls for any single-walled hydrocarbon (fuel, glycol. and lubricant) tanks. In the absence of double-walled tanks, secondary containment must be used;
- Spill prevention and response measures will be implemented during vehicle and equipment travel/operations in accordance with the **FMSCP** and any hazardous materials management in accordance with the **FMSCP** as well;
- The Project, including along the TAC and Rail Infrastructure, will have spill kits strategically located around site and on TCL and contractor vehicles to allow an immediate response to fuel spills, oil leaks, hydraulic line ruptures, and accidental spills of hazardous materials. Re-fueling and lubrication of equipment will not be conducted within 30 m of a watercourse and, where stationary equipment cannot be relocated beyond 30 m of a watercourse, it will be situated in a designated area that has been bermed and lined with a semi-impermeable barrier of sufficient size to provide secondary containment for liquids stored;
- Vehicles and equipment will be clean and free of leaks prior to working in proximity to a watercourse and checked routinely.

5.3.13 Summary of Mitigation Measures

Table 5.3-1 summarizes the mitigation measures that are designed and will be implemented to avoid, reduce, or limit the potential effects on the Surface Water VC.

Table 5.3-1: Summary of Potential Effects and Mitigation Measures for Surface Water Valued Component (VC)

Potential Effect	Contributing Activities within the Project Phases (C, O, D, P)	Proposed Mitigation Measure	Applicable VC Subcomponent	Residual Effect (Yes/No)
Change in Mean Annual Discharge	All activities (C, O, D, P)	▪ Avoid sensitive environments ▪ Limit Project footprint and Project Area ▪ Reclamation measures (refer to **RCP**) ▪ Management of ML/ARD ▪ Water capture measures	Surface Water Quantity	Yes
Change in Seasonal Flow Distribution	All activities (C, O, D, P)	▪ Limit Project footprint and Project Area ▪ Transport measures ▪ Water capture measures ▪ Project use of water ▪ Seepage management measures	Surface Water Quantity	Yes
Change in Low Flows and High Flows	All activities (O, D, P)	▪ Water capture measures ▪ Project use of water ▪ Seepage management measures	Surface Water Quantity	Yes
Change in Modelled Parameter Concentrations	All activities (C, O, D, P)	▪ Avoid sensitive environments ▪ Limit Project footprint and Project Area ▪ Reclamation measures (refer to **RCP**) ▪ Management of ML/ARD ▪ Blasting measures (refer to **EMP**) ▪ Water capture measures ▪ Erosion and sediment control (refer to **SEPSCP, CEMP,** and **MWMP**) ▪ Hazardous material and refueling (refer to **FMSCP**) ▪ Water quality monitoring and reporting measures	Surface Water Quality	Yes
Change in Other Measurable Water Quality Parameters	All activities (C, O, D, P)	▪ Transport measures ▪ Management of ML/ARD ▪ Erosion and sediment control (refer to **SEPSCP, CEMP,** and **MWMP**) ▪ Hazardous material and refueling (refer to **FMSCP**)	Surface Water Quality	Yes

Note: *C, O, D, P represent Project Phases: (C)onstruction, (O)peration, (D)ecomissioning and Reclamation, (P)ost-closure*
FMSCP=Fuel Management and Spill Control Plan (S13.0-C7); ML/ARD=metal leaching/acid rock drainage; (S13.0-C12); MWMP=Minesite Water Management Plan (S13.0-C11); RCP=Reclamation and Closure Plan (S13.0-C15); SEPSCP=Surface Erosion Protection and Sediment Control Plan (S13.0-C17); VC=Valued Component
See **Table 5.1-2** for list of applicable activities for each listed Project phase, unless otherwise noted in this table.

5.4 Residual Effects and Significance of Residual Effects

This subsection describes anticipated residual effects of the Project on the Surface Water VC. Residual effects are effects that remain after the implementation of all mitigation measures and management strategies and are the expected effects of the Project on the Surface Water VC.

The approach to assessing residual Project effects on the Water Quality VC follows the methodology outlined in **S3.0 Assessment Methodology** of the **EAC Application**. The Significance of residual effects on the Surface Water VC, including changes to Water Quantity and Water Quality subcomponents, are presented, along with the Likelihood of each effect and the Level of Confidence associated with the determination of Significance. Determination of Significance for residual effects on the Surface Water VC is based on consideration of the residual effects characteristics and environmental context at the RSA level.

5.4.1 Description of Evaluation Criteria

5.4.1.1 Residual Effects Characteristics

Residual effects on the Surface Water VC subcomponents, Water Quantity and Water Quality, have been characterised in terms of Magnitude, Geographical Extent, Frequency, Duration, Reversibility, and Context and are presented on **Table 5.4-1** and **Table 5.4-2,** respectively. The definitions for what qualifies as an affected area for each indicator were provided in **Table 5-1** and summarized in the Magnitude definitions for each subcomponent.

Table 5.4-1: Effect Characteristics Considered when Determining the Significance of Residual Effects on the Surface Water Quantity Subcomponent

Residual Effect Characteristic	Definition	Indicator	Rating
Magnitude	Change in streamflow because of Project Interactions, relative to pre-mining conditions	Change in mean annual discharge (MAD)	Low: Affected area, where MAD is expected to be reduced by more than 10% or increased by more than 30%, is less than 5% of RSA Moderate: Affected area is 5% or more but less than 10% of RSA High: Affected area is 10% or more of RSA
		Change in seasonal flow distribution	Low: Affected area, where monthly average streamflow is expected to be reduced by more than 10% or increased by more than 30%, is less than 5% of RSA Moderate: Affected area is 5% or more but less than 10% of RSA High: Affected area is 10% or more of RSA
		Change in low flows and high flows	Low: Affected area, where 7Q10 or high flows are expected to be reduced by more than 10% or increased by more than 30%, is less than 5% of RSA Moderate: Affected area is 5% or more but less than 10% of RSA High: Affected area is 10% or more of RSA

Residual Effect Characteristic	Definition	Indicator	Rating
Geographic Extent	Spatial scale over which the change is expected to occur.	All	Local: Affected area is within the LSA Regional: Affected area extends beyond the LSA but is confined within the RSA Beyond Regional: Affected area extends beyond the RSA
Duration	Length of time, in years, over which the change is expected	All	Short-term: Effect lasts less than 1.5 years (Construction Phase) Medium-term: Effect lasts 1.5 years or more and less than 25 years (encompassing operation, reclamation, closure periods) Long-term: Effect extends beyond the Post-closure period
Frequency	How frequently the change is expected over Base Case assessment	All	Infrequent: Effect occurs in sporadic intervals (i.e., under maximum conditions but not under average conditions) Frequent: Effect occurs on a regular basis (i.e., on a monthly average basis) Continuous: Effect occurs year-round under average conditions
Reversibility	Whether or not the change can be reversed once the activity causing the residual effect ceases.	All	Fully Reversible: Effect occurs in construction and operations only Partially Reversible: Effect occurs in the initial closure period but does not persist in steady-state (through to the Year 2100) Irreversible: Effect occurs in steady-state conditions (through to the Year 2100)
Context	The extent to which surface water has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience)	All	Low: Receiving environment has high resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the ecosystem, and/or a lack of historic and ongoing anthropogenic or natural disturbance. Moderate: Receiving environment has a neutral resilience to imposed stresses and expected to be able to respond and adapt to the effect High: Receiving environment has weak resilience to stress or ecological change. This resilience can be a result of the ecological characteristics of the ecosystem, and/or a high level of historic or ongoing anthropogenic or natural disturbance.

Notes: *%=percent; LSA=Local Study Area; Project=Tenas Project; RSA=Regional Study Area; VC=Valued Component*

Table 5.4-2: Effect Characteristics Considered when Determining the Significance of Residual Effects on the Surface Water Quality Subcomponent

Residual Effect Characteristic	Definition	Indicator	Rating
Magnitude	Increase of parameter concentrations compared to baseline conditions and water quality guideline or SPOs, where applicable[1]	Change in parameter concentrations	Low: Affected area, where water quality concentrations are expected to exceed guideline or SPO values as well as the 95th percentile from baseline monitoring, is less than 5% of RSA Moderate: Affected area is 5% or more but less than 10% of RSA High: Affected area is 10% or more of RSA
	Increase of parameter concentrations compared to baseline conditions	Change in other measurable parameters	Low: Affected area, where water quality concentrations are expected to exceed the 95th percentile from baseline monitoring, is less than 5% of RSA Moderate: Affected area is 5% or more but less than 10% of RSA High: Affected area is 10% or more of RSA
Geographic Extent	Spatial scale over which the change is expected to occur.	All	Local: Affected area is within the LSA Regional: Affected area extends beyond the LSA but is confined within the RSA Beyond Regional: Affected area extends beyond the RSA
Duration	Length of time, in years, for which the parameter exceeds the water quality guideline in any given month (winter or summer).	All	Short-term: Effect lasts less than 1.5 years (Construction Phase). Medium-term: Effect lasts 1.5 years or more and less than 25 years (encompassing operation, reclamation, closure periods). Long-term: Effect extends beyond the Post-closure Phase.
Frequency	How frequently modelled water quality is expected to exceed the water quality guideline, based on winter months (November through April) or summer months (May through October)	All	Infrequent: Effect occurs in sporadic intervals (i.e., under maximum conditions for winter or summer but not under average conditions) Frequent: Effect occurs on a regular basis (i.e., on a monthly average basis for winter or summer) Continuous: Effect occurs year-round under average conditions (winter and summer)
Reversibility	Whether or not the change can be reversed once the activity causing the residual effect ceases.	All	Fully Reversible: Effect occurs in construction and operations only Partially Reversible: Effect occurs in the initial closure period but does not persist in steady-state (through the Year 2100) Irreversible: Effect occurs in steady-state conditions (through the Year 2100)

Residual Effect Characteristic	Definition	Indicator	Rating
Context	The extent to which surface water has been affected by past and present environmental and socio-economic processes and conditions, its potential sensitivity to the Project-related residual effect, and its ability to recover from that effect (i.e., resilience)	All	Low: Receiving environment has a high resilience to imposed stresses and is expected to respond and adapt to the effect. Moderate: Receiving environment has a neutral resilience to imposed stresses and is expected to be able to respond and adapt to the effect. High: Receiving environment has a low resilience to imposed stresses and is not expected to easily respond and adapt to the effect.

***Notes:** %=percent; LSA=Local Study Area; Project=Tenas Project; RSA=Regional Study Area; SPO=Site Performance Objectives; VC=Valued Component*
*1. The applicable water quality guidelines and SPOs for each parameter are presented in **0***

5.4.1.2 Likelihood

Likelihood refers to the probability of the predicted residual effect occurring, including consideration of the potential that the mitigation will be successful. The probabilities are based on qualitative judgment and collective understanding of the hydrologic system within the profession.

- **Likely** Moderate-to-High probability of an effect; or
- **Unlikely** Low probability of an effect.

5.4.1.3 Significance Definition

The characterisation of residual effects is based on the review of existing conditions (**see 4**), the assessment of Project-related effects (**5.2**), other relevant scientific information, and the professional judgement of the effects assessment team. All residual effects (independent of their Significance rating) are carried forward to the CEA.

The Significance of the residual effect is rated as **Significant** or **Not Significant** and is defined as follows:

- **Significant** An effect that results in a change in the Surface Water VC within the RSA that will alter its integrity beyond an acceptable level, defined as High Magnitude effects, Regional or greater in Extent, with a Long-term Duration; or
- **Not Significant** An effect that does not meet the definition of **Significant**.

Confidence is a measure of how well residual effects are understood and the quality of the input data. It considers the scientific certainty relative to the quantification and/or qualification of the effect, including the quality and or quantity of data and the understanding of effect mechanisms, as well as professional judgment based on prior experience in predicting effects and the effectiveness of mitigation measures.

A Low Level of Confidence is assigned to effects predictions with little or no empirical site-specific data, whereas a Moderate Level of Confidence is assigned to predictions that are based on site-specific data sources such as predictive model outputs and published literature. A High Level of Confidence is assigned to predictions that have direct, site-specific quantitative data to support the predictions.

Based on these criteria, it was determined that an additional risk analysis was not required.

5.4.2 Surface Water Quantity Subcomponent

Model results were used to inform the assessment of effects for Surface Water Quantity in terms of the thresholds for each indicator, as defined in **Table 5-1**. The following sections summarize the affected areas for each Surface Water Quantity indicator.

5.4.2.1 Change in Mean Annual Discharge (MAD)

Changes to natural streams' catchment areas throughout the life of the Project has the potential to influence MAD. Where catchment areas are expected to be reduced or increased over pre-mining conditions, a similar change in MAD is expected.

The maximum change in pre-mining catchment area is experienced at the end of mining, resulting in an expected reduction to total catchment area of 5.0 km^2 and 4.1 km^2 in the Tenas Creek and Four Creek watersheds, respectively. A proposed diversion channel along the southern extent of the East Management Pond is also expected to increase the catchment area in portions of Four Creek. As a result, Four Creek is expected to experience the largest change in catchment area relative to baseline total catchment conditions, including portions with a net increase and portions with a net decrease in MAD.

Modelling results (**Appendix 4.3-A Tenas Project Water and Load Balance Modeling Report**) show that sections of Four Creek directly downstream of the East Management Pond diversion channel could experience an increase to MAD by up 47% over pre-mining conditions. This effect decreases along Four Creek until an overall decrease in catchment area and MAD is reached, with a maximum reduction in MAD of 24% over pre-mining conditions. Based on the threshold criteria defined in **Table 5-1**, these sections of Four Creek are expected to be affected by the Project in terms of change in MAD. The catchment area reporting to the affected section of Four Creek is 7.6 km^2.

The expected reduction in Tenas Creek's catchment area from the Project footprint could result in up to 8% reduction to MAD over pre-mining conditions. The Project influence on Goathorn Creek results in less than 3% reduction and up to 4% increase in MAD over pre-mining conditions. Change in MAD in Telkwa River and Bulkley River is predicted to be minimal (i.e., less than 1% reduction to pre-mining conditions). Based on the thresholds for affected areas, Tenas Creek, Goathorn Creek, Telkwa River and Bulkley River are not expected to be affected by the Project in terms of change in MAD.

Approximately 7.6 km^2 of the total Four Creek catchment area is expected to be affected by the Project in terms of change in MAD, which corresponds to an area that is 4% of the LSA and 0.5% of the RSA. Both the increase and decrease in flows occur throughout the Operation Phase as well as the Post-closure Phase, since the Project discharge continues to route runoff towards Four Creek in the upstream reaches, resulting in an increase over pre-mining conditions in the segments along the East Management Pond, and a decrease over pre-mining conditions in the lower reaches of Four Creek.

5.4.2.1.1 Residual Effects Characteristics

The summary of the residual effects characterisation for the change in mean annual discharge due to the Project is presented in **Table 5.4-3**.

Table 5.4-3: Summary of Effect Characteristics Ratings for the Change in Mean Annual Discharge (MAD)

Residual Effects Characteristic	Rating	Rationale for Rating
Magnitude	Low	Based on the thresholds identified in **Table 5-1** and modelling results, MAD in segments of Four Creek are expected to be affected by the Project. The catchment area for these segments is 7.6 km^2, which is less than 5% of the total RSA. These changes are not expected to be noticed by users of the RSA.
Geographic Extent	Local	The affected area for change in MAD is limited to Four Creek only, which is part of the LSA.
Duration	Long-term	The change in MAD is expected to extend beyond the Post-closure Phase.
Frequency	Continuous	The effect is expected to occur each year throughout open-water (summer) and frozen (winter) conditions.
Reversibility	Irreversible	The effect is expected to continue throughout the Post-closure Phase.
Context	Moderate	The Context of the residual effect of the change in MAD is predicted to be Moderate. Annual discharge fluctuates regularly based on variations in snowpack and rainfall. The changes expected from the Project within the RSA are within the natural variability experienced historically.

Notes: *%=percent; km^2=square kilometres; LSA=Local Study Area; MAD=mean annual discharge; Project=Tenas Project; RSA=Regional Study Area*

5.4.2.1.2 Likelihood

The residual effect of change in MAD is Likely. Watercourses are near the Project Area, and the reduction or increase in catchment area is a proxy for change in streamflow conditions.

5.4.2.1.3 Significance Determination

The residual effect of change on MAD because of the Project is not expected to result in a change that will alter its integrity within the Surface Water RSA to an unacceptable level (i.e., less than 5% is affected); the effect is predicted to be of Low Magnitude, Local and Long-term Duration. Therefore, the effect is predicted to be **Not Significant.**

The Level of Confidence of this prediction is Moderate. The modelling used to inform the assessment has inherent sources of error associated with characterisation of streamflow and catchment mapping.

5.4.2.2 Change in Seasonal Flow Distribution

Seasonal flow distribution was evaluated based on the change in monthly streamflow under Project Case conditions in relation to pre-mining conditions. Like the MAD results, the reduction and/or increase in catchment area in select locations along Four Creek is expected to result in the same reduction or increase to streamflow, with the effect most prominent during the open-water season.

During the peak of the Operation Phase, when the Project footprint is maximized, up to 25% of the Four Creek catchment area is likely to be reduced from pre-mining conditions, which is expressed in the change in monthly streamflow from April through October in the downstream section of Four Creek. Further upstream, the diversion channel around the East Management Pond is expected to result in an increase in monthly average streamflow of up to 35% over pre-mining conditions during the open-water season. Both changes are expected to be reduced by the Post-closure Phase, as portions of the covered backfill in the open pit are routed towards Four Creek, minimizing the final change in catchment area.

In addition to changing runoff rates from changes to natural catchment areas, the Project is expected to reduce the groundwater baseflow rates by up to 34% in segments of Four Creek adjacent to the open pit. This change is observed in segments upstream of the open pit as well as downstream. The change is more prominent in winter months, when baseflow governs the total streamflow. The change is reduced during the Post-closure Phase, with the formation of the open pit lake in the backfilled open pit. Further downstream in Four Creek, the management pond water levels are expected to increase the groundwater table, resulting in a net increase in winter baseflow by up to 4% over pre-mining conditions. Based on the thresholds defined for seasonal flow distribution in **Table 5-1**, the entire Four Creek Watershed is expected to be affected (i.e., increase monthly flow by more than 30% and/or reduced monthly flow by more than 10%), which represents an affected catchment area of 11.0 km^2.

Monthly streamflow in Tenas Creek is expected to be reduced by up to 10% during low flow periods (April and August) in the Operation Phase because of open pit groundwater drawdown and catchment area reductions. This change is not expected to occur throughout the entire Operation Phase, however, and is countered by the increase in seepage from the management ponds. Monthly streamflow in sections of Tenas Creek is expected to decrease by up to 6% over pre-mining conditions by the end of operations and throughout the post-closure period. Based on the thresholds in **Table 5-1,** Tenas Creek's seasonal flow distribution is not expected to be affected by the Project.

Monthly streamflows in upstream sections of Goathorn Creek are expected to be reduced by up to 6% over pre-mining conditions during low flow periods in operations. Monthly streamflow downstream of the Project discharge in Goathorn Creek may increase by up to 14% in the Operation Phase and 10% during the Post-closure Phase. The increase presented in modelling results is expected to be controlled by pump operations and a Trigger Action Response Plan (TARP) for the Tenas Control Pond, which are not incorporated into the model. Based on these expected mitigation measures and modeling results, and the thresholds in **Table 5-1**, Goathorn Creek is not expected to be affected by the Project in terms of seasonal flow distribution.

The Project may reduce monthly streamflow in the Telkwa River downstream of Goathorn Creek by less than 2% over pre-mining conditions during operations and increase monthly streamflow by up to 1% over pre-mining conditions during the Post-closure Phase. Changes reflect the change in water capture upstream and changes to groundwater baseflow. The expected change from the Project to Bulkley River monthly streamflow are minimal (less than 0.1% over pre-mining conditions). Both rivers are therefore not expected to be affected by the Project in terms of seasonal flow distribution.

The total affected area in terms of change in seasonal flow distribution includes the full Four Creek natural catchment area of 11 km^2. This corresponds to 5% of the area in the LSA and 0.8% of the area in the RSA. Both the increase and decrease in monthly flows are expected to occur throughout the Operation Phase as well as during the Post-closure Phase.

5.4.2.2.1 Residual Effects Characteristics

The summary of the residual effects characterisation for the change in seasonal flow distribution due to the Project is presented in **Table 5.4-4**.

Table 5.4-4: Summary of Effect Characteristics Ratings for the Changes in Seasonal Flow Distribution

Residual Effects Characteristic	Rating	Rationale for Rating
Magnitude	Low	Based on the thresholds identified in **Table 5-1** and modelling results, all the Four Creek pre-mining catchment area is expected to be affected by the Project in terms of change in seasonal flow distribution. The affected catchment area is 11 km^2, which is less than 5% of the total area in the RSA. These changes are not expected to be noticed by users of the RSA.
Geographic Extent	Local	The affected area resides within Four Creek only, which is part of the LSA.
Duration	Long-term	The effect is expected to continue throughout the Post-closure Phase.
Frequency	Continuous	The effect is expected in winter and summer months.
Reversibility	Irreversible	The effect is expected to continue throughout the Post-closure Phase.
Context	Moderate	Natural variability in monthly streamflow has been experienced historically, and the changes expected in the RSA from the Project are within the natural range.

Notes: *%=percent; km^2=square kilometres; LSA=Local Study Area; Project=Tenas Project; RSA=Regional Study Area*

5.4.2.2.2 Likelihood

The residual effect of change in streamflow distribution is Likely. Watercourses are near the Project Area, and the reduction or increase in catchment area as well as depth of the open pit excavation is likely to change monthly streamflow conditions.

5.4.2.2.3 Significance Determination

The residual effect of change on streamflow distribution because of the Project is not expected to result in a change that will alter its integrity within the Surface Water RSA to an unacceptable level (i.e., less than 5% of the RSA is expected to be affected based on thresholds presented in **Table 5-1**). The effect is predicted to be of Low magnitude, Local Extent, and Long-term Duration. Therefore, the effect is predicted to be **Not Significant.**

The Level of Confidence of this prediction is Moderate. The modelling used to inform the assessment has inherent sources of error, as does the mapping of groundwater and surface water catchments.

5.4.2.3 Change in Low and High Flows

The relative change in high flows is driven by the relative change in stream catchment area. Stream sections which are expected to experience a reduction in catchment area and MAD because of the Project will also likely experience a net reduction in high flows.

Stream sections which are expected to see an increase in catchment area from the Project include a portion of Four Creek, downstream of the East Management Pond diversion channel discharge. A control structure has been designed to limit the discharge into Four Creek from the diversion under extreme flood conditions (i.e., high flows), as described in **Appendix 1.0-I SRK Water Management Technical Report** and the **MWMP**. This structure and its operations have not been considered in the modelling. Based on this structure and its design intent of controlling high flow discharge, changes in high flows in Four Creek are expected to be mitigated.

Project discharge from the Tenas Control Pond in the Operation Phase and North Management Pond in the Post-closure Phase may also increase high flow conditions in Goathorn Creek. This condition was assessed using the model with three (3) consecutive 100-year wet precipitation years based on the synthetic historical record to estimate Project discharge rates (SRK 2021b). The results show a potential increase in streamflow over pre-mining conditions of up to 19% during spring freshet. The Tenas Control Pond will be operated to provide additional attenuation up to the 1 in 10-year flood event, reducing the peak discharges into the Goathorn tributary and downstream Goathorn Creek. This strategy has not been incorporated into the model but is expected to reduce the expected change in streamflow in Goathorn Creek during high flow events.

Further downstream in the Telkwa River and Bulkley River, the change in streamflow relative to pre-mining conditions is minimal under the repeated wet year condition modelled.

Based on the controls that have been designed as part of the Project to limit high flow discharge, including the diversion structure around the East Management Pond and the surge capacity in the Tenas Control Pond, the change in high flows from the Project are expected to be minimal. No area is expected to be affected for change in high flows.

Change in low flow conditions in the receiving environment are discussed in terms of winter baseflows (i.e., average annual low flow conditions) in the seasonal flow distribution characterization. These changes are a result of the Project's influence on groundwater baseflows and reduction in catchment area from the Project footprint. Modelling also considered a low-flow scenario using the 7Q10 flow rates in the receiving environment. Results show that low flows are expected to be reduced over pre-mining conditions by the same percentage as monthly average baseflow, where Four Creek and Tenas Creek could expect up to 34% and 6% reduction over pre-mining conditions in low flow, respectively, in sections downgradient of the open pit. These changes are expected during operations and are reduced in post-closure when the pit lake is formed.

The total affected area in terms of change in low flows include the full Four Creek catchment area of 11 km^2. This corresponds to 5% of the area in the LSA and 0.8% of the area in the RSA. The decrease in low flows is expected to occur throughout operations as well as post-closure.

5.4.2.3.1 Residual Effects Characteristics

The summary of the residual effects characterisation for the change in low and high flows due to the Project is presented in **Table 5.4-5**.

Table 5.4-5: Summary of Effect Characteristics Ratings for the Changes to Low and High Flows

Residual Effects Characteristic	Rating	Rationale for Rating
Magnitude	Low	High flows are expected to be reduced over baseline conditions for all streams which will experience a reduction in catchment area. Control structures will limit the increase to high flows and as a result, no area is expected to be affected in terms of change in high flows, which represents 0% of the RSA. Change in low flows is expected in Four Creek, with an affected area of 11 km^2. This represents an affected area that is 0.8% of the area in the RSA. The combined affected area for change in high and low flows from the Project is less than 5% of the area in the RSA.

Residual Effects Characteristic	Rating	Rationale for Rating
Geographic Extent	Local	The affected area is expected to include Four Creek, which is within the LSA.
Duration	Long-term	The effect is expected to continue beyond the Post-closure Phase.
Frequency	Infrequent	The changes in low or high flows would occur in sporadic extreme intervals, by nature.
Reversibility	Irreversible	The effect is irreversible as it is expected to continue throughout the Post-closure Phase.
Context	Moderate	Both low and high flow events are infrequent, by definition, and experience variability in magnitude naturally. Changes from the Project would have been experienced historically from agriculture, forestry, and other land uses in the RSA.

***Notes:** %=percent; km^2=square kilometres; LSA=Local Study Area; Project=Tenas Project; RSA=Regional Study Area*

5.4.2.3.2 Likelihood

The residual effect of change in high and low flows is Unlikely since extreme low flows and high flows are of low probability by nature. Mitigation measures have been built into Project design to reduce the effect of high flow events on Four and Goathorn Creek, however, extreme low flows cannot be further mitigated.

5.4.2.3.3 Significance Determination

The change in high and low flows because of the Project is not expected to alter Surface Water Quantity integrity within the RSA to an unacceptable level. The effect is predicted to be of Low Magnitude, Local Geographical Extent and Long-term Duration. Therefore, the effect is predicted to be **Not Significant.**

The Level of Confidence of this prediction is Moderate. The modelling used to inform the assessment has inherent sources of error associated with estimation of streamflow, as does the mapping of groundwater and surface water catchments.

5.4.3 Surface Water Quality Subcomponent

Model results were used to inform the assessment of effects for Surface Water Quality in terms of the thresholds for each indicator, as defined in **Table 5-1**. The following sections summarize the affected areas for each Surface Water Quality indicator.

5.4.3.1 Change in Modelled Parameter Concentrations

Changes in stream water quality in terms of modelled parameter concentrations were evaluated in relation to guideline values and SPOs, as well as in context with streams' natural variability observed through baseline monitoring. Model results present monthly average and maximum concentrations in winter (November through April) and summer (May to October) to capture seasonal variability. The modelling did not consider the potential for attenuation of loading through groundwater pathways, which is expected, and which would reduce the amount of change in some parameter concentrations. The modelling results for stream water quality are therefore considered to be conservative.

Modelling results show potential exceedances of water quality guidelines and the stream's natural variability (95th percentile from baseline records) for total selenium, nitrite, dissolved cadmium and sulphate. Results are consistently below the SPO values, where applicable.. All other parameters are below the SPO, where applicable, and the guideline and the 95th percentile of historical records. The following general observations can be made for the source and trend in change in water quality parameter concentrations:

- Guideline exceedances are expected during the winter months because of seepage discharge to the receiving environment(s) during periods of low flow, and therefore low dilution/assimilation capacity;
- Guideline exceedances are driven by seepage from the management ponds and occur in segments along Tenas Creek and Four Creek located downstream of the West, North and East Management Ponds. Note that attenuation of selenium, dissolved cadmium, and nitrite are expected in the management ponds and through the groundwater pathway, but this mechanism has not been modelled;
- In each management pond, the stream concentrations are expected to peak after approximately 25 years, reflecting the delay in seepage migration (SRK 2021b). The period of exceedance varies based on the magnitude of modelled results in relation to the guideline; and
- For exceedances of guidelines are expected to occur in Four Creek and Tenas Creek in the Post-closure Phase only. Exceedances of guidelines are not expected in either stream during the Project Operation Phase. Only stream segments located downstream of Project activities are expected to experience changes to water quality during the Operation Phase.

Table 5.4-6 summarizes the occurrence and magnitude of guideline exceedances in Tenas Creek and Four Creek and the affected area in context with the LSA and RSA. As a result, there is no affected area from change in modelled parameter concentration in Goathorn Creek. Additional exceedances of guidelines or SPOs are not expected in Goathorn Creek, Telkwa River and Bulkley River beyond those that have occurred historically in baseline data. Detailed modelling results are described in **Appendix 4.3-A Tenas Project Water and Load Balance Modeling Report.**

In total, the Project is expected to affect the modelled parameter concentrations over a catchment area that is equal to 14% of the area in the LSA and 2.0% of the area in the RSA. The affected area includes the downstream segments of Tenas and Four Creek. The affected area is only expected in the Post-closure Phase, after seepage from management ponds reaches the downstream segments of each creek. Attenuation of selenium, dissolved cadmium, and nitrite is expected in the management ponds and through the groundwater pathway, which is expected to improve the water quality of groundwater inflows to the streams. This mechanism has not been included in modelling but is expected to occur to some extent over the period of the modelling.

Table 5.4-6: Surface Water Quality Affected Areas based on Change in Modelled Parameter Concentration

Stream	Parameters with Exceedances of Guidelines and SPOs	Comments on Exceedance	Affected Area (km^2)	Affected Area as a Percentage of the LSA	Affected Area as a Percentage of the RSA
Tenas Creek	Total Selenium	Guideline is expected to be exceeded by up to 2.0 times the value during the winter months in the Post-closure Phase only in sections of the creek downstream of the management ponds. Long-term modelling results (i.e., Year 2100) are below the guideline. **No exceedances of the Tier 1 or Tier 2 SPO values are expected.**	23.2	11%	1.6%
	Nitrite	Guideline is expected to be exceeded by up to 2.3 times the value during the winter months in the Post-closure Phase only in sections of the creek downstream of the management ponds. Long-term modelling results (i.e. Year 2100) are below the guideline. **No exceedances of the SPO value are expected**.			
	Sulphate	Guideline is expected to be exceeded by up to 1.2 times the value during the winter months in the Post-closure Phase only in sections of the creek downstream of the management ponds. **Long-term modelling results (i.e. Year 2100) are below the guideline.**			
Four Creek	Total Selenium	Guideline value is expected to be exceeded by up to 2.9 times the value during the winter months in the Post-closure Phase only in sections of the creek downstream of the management ponds. Long-term modelling results (i.e. Year 2100) are below the guideline. **No exceedances of the Tier 1 or Tier 2 SPO value are expected.**	5.7	3%	0.4%
	Nitrite	Guideline is expected to be exceeded by up to 1.9 times the value during the winter months in the Post-closure Phase only in sections of the creek downstream of the management ponds. Long-term modelling results (i.e. Year 2100) are below the guideline. **No exceedances of the SPO value are expected.**			
	Sulphate	Guideline is expected to be exceeded by up to 1.2 times the value during the winter months in the Post-closure Phase only in sections of the creek downstream of the management ponds. **Long-term modelling results (i.e. Year 2100) are below the guideline.**			
	Dissolved Cadmium	Guideline value is expected to be exceeded by up to 1.5 times the value during winter months in the Post-closure Phase only in sections of the creek downstream of the management ponds. Long-term modelling results beyond the Post closure Phase (i.e. Year 2100) are below the guideline. **No exceedances of the SPO are expected**.			
Total Affected Area			**28.9**	**14%**	**2.0%**

Notes: *%=percent; km^2=square kilometre; LSA=Local Study Area; RSA=Regional Study Area; SPO=Site Performance Objective*

**Two (2) SPOs were developed for total and dissolved selenium, described as a Tier 1 value of 0.008 milligram per litre (mg/L) and a Tier 2 value that is dependent on the sulphate concentrations of the receiving environment. For further information see 3.2.3.1 Water Quality Guidelines (WQG) and Site Performance Objectives (SPOs).*

5.4.3.1.1 Residual Effect Characteristics

The summary of the residual effects characterisation for the change in modelled parameter concentrations due to the Project is presented in **Table 5.4-7**.

Table 5.4-7: Summary of Effect Characteristics Ratings for the Change in Modelled Parameter Concentrations

Residual Effects Characteristic	Rating	Rationale for Rating
Magnitude	Low	The affected catchment area for surface water modelled parameter concentrations is less than 5% of the RSA.
Geographic Extent	Local	The affected catchment area resides within Four and Tenas creeks only, which is part of the LSA.
Duration	Short-term	The effect is short-term since it is only expected to occur for a short period during the Post-closure Phase.
Frequency	Infrequent	The effect is only expected to occur in winter months.
Reversibility	Partially-reversible	The changes are expected to be within the range of natural variability and below guidelines and SPOs in the Post-closure Phase (Year 2100).
Context	Moderate	Surface water is a valued resource in the region, but it has experienced historic and ongoing effects from agriculture, forestry, mining, and other land uses in the RSA.

Notes: *%=percent; LSA=Local Study Area; RSA=Regional Study Area; SPO=Site Performance Objective*

5.4.3.1.2 Likelihood

The residual effect of change in surface water modelled parameter concentration is Unlikely. Attenuation of loading through groundwater pathways is expected for some water quality parameters and has not been considered in modelling, which would reduce the amount of change in parameter concentrations.

5.4.3.1.3 Significance Determination

The residual effect of change in surface water modelled parameter concentrations because of the Project is not expected to result in a change that will alter its integrity within the Surface Water RSA to an unacceptable level (i.e., less than 5% is effected); the effect is predicted to be of Low magnitude, Local Extent, and Short-term Duration. Therefore, the effect is predicted to be **Not Significant.**

The Level of Confidence of this prediction is Moderate. The modelling used to inform the assessment has inherent sources of error based on characterisation of streamflow and geochemical source terms.

5.4.3.2 Change in Other Measurable Water Quality Parameters

Changes in other measurable water quality parameters were evaluated in relation to each streams' natural variability observed through baseline monitoring, including the Telkwa and Bulkley rivers and Tenas, Four and Goathorn creeks. Effects for other measurable water quality parameters were evaluated using relationships to modelled parameters, where possible, or conservative assumptions based on available information. Parameters include pH, TSS, TDS EC, PAHs, temperature, and turbidity.

Results show potential exceedances of the natural variability experienced in both Tenas and Four creeks (i.e. greater than 95th percentile from baseline records) for TDS and EC. Other measurable parameters are expected to remain within the streams' natural variability (i.e. below the 95th percentile from baseline records).

The Project is not expected to change levels of PAHs due to mitigation measures including spill response plans, and the relative distance from activities from the water bodies.

TDS is a measure of the dissolved constituents in water. The most common source of TDS in undisturbed streams is from weathering of sedimentary rocks and erosion. Groundwater usually has higher levels of TDS than surface water. Conductivity is a measure of water's ability to carry an electrical charge. This is related directly to the concentration of ions in the water, and therefore the TDS.

The following general observations can be made from modelling results about the source and trend in change in other measurable water quality parameter concentrations:

- TDS and EC levels are expected to increase above natural levels in the Post-closure Phase only because of seepage from the management ponds;
- Elevated levels are expected in segments of Tenas Creek and Four Creek only downstream of the West, North and East management ponds, while levels are expected to be within the stream's natural variability in Goathorn Creek, Telkwa River and Bulkley River;
- Higher levels than historically observed are expected during the winter months because of seepage discharge to the receiving environment(s) during periods of low flow, and therefore, low dilution/assimilation capacity;
- The levels are expected to peak approximately 25 years after the peak concentrations are expected in each management pond, reflecting the delay in seepage migration (SRK 2021b). The period of elevated parameters varies based on the magnitude of modelled results in relation to the historical values; and
- Long-term TDS and EC results (average Post-closure Phase results through the Year 2100 are within the natural variability in both streams (Tenas Creek and Four Creek).

Table 5.4-8 summarizes the expected occurrence and predicted levels for TDS and EC in the receiving environment relative to each stream's natural levels. Results also present the affected area in context with the LSA and RSA. Additional increases in levels beyond natural variability are not expected in Goathorn Creek, Telkwa River and Bulkley River beyond those that have occurred historically in baseline data. Detailed modeling results are described in **Appendix 4.3-A Tenas Project Water and Load Balance Modeling Report**.

Table 5.4-8: Surface Water Quality Affected Areas based on Change in Other Measurable Water Quality Parameters

Stream	Parameters with Exceedances of Guidelines and SPOs	Comments on Exceedance	Affected Area [km^2]	Affected Areas as a percentage of the LSA	Affected Area as a percentage of the RSA
Tenas Creek	Total Dissolved Solids	95th percentile TDS concentration from baseline data is expected to be exceeded by up to 3.1 times during the winter months for 43 years in the Post-closure Phase only in sections of the creek downstream of the management ponds. Long-term modelling results (i.e., Year 2100) continue to exceed the natural variability by approximately 1.6 times in winter months.	23.2	11%	1.6%
	Conductivity	95th percentile EC concentration from baseline data is expected to be exceeded by up to 2.8 times during the winter months for 44 years in the Post-closure Phase only in sections of the creek downstream of the management ponds. Long-term modelling results (i.e. Year 2100) continue to exceed the natural variability by approximately 1.5 times in winter months.			
Four Creek	Total Dissolved Solids	95th percentile TDS concentration from baseline data is expected to be exceeded by up to 2.2 times during the winter months for 25 years in the Post-closure Phase only in sections of the creek downstream of the management ponds. Long-term modelling results (i.e. Year 2100) are within the stream's natural variability.	5.7	3%	0.4%
	Conductivity	95th percentile EC level from baseline data is expected to be exceeded by up to 2.2 times during the winter months for 26 years in the Post-closure Phase only in sections of the creek downstream of the management ponds. Long-term modelling results (i.e. Year 2100) are within the stream's natural variability.			
Total Affected Area			**28.9**	**14%**	**2.0%**

Notes: *%=percent; EC=electrical conductivity; km^2=square kilometre; LSA=Local Study Area; RSA=Regional Study Area; SPO=Site Performance Objective; TDS=Total Dissolved Solids*

In total, the Project is expected to affect other measurable water quality parameters over a catchment area that is equal to 14% of the area in the LSA and 2.0% of the area in the RSA. The affected area includes the downstream segments of Tenas Creek and Four Creek. The affected area is only expected in the Post-closure Phase, after seepage from management ponds reaches the downstream segments of each creek.

5.4.3.2.1 Residual Effect Characteristics

The summary of the residual effects characterisation for the change in other measurable water quality parameters due to the Project is presented in **Table 5.4-9**.

Table 5.4-9: Summary of Effect Characteristics Ratings for the Change in Other Measurable Water Quality Parameters

Residual Effects Characteristic	Rating	Rationale for Rating
Magnitude	Low	The affected catchment area is less than 5% of the RSA.
Geographic Extent	Local	The affected catchment area resides within Four Creek and Tenas Creek only, which is part of the LSA.
Duration	Long-term	The effect Duration is Long-Term since it occurs throughout the post-closure period.
Frequency	Infrequent	The effect is only expected to occur in winter months.
Reversibility	Irreversible	The affected streams are expected to remain above natural variability through the Post-closure Phase.
Context	Moderate	Natural processes such as erosion can result in elevated levels of both TDS and EC. Surface Water is a valued resource in the region, but it has experienced historic and ongoing effects from agriculture, forestry, mining, and other land uses in the RSA.

Notes: *%=percent; EC=electrical conductivity; LSA=Local Study Area; RSA=Regional Study Area; SPO=Site Performance Objective; TDS=Total Dissolved Solids*

5.4.3.2.2 Likelihood

The residual effect of change in Surface Water Quality other measurable parameters is Likely. Disturbance of ground and mining are expected to increase both TDS and EC levels over baseline conditions in localized areas around the Project footprint.

5.4.3.2.3 Significance Determination

The residual effect of change in Surface Water Quality of other measurable parameters because of the Project is not expected to result in a change that will alter its integrity within the Surface Water RSA to an unacceptable level (i.e., less than 5% is effected); the effect is predicted to be of Low Magnitude, Local Extent, and Long-term Duration. Therefore, the effect is predicted to be **Not Significant.**

The Level of Confidence of this prediction is Moderate. The modelling used to inform the assessment has inherent sources of error based on characterisation of streamflow and geochemical source terms.

5.5 Summary of Project-related Residual Effects and Significance

The following potential effects of the Project were identified as residual effects on the Surface Water VC subcomponents through the assessment process:

- Surface Water Quantity:
  - change in MAD;
  - change in seasonal flow distribution;
  - change in high and low flows;
- Surface Water Quality:
  - change in modelled parameter concentrations; and
  - change in other measurable water quality parameters.

The residual effect characteristics for each subcomponent are summarized in **Table 5.5-1**. The residual effects of the Project on Surface Water Quantity and Surface Water Quality were predicted to be **Not Significant**. Considering this, the Project effects are not expected to alter the integrity of the Surface Water VC within the RSA beyond an acceptable level (i.e., remain within acceptable ranges); and are predicted to be **Not Significant.** Residual effects were carried forward into the CEA.

Table 5.5-1: Summary of Residual Adverse Effects on the Surface Water Valued Component (VC)

Residual Adverse Effects	Contributing Activities within the Project Phases (C, O, D, P)	Proposed Mitigation Measures	Subcomponent	Residual Effects Characterisation								
				Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Change in Mean Annual Discharge (MAD)	All activities (C, O, D, P)	▪ Limit Project footprint and Project Area ▪ Reclamation measures (refer to **RCP**) ▪ Water capture measures	Surface Water Quantity	L	LSA	LT	C	IR	M	L	NS	M
Change in Seasonal Flow Distribution	All activities (O, D, P)	▪ Seepage management measures ▪ Water capture measures	Surface Water Quantity	L	LSA	LT	CF	IR	M	L	NS	M
Change in Low and High Flows	All activities (O, D, P)	▪ Water capture measures ▪ Seepage management measures	Surface Water Quantity	L	LSA	LT	IF	IR	M	UL	NS	M
Change in Modelled Parameter Concentrations	All activities (C, O, D, P)	▪ Erosion and sediment control (refer to **SEPSCP, CEMP,** and **MWMP**) ▪ Management of ML/ARD ▪ Blasting measures ▪ Water capture measures ▪ Reclamation measures (refer to **RCP**)	Surface Water Quality	L	LSA	ST	IF	PR	M	UL	NS	M

Residual Adverse Effects	Contributing Activities within the Project Phases (C, O, D, P)	Proposed Mitigation Measures	Subcomponent	Residual Effects Characterisation								
				Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Change in other measurable water quality parameters	All activities (C, O, D, P)	▪ Management of ML/ARD ▪ Transport measures ▪ Erosion and sediment control (refer to **SEPSCP, CEMP,** and **MWMP**) ▪ Hazardous material and refueling (refer to **FMSCP**)	Surface Water Quality	L	LSA	LT	IF	IR	M	L	NS	M

Notes: *C, O, D, P represent Project Phases: (C)onstruction, (O)peration, (D)ecomissioning and Reclamation, (P)ost-closure*
FMSCP=Fuel Management and Spill Control Plan (S13.0-C7); ML/ARD=metal leaching/acid rock drainage; MWMP=Minesite Water Management Plan (S13.0-C11); RCP=Reclamation and Closure Plan (S13.0-C15); SEPSCP=Surface Erosion Protection and Sediment Control Plan (S13.0-C17)
Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Local (LSA), Regional (RSA), beyond Regional (beyond RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully reversible (FR), Partially reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (UL), Likely (L)
Significance: Not-Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), or Low (L)
*See **Table 5.1-2** for list of applicable activities for each listed Project phase, unless otherwise noted in this table.*

6. Cumulative Effects Assessment (CEA)

Cumulative effects are the overall effects on a VC due to the Project's residual effects overlapping both spatially and temporally with the residual effects resulting from other projects and activities. This subsection presents an assessment of the cumulative effects on the Surface Water VC. The approach to determining cumulative effects is described in **S3.0-C1-6 Cumulative Effects Assessment** of the **EAC Application**.

The environmental effects of past and existing projects and activities are captured in the baseline conditions (i.e., existing environment; **4. Existing Conditions**). Thus, the likelihood of cumulative effects due to ongoing and reasonably foreseeable future projects and activities is the focus of this CEA.

As described in **3.2.3.1**, the spatial boundary of the CEA for the Surface Water VC is defined as the Surface Water RSA. Projects and activities that are outside of the Surface Water RSA but had potential effects that are expected to extend into the Surface Water RSA were also considered. The temporal boundaries within which cumulative effects were considered include past, present, and reasonably foreseeable future activities inclusive of the life of the Project including Construction, Operation, Decommissioning and Reclamation, and Post-closure phases **(3.2.4.2)**.

Baseline conditions represent past and present projects and activities, including existing disturbance. All Projects and activities listed in the Project and Activity Inclusion List in **S3.0 Assessment Methodology** of the **EAC Application** that are not listed in in **Table 6.1-1** are not considered in the Surface Water CEA as the residual effects of these developments are not anticipated to overlap temporally with the residual effects of the Project and are not in proximity to the Surface Water RSA.

6.1 Potential Cumulative Effects

Cumulative effects resulting from ongoing and future projects are the focus of this CEA. Future projects and activities with overlapping residual effects on Surface Water are outlined in **Table 6.1-1**, followed by text that provides supporting rationale.

As outlined in **5.2**, the following Project-related residual effects were considered for their potential to interact cumulatively with residual effects of reasonably foreseeable projects and activities identified within, or extending into the Surface Water RSA:

- Surface Water Quantity subcomponent:
  - change in mean annual discharge;
  - change in seasonal flow distribution;
  - change in high and low flows;
- Surface Water Quality subcomponent:
  - change in modelled parameter concentrations; and
  - change in other measurable water quality parameters.

Table 6.1-1: Projects Included in the Assessment of the Surface Water Valued Component (VC) Based on Spatial and Temporal Interaction

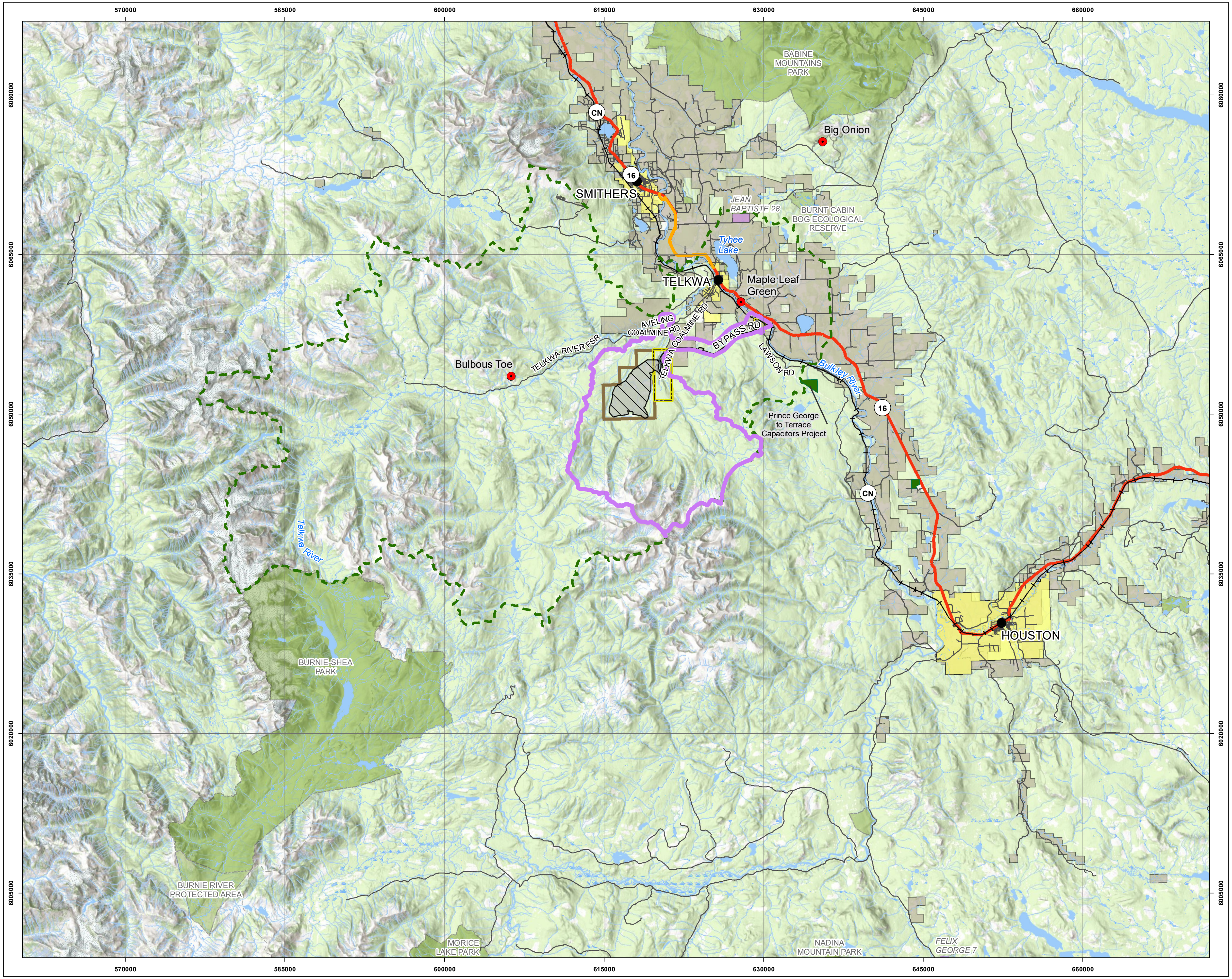
Project/Activity Name	Interacts with Project-related Effects on the VC as a Past, Present or Future Project/Activity	
	Past and Present	Future
Big Onion Project	Yes	Yes
Bulbous Toe	No	Yes
Maple Leaf Cannabis Production Facility	No	Yes
Forestry Activities	Yes	Yes
Telkwa to Smithers Bike Trail	No	Yes
Prince George to Terrace Capacitors Project	No	Yes
Recreation Activities	Yes	Yes
Agricultural Activities	Yes	Yes
Urban Activities	Yes	Yes

Notes: *Project=Tenas Project; VC=Valued Component*

Spatial information is not available for some future projects and most activities. The following projects and activities are expected to have residual effects on the Surface Water VC subcomponents, within or extending into the Surface Water RSA (**Figure 6.1-1**).

- Big Onion Project: The property consists of nine (9) contiguous mineral claims comprising a total area of 3,206 hectares (ha). Exploration occurred from 2006 to 2009. The development and potential operations of the Big Onion Project has the potential to interact cumulatively with the Project residual effects and result in increased potential for change in mean annual discharge, change in seasonal flow distribution, change in low and high flows, and change in modelled parameter concentrations and other water quality parameters, including increased sediment, dust deposition and trace metals. The mine will be required to undergo environmental assessments and meet permit conditions to restrict and control discharge and effects on surface water, and water quality in the receiving environment is expected to be maintained below water quality guidelines or other approved limits;
- Bulbous Toe: This slow-moving landslide has a major transmission line traversing it, and as a result one (1) of the towers requires periodic maintenance. The access crosses through a portion of the Surface Water RSA as does the tower and expected maintenance area. Maintenance activities and vehicle traffic periodically travelling through the Surface Water RSA have the potential to result in adverse residual effects on the Surface Water VC that act cumulatively with the Project residual effects through the introduction and/or proliferation of sediment, dust deposition, and trace metals deposition into watercourses within the Surface Water RSA;
- Maple Leaf Cannabis Production Facility: Maple Leaf has leased over 15 ha of land and is constructing a 0.25 ha cannabis production facility in Telkwa, BC. Construction activities and agricultural activities have the potential to result in residual effects that interact cumulatively with the Project residual effects and result in increased potential for change in seasonal flow distribution, change in high flows, and change in modelled parameters through the change in land use and increase in runoff and use of herbicides within the Surface Water RSA;

- Forestry Activities: The Surface Water RSA is located within the Bulkley Timber Supply Area (TSA). Scattered parcels of forest within the Surface Water RSA are expected to be harvested over the life of the Project. Once harvested, the areas are expected to be reforested, resulting in temporary potential effects on Surface Water Quantity and Surface Water Quality subcomponents. Future forestry activities are expected to be conducted with consideration of provincial regulatory requirements, including control of sediment migration, and mitigating change in streamflow. These forestry activities are expected to contribute to change in seasonal flow distribution and change in high flows, as well as change in modelled parameters and other measurable water quality parameters directly through change in land use and infiltration or runoff rates, and increased vehicle and equipment traffic that can result in the introduction of sediment, dust deposition, and trace metals deposition into watercourses of the Surface Water RSA;
- Telkwa to Smithers Bike Trail: This project has been routed predominantly along the Highway 16 right-of-way (ROW), adjacent to the Bulkley River, where historic disturbance during highway construction and maintenance has occurred. Construction of the bike trail is anticipated to result in limited clearing and grubbing as well as increased vehicle and equipment traffic within the Surface Water RSA. These effects have the potential to act cumulatively with the residual effects of the Project, resulting in a potential change in seasonal flow distribution, high flows, and modelled parameters to watercourses within the Surface Water RSA;
- Prince George to Terrace Capacitors Project: The project involves constructing three new capacitor stations to increase capacity along the 450-km, 500-kilovolt (kV) transmission line that runs between Prince George and northern BC. One (1) of the proposed capacitor stations (3H) is located within the southeast portion of the Surface Water RSA and includes an access road. Construction and operation of this capacitor station is expected to contribute to increased vehicle and equipment traffic within the Surface Water RSA. These activities have the potential to result in residual effects that can interact cumulatively with the Project residual effects, and result in increased potential for introduction and/or proliferation of sediment, dust deposition, and trace metals deposition into watercourses within the Surface Water RSA;
- Recreational Activities: Ongoing use of existing recreational trails and watercourses within the Surface Water RSA may result in residual effects that contribute cumulatively with the residual effects of the Project by resulting in change in water quality parameters;
- Agricultural Activities: Agricultural land uses (e.g., cultivation, tame pasture/hay) are present within the Surface Water RSA. The current areal extent of agricultural activity within the Surface Water RSA is not expected to change. However, ongoing agricultural activities (e.g., cultivation, seeding, herbicide use) may result in the change in seasonal flow distribution, change in high flows, and change in modelled parameters and other measurable water quality parameters through the translocation of herbicides from surface water and sediment release within the Surface Water RSA; and
- Urban Development: The municipality of Telkwa is located within the Surface Water RSA. Urban development projects, such as road maintenance and construction, municipal works, and industrial construction, have the potential to result in residual effects that interact cumulatively with the Project residual effects and result in potential change in mean annual discharge, seasonal flow distribution, low and high flows, and modelled parameters as well as other measurable water quality parameters. These changes are expected to be on a short timescale during construction activities, however long-term increased runoff rates are typically expected after urban development through the change in land use, as well as increased levels of sediment and dust within the Surface Water RSA.



Tenas Project

Surface Water Cumulative Effects Assessment Project Inclusion List

Legend

- Project
- City/Town
- Rail Line
- Highway
- Road
- Watercourse
- LSA Boundary
- RSA Boundary
- PGTC BCHydro Capacitor Lots
- Telkwa to Smithers Bike Trail
- Wetland
- Waterbody
- Park or Protected Area
- First Nation Reserve
- Municipal Area
- General Private Property
- Tenas Coal Licenses
- Telkwa Coal Limited Private Property
- Project Area

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Project Area: Allegiance Coal, April 21, 2021
- Basedata: Government of British Columbia
- Basemap: World Topo Base

N

1:350,000

0 4 8 12 16 20

Kilometres

NAD 1983 UTM Zone 9N

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Project No.	Production Date: Dec 08, 2021	Figure 6.1-1

TELKWA COAL LIMITED

srk consulting

6.2 Additional Mitigation Measures

Additional mitigation measures to those considered in the assessment of Project-related effects (see **5.3**) are not considered to be necessary to avoid or minimize the predicted cumulative effects on the Surface Water VC and its subcomponents. It is assumed that the current and future projects and activities have appropriate environmental protection measures in place as required by laws and regulations to limit their potential effects within acceptable levels. However, if required, there are several further mitigations that could be incorporated sequentially into the Project dependent on actual monitoring values reflecting mitigations as they are included and still indicating that parameters will exceed SPO's in the Post-closure Phase are listed below:

- Place PAG material into saturated conditions faster than the six (6)-month average proposed for the Project to decrease the amount of parameters flushed from this material **which is expected to** improve water quality for both non-point and point source effluents and subsequently for the receiving environment;
- Increase the thickness on the bentonitic liner to reduce seepage volumes from management ponds to reduce non-point source loads to surrounding creeks in low flow winter conditions **which is expected to** improve water quality for both non-point source effluents and subsequently for the receiving environment;
- Cover non-PAG material with geomembranes during the Operation Phase until the Decommissioning and Reclamation Phase when this material is covered with overburden and reclamation materials to reduce infiltration volumes **which is expected to** improve water quality for both non-point and point source effluents and subsequently for the receiving environment;
- Incorporate attenuation from saturated backfills that are being constructed in the management ponds which again will reduce several parameters such as selenium **which is expected to** improve water quality for both non-point and point source effluents and subsequently for the receiving environment;
- Allow more non-contact water to flow into the Project to assist with maintaining water covers and further reduced parameter concentrations **which is expected to** improve water quality for both non-point and point source effluents and subsequently for the receiving environment;
- Construct semi-active biochemical reactors for pumped open pit water and seepage from non-PAG buttresses and dams prior to discharge into the management and control ponds **which is expected to** improve water quality for both non-point and point source effluents and subsequently for the receiving environment; and
- Construct approved active water treatment systems of SeHawk and Selen-X that are currently in operation or approved for use in the province of BC for treating water pumped from the open pit during the Operation Phase. Runoff and seepage from non-PAG rock areas, including buttresses and dams, would also be collected and pumped for water treatment. **This is expected to** reduce the concentration of some parameters such as nitrate and selenium which is expected to improve water quality for both non-point and point source effluents and subsequently for the receiving environment.

6.3 Cumulative Effects and Characterisation of Significance by Subcomponent

The interactions between the predicted Project residual effects and the residual effects of other projects and activities (**Table 6.1-1**) were reviewed to predict the cumulative effects on the Surface Water VC and associated subcomponents.

Cumulative effects on the Surface Water VC and subcomponents have been characterised and assessed in terms of Magnitude, Geographical Extent, Duration, Frequency, Reversibility, Context, Likelihood, Significance, and Level of Confidence of effect. Characterisation criteria and significance definitions for this CEA are consistent with those presented in **5.4**.

Due to limited information on location and quantified effects on water quality and quantity of other projects and activities, particularly those in the reasonably foreseeable future, cumulative effects were evaluated qualitatively.

6.3.1 Surface Water Quantity Subcomponent

The interactions between the predicted Project residual effects and the residual effects of past, current, and reasonably foreseeable projects and activities (**Table 6.1-1**) were reviewed to determine potential cumulative effects on the Surface Water Quantity subcomponent.

Residual effects on the Surface Water Quantity subcomponent resulting from the Project relative to the baseline conditions were identified and assessed as **Not Significant** in **5.4.2**. Residual effects resulting from past, current, and reasonably foreseeable future projects and activities may act cumulatively with the residual effects of the Project on Surface Water Quantity in the RSA through change in MAD, change in seasonal flow distribution and change in low and high flows.

6.3.1.1 Change in Mean Annual Discharge (MAD)

Project-related changes in MAD have the potential to interact with potential changes resulting from forestry, agriculture, urban development, and other mining projects, as listed in **Table 6.1-1**. All future projects are located outside of the LSA but within the RSA in the watersheds of the Telkwa and Bulkley rivers. The Project-related changes to MAD in Telkwa River and Bulkley River are expected to be minor. None of the proposed projects identified are expected to occupy a sizable portion of either watershed, and future projects will be subject to the regulatory process and their permit conditions, which are expected to minimize effects on downstream watercourses.

Natural disturbances, such as forest fires and landslides, have the potential to affect the MAD by temporarily reducing infiltration and increasing runoff rates to adjacent watercourses. These effects would be expected to occur in isolated areas over relatively short-durations, and the catchment would be expected to re-establish natural conditions within a period of years.

Historic forestry and agricultural activities would also be expected to affect the MAD in streams by reducing canopy losses and increasing runoff rates. Forestry activities are temporary and occupy specific parcels of land at a time, subject to the allowable annual cut determined by the Chief Forester based on the *Forest Act,* RSBC, c. 157 (GovBC 1996a). This determination is based on the consideration of the composition of the forest and rate of growth in the area, as well as the short- and long-term implications to the province. The magnitude of change in catchment area because of forestry relative to the total Telkwa or Bulkley watersheds is expected to be small. Agricultural and/or mining activities may have a more permanent change in land use, however, the coverage and associated effect is expected to be small relative to the total Telkwa or Bulkley watersheds.

Based on this qualitative summary, the Magnitude of the cumulative effect from change in MAD is expected to be Low, with the expectation that less than 5% of the RSA would be affected. Geographical Extent is Regional since the projects, and the effects, are located within the RSA. The Duration is predicted to be Long-Term, due to long-term change in catchment areas from the agricultural or mining activities. The Frequency of the effect is expected to be Continuous since the change is expected to occur year-round. The Reversibility of the effect is expected to be expected to be Partially Reversible, since it is not expected to continue beyond the Year 2100. The Context of the effect is expected to be Moderate, considering that these projects/activities have been ongoing in the past and the streams have high resilience to small-scale changes in land use. The Likelihood of an effect is Likely, based on the expected change in catchments from the projects and activities.

The cumulative effect on Surface Water Quantity is predicted to be **Not Significant**, as the change is not expected to alter its integrity within the Surface Water RSA to an unacceptable level (i.e., less than 5% is effected); the effect is predicted to be of Low Magnitude, Regional Extent, and Long-term Duration. This prediction was deemed to have a Moderate Level of Confidence, based on the qualitative assessment.

6.3.1.2 Change in Seasonal Flow Distribution

Project-related changes to seasonal flow distribution have the potential to interact with potential changes resulting from forestry, agriculture, urban development, and other mining projects, as listed in **Table 6.1-1.** The Project is expected to both increase and decrease monthly streamflow in sections of Four Creek, Tenas Creek and Goathorn Creek. These streams are within the LSA, and historical, current, or future activities are not anticipated in the LSA.

Activities and future projects are in the RSA within the Telkwa and Bulkley watersheds. The Project-related changes to seasonal flow distribution in Telkwa River and Bulkley River are expected to be minor. None of the proposed projects identified are expected to occupy a sizable portion of either watershed, and all future projects will be subject to the regulatory process and their permit conditions, which are expected to minimize effects on the watercourses. Localized changes to groundwater recharge may occur as infiltration rates are reduced around active forestry or agricultural land parcels. Similarly, active water storage in planned mining areas may change the timing and magnitude of spring freshet and the low flow during the summer months.

Natural disturbances, including forest fires and landslides, have historically altered the storage and runoff rates from specific areas, however, these effects are expected to be temporary and small in comparison to the total catchment areas of the Telkwa River and Bulkley River.

Based on the qualitative assessment, the Magnitude of the cumulative effect on seasonal flow distribution is Low, as less than 5% of the RSA is expected to be altered from past, current, and future projects in combination with the Project effects. Geographical Extent is expected to be Regional since activities and their effects are located within the RSA. The Duration of the effect is Long-term since the changes in land use from planned projects are expected to continue through the Post-closure Phase. The Frequency is expected to be Continuous since changes to streamflow could be expected in both winter and summer periods. The Reversibility of the effect is expected to be Partially Reversible since it is not expected to continue beyond the Year 2100. The Context of the effect is expected to be Moderate, considering that these projects/activities have been ongoing in the past and the streams have high resilience to small-scale changes in land use. The Likelihood of an effect is Likely.

The cumulative effect on Surface Water Quantity is predicted to be **Not Significant**, as the change is not expected to alter its integrity within the Surface Water RSA to an unacceptable level (i.e., less than 5% is effected). The effect is predicted to be of Low Magnitude, Regional Extent, and Long-term Duration. This prediction was deemed to have a Moderate Level of Confidence, based on the qualitative assessment.

6.3.1.3 Change in Low and High Flows

Project-related changes in low and high flows have the potential to interact with changes resulting from forestry, agriculture, urban development, and other mining projects, as listed in **Table 6.1-1.** The Project is expected to both increase and decrease low flows in Tenas Creek and Four Creek based on interactions with the groundwater table, as well as increase high flows in some segments of Four Creek. These streams are within the LSA, and historical, current, or future activities are not anticipated in the LSA.

Current activities and future projects are in the RSA within the Telkwa and Bulkley watersheds. The Project-related changes to low and high flows in Telkwa River and Bulkley River are expected to be minor. None of the proposed projects identified are expected to occupy a sizable portion of either watershed, and all future projects will also be subject to the regulatory process and their permit conditions, which are expected to minimize effects on downstream watercourses. Local changes to groundwater recharge may occur as infiltration rates are reduced around active forestry or agricultural land parcels, resulting in low flows, while reduced forest canopy and removal of vegetation for agriculture may increase high flows. Mining activities could lower or raise the groundwater table, resulting in localized changes to low flow conditions.

Natural disturbances, including forest fires and landslides, have historically altered the storage and runoff rates from specific areas, however, these effects are expected to be temporary and small in comparison to the total catchment areas of the Telkwa River and Bulkley River.

Based on the qualitative assessment, the Magnitude of the cumulative effect on low and high flows is Low, as less than 5% of the RSA is expected to be altered from past, current, and future projects in combination with the Project effects. Geographical Extent is expected to be Regional, since proposed activities are located within the RSA. The Duration of the potential effect is Long-term, since agricultural and other mining activities may change portions of the landscape through the Post-closure Phase. The Frequency of the effect is expected to be Infrequent, since low flow and high flow events are rare by nature. The Reversibility of the effect is expected to be Partially Reversible since the effect is not expected to continue beyond the Year 2100. The Context of the effect is expected to be Moderate, considering that these projects and/or activities have been ongoing in the past and the streams have high resilience to small-scale changes in land use. The Likelihood of an effect is Unlikely, considering that engineering controls will be in-place to limit change in high and low flows, and these events are rare by nature.

The cumulative effect on Surface Water Quantity is predicted to be **Not Significant**, as the change is not expected to alter its integrity within the Surface Water RSA to an unacceptable level (i.e., less than 5% is effected); the effect is predicted to be of Low Magnitude, Regional Extent, and Long-term Duration. This prediction was deemed to have a Moderate Level of Confidence, based on the qualitative assessment.

6.3.1.4 Summary of Cumulative Effects to Surface Water Quantity Subcomponent

Table 6.3-1 presents a summary of the cumulative effects assessment for Surface Water Quantity.

Table 6.3-1: Summary of Cumulative Effects on Surface Water Quantity Subcomponent

Cumulative Effects	Contributing Activities within the Project Phases (C, O, D, P)	Cumulative Effects Characterisation								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Change in Mean Annual Discharge	▪ Existing activities including agriculture, forestry, harvesting and recreation (C, O, D, P). ▪ Reasonably foreseeable developments within the Surface Water RSA as outlined in **Table 6.1-1** (C, O, D, P). ▪ Project-related activities that could interact with the above activities, as outlined in **Table 5.5-1**	L	R	LT	C	PR	M	L	NS	M
Change in Seasonal Flow Distribution		L	R	LT	C	PR	M	L	NS	M
Change in Low and High Flows		L	R	LT	IF	PR	M	UL	NS	M

Notes: *C, O, D, P represent Project Phases: (C)onstruction, (O)peration, (D)ecomissioning and Reclamation, (P)ost-closure*
Project=Tenas Project

Magnitude:	*Low (L), Moderate (M), High (H)*
Geographic Extent:	*Local (LSA), Regional (RSA), Beyond Regional (beyond RSA)*
Duration:	*Short-term (ST), Medium-term (MT), Long-term (LT)*
Frequency:	*Infrequent (IF), Frequent (FF), Continuous (CF)*
Reversibility:	*Fully reversible (FR), Partially reversible (PR), Irreversible (IR)*
Context:	*Low (L), Moderate (M), High (H)*
Likelihood:	*Unlikely (UL), Likely (L)*
Significance:	*Not-Significant (NS), Significant (S)*
Level of Confidence:	*High (H), Moderate (M), Low (L)*

*See **Table 5.1-2** for list of applicable activities for each listed Project phase, unless otherwise noted in this table. Includes all existing and reasonably foreseeable projects as outlined in **Table 6.1-1.***

6.3.2 Surface Water Quality Subcomponent

The interactions between the predicted Project residual effects and the residual effects of past, current, and reasonably foreseeable projects and activities (**Table 6.1-1**) were reviewed to predict the cumulative effects on the Surface Water Quality subcomponent.

Residual effects on the Surface Water Quality subcomponent resulting from the Project relative to the baseline conditions were identified and assessed as **Not Significant** in **0**. Residual effects resulting from past, current, and reasonably foreseeable projects and activities may act cumulatively with the residual effects of the Project on the Surface Water Quality subcomponent in the RSA through change in modelled parameter concentrations and change in other measurable water quality parameters.

6.3.2.1 Change in Modelled Parameter Concentrations

Project-related changes to modelled parameter concentrations have the potential to interact with potential changes resulting from forestry, agriculture, urban development, and other mining projects, as listed in

Table 6.1-1. Future projects are located outside the LSA but within the Telkwa and Bulkley watersheds. The Project-related changes to parameter concentrations in the Telkwa River and Bulkley River are expected to be minor. None of the proposed projects identified are expected to occupy a sizable portion of either watershed, and future projects will be subject to the regulatory process and their permit conditions, which are expected to minimize effects on the watercourses and meet water quality guidelines or appropriately selected site-specific objectives.

Natural disturbances, such as forest fires and landslides, have the potential to affect modelled parameter concentrations by temporarily increasing sediment and nutrient loads in adjacent watercourses. These effects would be expected to occur in isolated areas over relatively short-durations, and the catchment would be expected to re-establish natural conditions within a period of years.

Historic forestry and agricultural activities would also be expected to affect modelled parameter concentrations in streams with increased total suspended solids concentrations in the case of forestry and increased nutrients associated with pesticides and other products for agriculture. Forestry activities are temporary and occupy specific parcels of land at a time, subject to the allowable annual cut determined by the Chief Forester based on the *Forest Act,* RSBC, c. 157 (GovBC 1996a). Agricultural activities may have a longer lasting change in downstream water quality; however, the amount of agricultural area and the associated effect is also expected to be small relative to the total Telkwa and Bulkley watersheds. Mitigation measures would be expected to be incorporated in agricultural practices to control release of nutrients or other chemicals.

Other mining activities have the potential to increase the metals concentrations, as well as blasting residuals including ammonia, nitrate, and nitrite. Effluent discharge from future mining projects would be subject to permit conditions and independent effects assessments, which would be expected to limit discharge to within the water quality guidelines and incorporate mitigation measures as needed. The Big Onion Project could discharge higher concentrations of metals and nutrients into a tributary of Bulkley River, which has the potential to result in a cumulative effect with the Project's discharge. However the change relative to baseline is expected to minimal, due to the large watershed of the Bulkley River.

Based on this qualitative summary, the Magnitude of the cumulative effect from change in modelled parameter concentrations are expected to be Low, as it is expected that less than 5% of the RSA would be affected. Geographical Extent is Regional since planned activities are within the RSA. The Duration of the potential effect is Short-term, since any potential change in water quality parameters above water quality guidelines would only be expected for a period of years before additional mitigation measures are implemented. The Frequency of the effect is expected to be Infrequent since the change is not expected to occur year-round. The Reversibility of the effect is expected to be Partially Reversible since the effect is not expected to continue beyond the Year 2100. The Context of the effect is expected to be Moderate, considering that these activities have been ongoing in the past and the streams have high resilience to small-scale changes in land use and parameter concentrations. The Likelihood of an effect is Unlikely since modeling does not account for attenuation of loads through groundwater pathways.

The cumulative effect from change in modelled parameter concentrations is predicted to be **Not Significant**, as the change is not expected to alter its integrity within the Surface Water RSA to an unacceptable level (i.e., less than 5% is effected); the effect is predicted to be of Low Magnitude, Regional Extent, and Short-term Duration. This prediction was deemed to have a Moderate Level of Confidence, based on the qualitative assessment.

6.3.2.2 Change in Other Measurable Water Quality Parameters

Project-related changes in other measurable water quality parameters have the potential to interact with potential changes resulting from forestry, agriculture, urban development, and other mining projects, as listed in **Table 6.1-1**. Future projects are located outside the LSA but within the Telkwa and Bulkley watersheds. The Project-related changes to other measurable water quality parameters in the Telkwa River and Bulkley River are expected to be minor. The identified future projects are expected to occupy a small portion of the RSA, and future projects will be subject to the regulatory process and their permit conditions, which are expected to minimize effects on the watercourses and minimize changes relative to baseline conditions.

Natural disturbances, such as forest fires and landslides, have the potential to affect other water quality parameters by temporarily increasing TSS, TDS and conductivity in adjacent watercourses. These effects would be expected to occur in isolated areas over relatively short-durations, and the catchment would be expected to re-establish natural conditions within a period of years.

Historic forestry and agricultural activities would also be expected to affect TSS, TDS concentrations and EC levels in streams. Erosion rates can increase after forestry activities, increasing TDS and associated EC levels. Agricultural runoff can also increase TSS, TDS and EC levels. Forestry activities are temporary and occupy specific parcels of land at a time, subject to the allowable annual cut determined by the chief forester based on the *Forest Act,* RSBC, c. 157 (GovBC 1996a). Agricultural activities may have a longer lasting change in downstream water quality than forestry activities, however, the amount of agricultural area and the associated effect is expected to be small relative to the total Telkwa and Bulkley watersheds. Mitigation measures would be expected to be incorporated in agricultural practices to control release of sediment particles that could increase TDS and EC levels.

Other mining activities have the potential to increase the TDS concentrations, as well as conductivity or pH. Effluent discharge from future mining projects would be subject to permit conditions and independent effects assessments, which would be expected to limit discharge to within the receiving environment's natural variability and incorporate mitigation measures as needed. The Big Onion Project could discharge higher TDS concentrations and conductivity levels into a tributary of the Bulkley River, which has the potential to result in a cumulative effect with the Project's discharge. However the change relative to baseline is expected to be minimal, due to the large watershed of the Bulkley River.

Based on this qualitative summary, the Magnitude of the cumulative effect from change in other measurable water quality parameters are expected to be Low, as it is expected that less than 5% of the RSA would be affected. Geographical Extent is Regional since planned activities are within the RSA. The Duration of the potential effect is Short-term, since any potential change in other measurable water quality parameters above the baseline would only be expected for a period of years before additional mitigation measures are implemented. The Frequency of the effect is expected to be Infrequent since the change is not expected to occur year-round. The Reversibility of the effect is expected to be Partially Reversible since the effect is not expected to continue beyond the Year 2100.

The Context of the effect is expected to be Moderate, considering that these activities have been ongoing in the past and the streams have high resilience to small-scale changes in land use and parameter levels. The Likelihood of an effect is Unlikely, due to the small scale of the projects in relation to the natural watersheds of the Bulkley River and Telkwa River.

The cumulative effect of change in other measurable water quality parameters is predicted to be **Not Significant**, as the change is not expected to alter its integrity within the Surface Water RSA to an unacceptable level (i.e., less than 5% is effected); the effect is predicted to be of Low Magnitude, Regional

Extent, and Short-term Duration. This prediction was deemed to have a Moderate Level of Confidence, based on the qualitative assessment.

6.3.2.3 Summary of Cumulative Effects to Surface Water Quality Subcomponent

Table 6.3-2 presents a summary of the CEA for the Surface Water Quality subcomponent.

Table 6.3-2: Summary of Cumulative Effects for Surface Water Quality Subcomponent

Cumulative Effects	Contributing Activities within the Project Phases (C,O,D,P)	Cumulative Effects Characterisation								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Change in Modelled Parameter Concentrations	▪ Existing activities including agriculture, forestry, harvesting and recreation (C, O, D, P). ▪ Reasonably foreseeable developments within the Surface Water RSA as outlined in **Table 6.1-1** (C, O, D, P). ▪ Project-related activities that could interact with the above activities, as outlined in **Table 5.5-1**	L	R	ST	IF	PR	M	UL	NS	M
Change in Other Measurable Water Quality Parameters		L	R	ST	IF	PR	M	UL	NS	M

Notes: *C, O, D, P represent Project Phases: (C)onstruction, (O)peration, (D)ecomissioning and Reclamation, (P)ost-closure*
Project=Tenas Project

Magnitude:	*Low (L), Moderate (M), High (H)*
Geographic Extent:	*Local (LSA), Regional (RSA), Beyond Regional (beyond RSA)*
Duration:	*Short-term (ST), Medium-term (MT), Long-term (LT)*
Frequency:	*Infrequent (IF), Frequent (FF), Continuous (CF)*
Reversibility:	*Fully reversible (FR), Partially reversible (PR), Irreversible (IR)*
Context:	*Low (L), Moderate (M), High (H)*
Likelihood:	*Unlikely (UL), Likely (L)*
Significance:	*Not-Significant (NS), Significant (S)*
Level of Confidence:	*High (H), Moderate (M), Low (L)*

*See **Table 5.1-2** for list of applicable activities for each listed Project phase, unless otherwise noted in this table. Includes all existing and reasonably foreseeable projects as outlined in **Table 6.1-1.***

6.4 Summary of Cumulative Effects Assessment (CEA)

The following Project-related residual effects of the Project on the Surface Water VC were carried forward to the CEA:

- Surface Water Quantity subcomponent:
  - change in MAD;
  - change in seasonal flow distribution; and
  - change in high and low flows.

- Surface Water Quality subcomponent:
  - change in modelled parameter concentrations; and
  - change in other measurable water quality parameters.

As detailed in **6.3**, the residual effects of the Project, in conjunction with the comparable residual effects from past, present, and reasonably foreseeable future projects are not expected to alter the integrity of the Surface Water Quantity or Surface Water Quality subcomponents. Future forestry, agricultural or mining activities are expected to have the greatest contribution to cumulative effects on the Surface Water VC, however, this is expected to be mitigated with the implementation of regulatory guidance and requirements in their permit conditions.

Considering this, the cumulative effects are not expected to alter the integrity of the Surface Water VC within the Surface Water RSA beyond an acceptable level (i.e., it remains sustainable and is available to contribute to ecological function); and are predicted to be **Not Significant** (**Table 6.4-1**).

Table 6.4-1: Summary of Cumulative Effects on Surface Water Subcomponents

VC Subcomponent	Potential Cumulative Effect	Contributing Activities within the Project Phases (C, O, D, P)	Cumulative Effect (Yes/No)	Significant (Yes/No)
Surface Water Quantity	▪ Change in Mean Annual Discharge ▪ Change in Seasonal Flow Distribution ▪ Change in Low and High Flows	Forestry, mining, agricultural activities	Yes	No
Surface Water Quality	▪ Change in Modelled Parameter Concentrations ▪ Change in Other Measurable Water Quality Parameters		Yes	No

Notes: *C, O, D, P represent Project phases: (C)onstruction, (O)peration, (D)ecomissioning and Reclamation, (P)ost-closure Project=Tenas Project*

*See **Table 5.1-2** for list of applicable activities for each listed Project phase, unless otherwise noted in this table. Includes all existing and reasonably foreseeable projects as outlined in **Table 6.1-1.***

7. Summary of Effects Assessment For Surface Water Valued Component (VC)

The following potential effects of the Project on the Surface Water VC subcomponents are predicted to occur due to the Project:

- Surface Water Quantity subcomponent:
  - change in MAD;
  - change in seasonal flow distribution;
  - change in high and low flows;
- Surface Water Quality subcomponent:
  - change in modelled parameter concentrations; and
  - change in other measurable water quality parameters.

Mitigation measures employed during all Project phases are expected to avoid, minimize, or rehabilitate onsite the potential Project effects on the Surface Water VC; however, these effects are not anticipated to be fully mitigated and residual effects are anticipated.

The Project-related residual effects on the Surface Water VC subcomponents were predicted to be **Not Significant**. Project-related residual effects were carried forward into the CEA and were assessed in relation to their overlap in time and space with the comparable residual effects of other projects and activities within the Surface Water RSA. Future forest, mining or agricultural activities are expected to have the greatest contribution to cumulative effects on the Surface Water VC, however, this is expected to be mitigated with the implementation of regulatory guidance and requirements in their permit conditions. Considering this, the cumulative effects are not expected to alter the integrity of the Surface Water VC within the Surface Water RSA beyond an acceptable level. As such, the cumulative effects on the Surface Water VC are predicted to be **Not Significant.**

8. Follow-up Strategy

TCL has developed mitigation measures that have been incorporated in the Project's design and/or operational procedures. These Project mitigation measures are outlined in **S1.0 Overview of Project Proponent Description** of the **EAC Application** and include Project design aspects such as site selection, selection of BAT to-date for Project infrastructure and mining equipment, and a commitment to progressive reclamation.

Moreover, as described in **5.3 Mitigation Measures**, TCL has developed management plans that will be used to manage environmental issues, including surface water. The **DMP** provides details pertaining to the operational plans for discharges to surface water for the Project. The **DMP** contains information on expected discharge water quality limits, surface water discharge rates, discharge locations, emergency procedures for discharge system upsets, and contingency plans.

Along with the **DMP**, a comprehensive monitoring program, found in the **MWMP** will be used to gauge the performance of the Project's water management system and mitigation measures against model results and regulatory commitments. This **MWMP** contains monitoring plans for Project phases, including Post-closure. When changes are observed, solutions will be developed using adaptive management to determine the appropriate response. The following monitoring types are recommended:

- Environmental monitoring in Tenas, Four and Goathorn creeks, including water quality and streamflow, to detect alterations in receiving environment from baseline datasets;
- Water quality sampling in Project ponds and in the downstream environment, including monitoring wells, to characterise migration of seepage and ensure end-of-pipe limits and instream water quality guidelines are not exceeded;
- Survey Project pond water levels to maintain minimum freeboard requirements in preparation for emergency flood events;
- Monitor performance of soil covers over management ponds as they are subsequently covered as part of progressive reclamation in terms of erosion, and runoff rates;
- Monitor discharge rates from the control structure on the diversion channel south of the East Management Pond to verify high flow events are being discharged towards the management pond and not resulting in erosion in Four Creek;
- Monitor water cover depth over management ponds to ensure PAG material is submerged; and
- Monitor parameters of potential concern and parameters of concern related to aquatic life, terrestrial vegetation, wildlife and people and land uses.

Monitoring of Parameters of Potential Concern/Contaminants of Potential Concern (POPC/COPC) and Parameters of Concern/Contaminants of Concern (POC/COC) identified for aquatic life, wildlife, terrestrial vegetation, human health, and land uses will be conducted for soils, vegetation, sediment, and surface and groundwater.

Results of monitoring programs will be used to refine model predictions. Detailed surface water monitoring plans for all Project phases are provided in **Appendix 13.11-E Minesite Water Monitoring Program** of the **MWMP.** The **Tenas Project Water and Load Balance Modeling Report (Appendix 4.3-A)** results will be used to evaluate if additional follow-up programs or interventions are required. Based on modelling results, no follow-up programs are expected at this time.

8.1 Trigger Action Response Plan (TARP)

Given the potential effects on streams due to the development of this Project on streamflows, water quality in streams and water quality in management and control ponds (end-of-pipe) a Trigger Action Response Plan (TARP) will be developed and implemented for:

- changes in streamflow relative to baseline conditions;
- water quality within management ponds and the Tenas Control Pond prior to discharge so that regulatory limits and/or threshold discharge rates are not exceeded. Monitoring results will be compared against model results to verify conceptual models and model updates will be performed if deviations from expected quality are noted; and
- discharge of water when water quality in discharging facilities exceeds the threshold end-of-pipe limits. A maximum discharge rate would be calculated to meet downstream water quality guidelines and water flows above this rate would be temporarily stored in management ponds or pumped to backfilled areas of the open pit.

As part of the TARP, testing of the management pond cover will be completed on the first covered facility (North Management Pond) early during the Operation Phase to improve the long-term closure strategy for revegetation and effective maintenance of water covers and the effectiveness of the cover reducing evaporative losses. This TARP will be developed prior to the start of the Construction Phase for the Project.

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