



**Environmental and Social Impact
Assessment for the Troilus Mine Project**

FISH AND FISH HABITAT

Environmental and Social Impact Assessment for the Troilus Mine Project

FISH AND FISH HABITAT

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Acronyms and abbreviations

CC	Climate change
CCME	Canadian Council of Ministers of the Environment
CDPNQ	Centre de données sur le patrimoine naturel du Québec
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CVAC	Critère de vie aquatique chronique
CWQG-FAL	Canadian Water Quality Guidelines for the Protection of Aquatic Life
DFO	Department of Fisheries and Oceans Canada
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
ECCC	Environment and Climate Change Canada
EEM	Environmental Effects Monitoring
EPT	Ephemeroptera, Plecoptera and Trichoptera
ESIA	Environmental and Social Impact Assessment
GIS	Geographic Information System
HST	Historical Climate Conditions
JBNQA	James Bay and Northern Quebec Agreement
kPa	Kilopascal
LSA	Local Study Area
MDMER	Metal and Diamond Mining Effluent Regulation
MELCCFP	Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (Quebec Ministry of the Environment, the Fight Against Climate Change, Wildlife and Parks)
PDA	Project Development Area
PoPCs	Parameters of Potential Concern
PPV	Peak Particle Velocity
RSA	Regional Study Area
SAR	Species at Risk
SARA	Species at Risk Act
TIA	Tailings Impoundment Area
TSS	Total Suspended Solids
VC	Valued Component

18. Fish and Fish Habitat

Fish and fish habitat was selected as a Valued Component (VC) because fish and fish habitat, and the productivity of the fisheries that they support, are valued by Indigenous communities, recreational anglers, and the public-at-large. Fish and fish habitat in Canada are protected by the *Fisheries Act* and in Québec by the *Act Respecting the Conservation and Development of Wildlife* and the Quebec Fishery Regulations, 1990. Fish and fish habitat also contribute to biodiversity and are indicators of aquatic ecosystem health.

The Troilus Mine Project (the Project) may affect fish and fish habitat because of potential changes to water quality and quantity, and habitat quantity and quality. These changes could affect fish community composition, population abundance, and individual fish health, growth, or survival directly due to overprinting or dewatering of watercourses and lakes, changes in stream flow and fish passage, changes in water quality, or indirectly through effects to lower trophic communities upon which fish depend for food.

18.1 Scope of Assessment

18.1.1 Regulatory Framework

18.1.1.1 Federal

Fisheries Act

The *Fisheries Act* defines ‘fish’ as all parts and life history stages of fish, crustaceans, and shellfish and ‘fish habitat’ as water frequented by fish and any other areas on which fish depend, directly or indirectly, to carry out their life processes, including spawning grounds, nursery, rearing, food supply, and migration areas.

The purpose of the *Fisheries Act* is to provide a framework for the “proper management and control of fisheries and the conservation and protection of fish and fish habitat, including by preventing pollution.” To do so, the *Fisheries Act* includes the following fish and fish habitat protection provisions:

- Section 34(2) provides provisions for maintaining adequate flow and passage of fish;
- Section 34.4(1) prohibits any work, undertaking, or activity, other than fishing, that results in the death of fish;
- Section 35(1) prohibits the carrying out of a work, undertaking, or activity that results in the harmful alteration, disruption or destruction (HADD) of fish habitat;
- Section 36(3) prohibits the deposit of deleterious substances of any type in water frequented by fish or in place under any conditions where the deleterious substance or any other deleterious substance may enter such water;
- The *Fisheries Act* is administered by the Department of Fisheries and Oceans Canada (DFO) except for section 36, which is administered by Environment and Climate Change Canada (ECCC).

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Section 34.1(1) of the *Fisheries Act* identifies the following factors that the Minister of Fisheries, Oceans, and the Canadian Coast Guard must consider when exercising his or her authority under the fish and fish habitat protection provisions of the *Fisheries Act* (e.g., issuance of authorizations or permits related to the death of fish or the HADD of fish habitat):

- The contribution to the productivity of relevant fisheries by the fish or fish habitat that is likely to be affected;
- Fisheries management objectives;
- Whether there are measures and standards to avoid the death of fish or to mitigate the extent of their death or offset their death, or to avoid, mitigate or offset the HADD of fish habitat;
- The cumulative effects of the carrying out of the work, undertaking, or activity in combination with other works, undertakings, or activities that have been or are being carried on, on fish and fish habitat;
- Any fish habitat banks that may be affected;
- Whether any measures or standards to offset the HADD of fish habitat give priority to the restoration of degraded fish habitat;
- Indigenous knowledge of the Indigenous peoples of Canada that has been provided to the Minister;
- Any other factor that the Minister considers relevant.

Fish and Fish Habitat Policy Protection Statement

The Fish and Fish Habitat Protection Policy Protection Statement (DFO 2019) provides guidance on how DFO interprets and implements the fish and fish habitat protection provisions in the *Fisheries Act*. The Policy describes how avoidance, mitigation, and offsetting form a hierarchy of measures to limit harmful impacts to fish and fish habitat, emphasizing that efforts should be made first to prevent (i.e., avoid) and then minimize (i.e., mitigate) harmful impacts to fish and fish habitat, with offsetting being the last resort when death of fish or HADD of fish habitat cannot be entirely avoided.

The Policy applies to proponents of existing or proposed works, undertakings, or activities that may result in harmful impacts to fish or fish habitat, specifically the death of fish by means other than fishing or the HADD of fish habitat.

Policy of Applying Measures to Offset Harmful Impacts to Fish and Fish Habitat

The Policy for Applying Measures to Offset Harmful Impacts to Fish and Fish Habitat (DFO 2025a) provides guidance to proponents and to DFO staff on the use of offsetting measures to counterbalance harmful impacts to fish and fish habitat. It also provides guidance on the development of offsetting plans when seeking authorization under paragraph 34.4(2) for the death of fish and/or paragraph 35(2)(b) for the HADD of fish habitat or on the development of conservation project plans for habitat banks.

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Metal and Diamond Mine Effluent Regulation

The Metal and Diamond Mining Effluent Regulation (MDMER), promulgated under the *Fisheries Act*, regulates the deposit of deleterious mine effluents, tailings, and waste rock into waters frequented by fish and is administered by Environment and Climate Change Canada (ECCC), on behalf of DFO. The MDMER defines mine effluent as:

“(a) hydrometallurgical facility effluent, milling facility effluent, mine water effluent, tailings impoundment area effluent, treatment pond effluent or treatment facility effluent other than effluent from a sewage treatment facility; or (b) any seepage or surface runoff containing any deleterious substance that flows over, through or out of the site of a mine.”

The MDMER applies to metal and diamond mines with an effluent flow rate of greater than 50 cubic metres per day (m³/d) based on effluent deposited from all final discharge points of the mine. For these mines, the MDMER allows the discharge of mine effluent containing deleterious substances if:

1. The effluent is not acutely lethal;
2. The pH is equal or greater than 6.0, but not greater than 9.5;
3. Concentrations of deleterious substances do not exceed concentration limits identified in Schedule 4 of the MDMER at the final discharge point(s).

Schedule 4 of the MDMER prescribes “end-of-pipe” discharge limits for arsenic, copper, cyanide, lead, nickel, zinc, total suspended solids (TSS), radium-226, and un-ionized ammonia in metal and diamond mine effluent in Canada. All mines and recognized closed mines subject to the MDMER are required to conduct water quality monitoring, acute lethality testing of final effluent, effluent characterization, and Environmental Effects Monitoring (EEM) in the downstream receiving environment in three-year cycles.

Deposition of mine effluent, tailings, and waste rock into waterbodies frequented by fish is prohibited by the *Fisheries Act* unless those waterbodies are designated as a Tailings Impoundment Area (TIA) by the Parliament of Canada and listed in Schedule 2 of the MDMER.

Species at Risk Act

The *Species at Risk Act* (SARA) provides protection, and mandates recovery strategies and action plans, for extirpated, endangered, or threatened species in Canada, while managing species of special concern to prevent further declines. DFO administers SARA for aquatic species listed on Schedule 1 of the SARA. Species at Risk (SAR) are added to Schedule 1, the official list of SAR, through a federal government process after receiving scientific information and recommendations from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Each species is classified as extirpated, endangered, threatened, or special concern. Species listed on Schedule 1 of the SARA are subject to protection and recovery measures.

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18.1.1.2 Provincial

La Directive 019 sur l'industrie minière

La Directive 019 sur l'industrie minière (Directive 019) has been developed by the Quebec Ministry of the Environment, the Fight Against Climate Change, Wildlife and Parks (MELCCFP) for mining activities, including new and existing mining activities, regulates the effluent released into the environment to reduce the potential for adverse effects on the environment and considers climate change and associated potential effects. Directive 019 allows the discharge of mine effluent containing a deleterious substance if:

1. The pH is greater than 6.0, but not greater than 9.5;
2. The concentration of thiosalts does not result in a change of pH that is less than 6.0 or greater than 9.5;
3. The total toxicity is less than the acute toxicity for rainbow trout (*Oncorhynchus mykiss*) and daphnia (*Daphnia magna*);
4. Concentrations of deleterious substances do not exceed the concentration limits identified in Table 3.1 of Directive 019 at the final discharge point(s).

Directive 019 prescribes the “end-of-pipe” discharge limits for arsenic, copper, iron, nickel, lead, zinc, cyanide, petroleum hydrocarbons (C₁₀–C₅₀), TSS, and radium 226. Table 3.1 of Directive 019 includes average maximum concentrations and daily maximum concentrations of deleterious substances.

Act Respecting the Conservation and Development of Wildlife (C-61.1)

This legislation is in place for the conservation and development of fish and includes provisions for fish habitat protection as well as provincial fisheries management.

Quebec Fishery Regulations (1990)

The Quebec fishery regulations are made under the federal *Fisheries Act* and are in place to govern fishing in Quebec's fresh and marine waters. The regulations provide provisions for the protection of fish and their habitat.

18.1.2 Influence of Consultation and Engagement on the Assessment

Consulting with relevant stakeholders allows their expectations and concerns to be incorporated into the project and deepens understanding of the environment by integrating the traditional knowledge of indigenous communities and groups.

As part of the Troilus mining project, consultations were held with land users, Indigenous communities, surrounding communities, the City of Chibougamau, Eeyou Istchee James Bay Regional Government, and non-profit organizations. These consultations helped identify stakeholder concerns, guide the identification and assessment of potential project impacts, and establish communication between the proponent and stakeholders during project design and implementation.

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Table 18.1 presents the concerns raised during consultations with stakeholders. These elements, detailed in chapter 4 dedicated to the ESIA consultation, illustrate how this feedback influenced and modified the project design to better address the environmental and social issues identified during the impact assessment.

Table 18.1 Summary of Key Information, Indigenous Knowledge, and Concerns for the Project Related to Fish and Fish Habitat

Topic	Key Information, Indigenous Knowledge, and Concerns	Influence on the Assessment	Where Information is addressed in the ESIA
Bibou Creek Diversion	Importance of maintaining connectivity between Lac A and Lac Amont in order allow fish to circulate between the two lakes via Bibou Creek.	Taken into account when evaluating fish passage and the importance of maintaining fish passage between Lac Amont and Lac A.	Chapter 3 Chapter 4 Chapter 18
	Concerns about impacts of Bibou Creek diversion on fish and spawning grounds	Taken into account when evaluating fish the quality of fish habitat available. Spawning areas were identified in the baseline assessment.	Chapter 3 Chapter 4 Chapter 18
Construction and operation	Protection of aquatic fauna during construction and operation	Overall, mitigation measures have been incorporated that align with best practices and established DFO guidance to limit potential effects to fish and fish habitat and the invertebrate community.	Chapter 3 Chapter 4 Chapter 18

18.1.3 Potential Impacts, Pathways and Measurable Parameters

Table 18.2 summarizes the potential impacts of the Project on fish and fish habitat, impact pathways, and measurable parameters. These potential impacts and measurable parameters were selected based on professional judgement, understanding of the Project, recent environmental assessments for mining projects in Canada, and comments provided during engagement.

Table 18.2 Potential Impacts, Impacts Pathways, and Measurable Parameters for Fish and Fish Habitat

Potential Impact	Impact Pathway	Measurable Parameter(s) and Units of Measurement
Change in Fish Habitat ¹	Construction, operations, and decommissioning/closure of the Project has the potential to physically alter, disrupt, or destroy instream and/or riparian habitat, create barriers to fish passage, and/or alter stream flows, that may impair the ability of different fish species to conduct their different life stages (e.g., spawning).	<ul style="list-style-type: none"> • Area of altered fish habitat (m²), by habitat type and/or fish species life stage. • Fish habitat quality as described in Malavoi and Souchon 2001, including stream habitat units (e.g., riffle, pool), substrate types (e.g., gravel, cobble), and % cover (i.e., instream and overhead) relative to baseline (Wachiih 2024). • Change in stream flow (m³/sec)

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Potential Impact	Impact Pathway	Measurable Parameter(s) and Units of Measurement
Change in Fish Health, Growth, or Survival	Construction, operations, and decommissioning/closure of the Project has the potential to affect fish health, growth, or survival due to stranding of fish or fish eggs, death of fish or fish eggs due to sound over-pressure from blasting, trauma from physical impacts, changes in prey quantity or quality, or acute or chronic toxicological effects from changes in water quality or sediment quality.	<ul style="list-style-type: none"> • Number of fish killed or stranded, by species and age class. • Underwater sound pressure (kPa) and Peak Particle Velocity (PPV) (mm/second) • Water quality parameters that influence fish health: water temperature (°C), pH (pH units), specific conductivity (µS/cm), and dissolved oxygen (DO), and total suspended solids (TSS) concentrations (mg/L) • Water quality parameters that influence fish prey availability or contribute to eutrophication: phosphorous, nitrogen, dissolved organic carbon (DOC), and chlorophyll a (mg/L) concentrations. • Fish community composition (% relative abundance of individual species, species presence/absence). • Fish population composition (average length, weight, age, length-frequency distribution, age-frequency distribution). • Fish abundance (fish per unit effort by gear type). • Fish condition (length-weight relationship). • Fish growth (length-at-age, weight-at-age). • Fish health (hepatosomatic index², gonadosomatic index³). • Contaminant (e.g., metals) body burdens in fish tissue (mg/kg wet weight and mg/g dry weight).

Notes:

¹ Fish habitat is defined under the *Fisheries Act* as “waters frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas”.

² A commonly used metric or measurement in fisheries biology that represents the relative size of a fish’s liver compared to its total body weight. This metric is used as an indicator of the nutritional status, energy reserves, and overall health of the fish.

³ A commonly used metric or measurement in fisheries biology that represents the relative size of a fish’s gonads (reproductive organs) compared to its total body weight. The metric is used to assess the reproductive cycle, determine the time of spawning and assess the reproductive health of a given population of fish.

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For this assessment, all fish and fish habitat end-points for the above pathways of effects were organized into two over-arching potential effects of the Project: 1) change in fish habitat, including the potential HADD of fish habitat and potential change in fish passage; and 2) change in fish health, growth, and survival, including potential impacts of predicted changes in water quality.

Change in fish habitat was included as a potential effect because:

- Activities required for construction, operation, and decommissioning of the Project have the potential to cause a HADD of fish habitat, an activity prohibited by paragraph 35(1) of the *Fisheries Act* unless authorized by DFO;
- Changes in fish habitat may occur due to physical destruction of in-water and riparian habitat during construction of the mine infrastructure, and alteration of lake levels or stream flows due to changes in groundwater-surface water interactions, and/or diversion, extraction, or storage of surface water runoff;
- Changes to fish habitat have the potential to affect the ability of fish to conduct one or more life stages and, thereby, alter the annual recruitment and production of fish populations.

Changes in fish health, growth, or survival was included as a potential effect because:

- Carrying out a work, undertaking or activity other than fishing, that results in the death of fish, by means other than fishing, is prohibited by paragraph 34.4(1) of the *Fisheries Act*;
- Changes in fish health, growth, and survival may occur due to changes in water quality or sediment quality due to release of mine effluent or contact water, mobilization of sediment, stranding of fish, effects from underwater noise due to blasting, increased fishing pressure, or changes to the composition, abundance, and distribution of periphyton, plankton, and benthic invertebrate communities that fish depend on for food

While baseline studies associated with the Project identified 22 different fish species, this assessment focuses on six representative groups of fish species. This is because assessing Project-related changes to all 22 species could be too complex to reasonably assess potential effects, but more importantly, is unnecessary given that many of these species, particularly forage fish, have similar life histories and habitat requirements. As such, their vulnerability to potential effects of the Project, their abundance and distribution, and their importance to people as recreational, commercial, or Indigenous fisheries.

Focusing on the six representative, or focal, groups of species allows for the identification of potential interactions between the Project and the factors important to fish production. This approach also provides for the identification of avoidance and mitigation measures that would reduce potential effects to most fish species and their habitats. The focal fish species/groups used in this assessment were:

- Northern pike (*Esox lucius*): a large-bodied, piscivorous (fish-eating) species that is widespread in the local streams and lakes and is the top predatory fish species. Northern pike spawn in the spring in still or slow-moving water with aquatic vegetation or submerged terrestrial vegetation. Northern pike are an important recreational fish species;
- Brook trout (*Salvelinus fontinalis*): a large-bodied salmonid that typically spawns in the fall through the construction of redds. The eggs incubate over winter and require upwelling from groundwater to

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support temperature regulation over winter for successful hatching in spring. The species can survive in lakes but typically spawn over areas with small gravel substrate. Brook trout are an important recreational fish species;

- Walleye (*Sander vitreus*): a large-bodied, piscivorous (fish-eating) species that are found in the LSA. Walleye spawn in spring after ice break-up in shallow shoreline areas and shoals in lakes and in riffles and dam faces in rivers with rocky substrate and good water circulation from currents or wave action. Walleyes are an important recreational fish species or may be harvested by Indigenous communities;
- Burbot (*Lota lota*): a large-bodied piscivorous species that is different from the other local species as they spawn under ice between January and March over substrate comprised of sand or gravel in shallow bays. Burbot exhibit and anguilliform (eel-like) swimming motion and juveniles tend to be the weakest swimmers of the various fish groups and are therefore a valuable fish species to consider for conservative fish passage evaluations. The species is also often targeted as a recreational species or may be harvested by Indigenous communities;
- Coarse fish: includes white sucker (*Catostomus commersoni*) and longnose sucker (*Catostomus catostomus*). Both species are large-bodied species that feed on benthic (river/lake bottom) material and organisms (e.g., chironomids, molluscs, insects, algae). Both species tend to spawn from May to June or into July at shallow lakeshores generally over gravel; however, spawning can also occur in small watercourses. Both species may be harvested by Indigenous communities;
- Forage fish: a group of small-bodied species including longnose dace (*Rhinichthys cataractae*), northern pearl dace (*Margariscus nacheibii*), trout-perch (*Percopsis omiscomaycus*), lake chub (*Couesius plumbeus*), ninespine stickleback (*Pungitius pungitius*), blacknose dace (*Rhinichthys atratulus*), spottail shiner (*Hudsonius hudsonius*), and fallfish (*Semotilus corporalis*) found throughout the local area in the slow moving waters of Bibou Creek (CE2) as well as Lac A (PE43) and Lac Amont (PE2). These species are common prey items for large-bodied piscivorous fish such as walleye, yellow perch (*Perca flavescens*), and northern pike. This group of fish typically spawn in late spring or early summer and feed on benthic invertebrates, plankton, or algae. Most species in this group (not ninespine stickleback) have a swim-bladder that is connected to their inner ears, making them sensitive to underwater noise (e.g., blasting).

18.1.4 Spatial and temporal limits

18.1.4.1 Spatial Boundaries

The study area corresponds to the spatial framework associated with the description and analysis of the VC of fish and fish habitat of the receiving environment, as well as the assessment of the impacts of the Project on it. The study area includes the Project Development Area (PDA), the Local Study Area (LSA), and the Regional Study Area (RSA). The study area aligns with other related VCs, including hydrology and surface water quality (Map 18.1).

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Project Development Area

The PDA encompasses the physical footprint of all Project components including both permanent and temporary disturbances and includes the anticipated area of physical disturbance associated with the construction, operation, and decommissioning and closure of the Project.

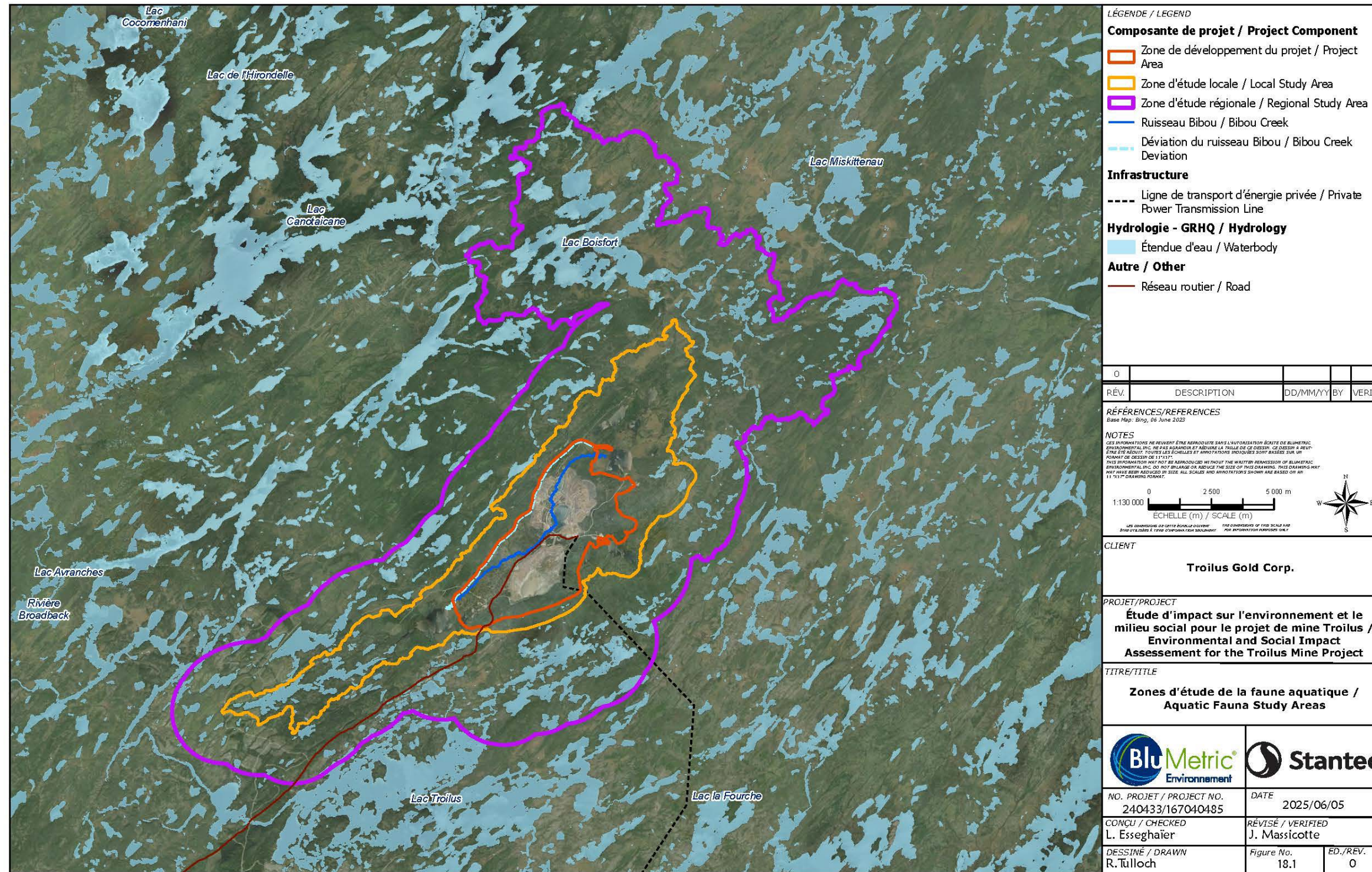
Local Study Area

The LSA includes the PDA and corresponds to the maximum area within which the residual environmental impacts, both direct and indirect, can be predicted or measured with a sufficient degree of accuracy and confidence. The LSA includes the watershed, as identified in the hydrology VC (Chapter 11) as the representative of the Troilus mining project with fish and fish habitat and the impacts on fish and fish habitat. The LSA represents the spatial extent where it is reasonable to expect potential effects on surface water quality, hydrology, and fish and fish habitat.

Regional Study Area

The RSA includes the LSA and provides a framework for assessing regional and cumulative impacts of the Project in combination with historical, present, and future activities. The RSA allows for the characterization of the fish and fish habitat VC of the regional receiving environment located downstream of the LSA. The RSA includes lac Boisfort and the sub-watersheds downstream of the RSA draining into lac Boisfort. Stream CE52-SH1 also flows into lac Boisfort. In addition, a 2 km buffer zone around the LSA was considered and merged with a watershed boundary to define the LSA. This approach contextualizes the specific effects of the Project and their contribution to regional impacts.

Map 18.1 Fish and Fish Habitat Study Area



LÉGENDE / LEGEND

Composante de projet / Project Component

- Zone de développement du projet / Project Area
- Zone d'étude locale / Local Study Area
- Zone d'étude régionale / Regional Study Area
- Ruisseau Bibou / Bibou Creek
- Déviation du ruisseau Bibou / Bibou Creek Deviation

Infrastructure

- Ligne de transport d'énergie privée / Private Power Transmission Line

Hydrologie - GRHQ / Hydrology

- Étendue d'eau / Waterbody

Autre / Other

- Réseau routier / Road

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RÉV.	DESCRIPTION	DD/MM/YY	BY	VERIF.

RÉFÉRENCES/REFERENCES
Base Map: Bing, 06 June 2023

NOTES
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CLIENT
Troilus Gold Corp.

PROJET/PROJECT
Étude d'impact sur l'environnement et le milieu social pour le projet de mine Troilus / Environmental and Social Impact Assessment for the Troilus Mine Project

TITRE/TITLE
Zones d'étude de la faune aquatique / Aquatic Fauna Study Areas

NO. PROJET / PROJECT NO. 240433/167040485	DATE 2025/06/05
CONÇU / CHECKED L. Essegheier	RÉVISÉ / VERIFIED J. Massicotte
DESSINÉ / DRAWN R. Tilloch	Figure No. 18.1
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18.1.4.2 Temporal Boundaries

The temporal boundary of the assessment includes all Project phases from the start of construction, including mobilization to site, through to the end of closure. Based on the current Project schedule, the temporal boundaries for the Project are:

- Construction (years -3 to -1)
- Operations
 - Operation 1 (years 1 – 21) milling with ore extraction
 - Operation 2 (year 22) milling without ore extraction
- Decommissioning and closure
 - Active closure (years 22 – 24)
 - Passive closure (years 24+)

Chapter 3 of the ESIA (Project description) provides a detailed description of the proposed activities and length of each phase.

18.1.5 Residual Impacts Characterization

Descriptions and quantitative measures or qualitative definitions for criteria used to characterize potential residual effects on fish and fish habitat are provided in Table 18-2.

Table 18.3 Characterization of Residual Impacts on Fish and Fish Habitat

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual impact.	Positive – a residual impact that moves measurable parameters in a direction beneficial to fish and fish habitat relative to baseline. Adverse – a residual impact that moves measurable parameters in a direction detrimental to fish and fish habitat relative to baseline. Neutral – no net change in measurable parameters for fish and fish habitat relative to baseline.
Magnitude	The amount of change in measurable parameters for the Fish and Fish Habitat VC relative to existing conditions.	Change in Fish Habitat : Negligible – following mitigation and/or offsetting, no measurable change in habitat area (m ² or ha) and/or monthly flows (m ³ /s) in a waterbody or watercourse compared to long-term baseline variability and trends. Low – following mitigation and/or offsetting, a measurable change in habitat area and/or monthly flows in a waterbody or watercourse but that is within the range of natural variability. Moderate – following mitigation and/or offsetting, a measurable change in habitat area and/or monthly flows (increase or decrease greater than 10%) ² in a waterbody or watercourse that is greater than the range of natural variability, but that does not affect the ability of fish to use this habitat to carry out one or more of their life processes. High – following mitigation and/or offsetting, a measurable change in habitat area and/or monthly flows (increase or decrease

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Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
		<p>greater than 10%) in a waterbody or watercourse that is greater than the range of natural variability and large enough that fish can no longer rely on this habitat to carry out one or more of their life processes.</p> <p>Change in Fish Health, Growth or Survival: Negligible – no measurable change in the abundance, structure, or health metrics of focal fish populations Low – a measurable change in the abundance, structure, or health metrics of focal fish populations, but that is within the range of natural variability. Moderate – a measurable change in the abundance, structure, or health metrics of focal fish populations that is greater than the range of natural variability but not large enough to affect the productivity of focal fish populations. High – a measurable change in abundance, structure, or health metrics of focal fish populations that is greater than the range of natural variability and large enough to affect the productivity of focal fish populations.</p>
Geographic Extent	The geographic area in which a residual impact occurs.	PDA – residual effects are restricted to the PDA. LSA – residual effects extend into the LSA. RSA – residual effects extend into the RSA.
Timing ¹	Considers when the residual impact is expected to occur, where relevant to the VC.	No sensitivity – effect does not occur during a critical life stage (e.g., fish spawning or migration period) or timing does not affect the VC. Moderate sensitivity – effect may occur near or at the start or end of a critical life stage (e.g., fish spawning or migration period). High sensitivity – effect occurs during a critical life stage (e.g., fish spawning or migration period).
Duration	The time required until the measurable parameter of the VC returns to its existing condition, or the residual impact can no longer be measured or otherwise perceived.	Short-term – the residual effect is restricted to less than two years or is shorter than one generation of the focal fish species. Medium-term – the residual effect extends through operation and decommissioning/closure or is greater than one but less than two generations of focal fish species. Long-term – the residual effect extends beyond the life of the Project (>24 years) and is greater than two generations of focal fish species.
Frequency	How often the residual effect occurs during the Project or specific Project phase.	Single event – occurs only once. Multiple irregular event – occurs at no set schedule. Multiple regular event – occurs at regular intervals. Continuous – occurs continuously.
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the Project activity ceases.	Reversible – the residual effect is likely to be reversed after activity completion and reclamation. Irreversible – the residual effect is unlikely to be reversed after activity completion and reclamation.

Note:

¹ Timing depends on when critical life stages for various fish species occur, for how long, and what environmental variables contribute to the natural variability of this timing.

² DFO 2013

18.1.6 Significance Definition

The Impact Statement must characterize any residual adverse federal effect, which includes residual adverse effects within federal jurisdiction and any adverse indirect or incidental effects as defined in

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section 2 of the *Impact Assessment Act*. A change to fish and fish habitat, as defined in subsection 2(1) of the *Fisheries Act*, is identified as an effect within federal jurisdiction for which a determination of significance is required. As such, the criteria to characterize the extent to which residual adverse effects on fish and fish habitat are considered significant is presented in Section 18.4.5.

Negligible effect : A negligible residual adverse effect on fish and fish habitat is one that, following the application of avoidance and mitigation measures (including offsets), causes an alteration or destruction of fish habitat or a change in fish health, growth, or survival that is not likely to cause a measurable reduction in the productivity, abundance, community composition, or population structure of focal fish populations.

Moderate effect: A moderate residual adverse effect on fish and fish habitat is one that, following the application of avoidance and mitigation measures (including offsets), causes an alteration or destruction of fish habitat or a change in fish health, growth, or survival that is likely to cause a measurable reduction in the productivity, abundance, community composition, or population structure of focal fish populations within the RSA but does not threaten the long-term persistence or viability of an aquatic species at risk.

Significant effect : A significant residual adverse effect on fish and fish habitat is one that, following the application of avoidance and mitigation measures (including offsets), causes an alteration or destruction of fish habitat or a change in fish health, growth, or survival that is likely to cause a measurable reduction in the productivity, abundance, community composition, or population structure of focal fish populations within the RSA that threatens the long-term persistence or viability of an aquatic species at risk.

A change to aquatic species at risk, as defined in subsection 2(1) of the *Species at Risk Act*, is identified as an effect within federal jurisdiction for which a determination of significance is required. However, since residual adverse effects on lake sturgeon (*Acipenser fulvescens*; Southern Hudson Bay – James Bay populations, Special Concern) are not anticipated as a result of the Project due to changes that avoid discharge or modification of habitat within lac Avranches, the extent to which residual adverse effects on this species is not assessed. No other aquatic species at risk occur within the RSA.

18.2 Existing Conditions for Fish and Fish Habitat

18.2.1 Methods

Existing conditions for fish and fish habitat were determined based on both desktop and field studies. A desktop assessment was conducted using digital imagery and the Géobase du réseau hydrographique du Québec (MRNF, 2019) to identify potential watercourses within the LSA and RSA. Timing windows for instream activities were identified from DFO's timing windows for carrying out work in fish habitat within the Nord-du-Québec region (DFO, 2017).

A review of historical fish sampling data and recent supplemental fish sampling (Appendix G5.1) was reviewed within the LSA and RSA. Fish species information was cross-referenced with provincial (e.g., CDPNQ, 2025) and federal (DFO 2025b) listings to determine if fish species identified in the study area are listed as species of risk or species of management concern. For this assessment, fish species at risk in Quebec are defined as fish that are protected under federal or provincial legislation, including species:

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- Listed under Schedule 1 of SARA as endangered, threatened, or species of concern (GOC, 2025)
- Listed under the Division 1 of the Act respecting threatened or vulnerable species as vulnerable or threatened (GOQ, 2024).
- The assessment also considers a wider group of species of management concern, which includes species identified in federal or provincial tracking lists, including species:
 - Listed by COSEWIC as endangered, threatened, or special concern but not yet listed under SARA
 - Listed as threatened, vulnerable, or susceptible by the Centre du données sur le patrimoine naturel du Québec (CDPNQ, 2025) but not yet listed under the Act respecting threatened or vulnerable species

A detailed description of methods and existing fish and fish habitat present within the RSA with the potential to be affected by the Project is provided in Appendices G1.3 and G5.1 In general, field studies were conducted throughout the history of the mine site (Entraco 1991, 1993; SEDAC and JGCEF 1997) and, most recently, Wachiih (Appendix G1.3) provided an assessment of fish and fish habitat within the study area based on work conducted between 2019 and 2023. This was the primary source for fish habitat and existing conditions within the RSA. Field data were used to develop an overview of functional habitat features and general channel morphology. Habitat requirements of species suspected to occur in the RSA and presence of potential fish barriers were considered when assessing habitat quality of waterbodies in the study area. The Wachiih (Appendix G1.3) field data was reviewed to determine whether the LSA provided suitable habitat for lake sturgeon.

18.2.2 Overview

The RSA is located within the Rupert River watershed and extends slightly into the Broadback River watershed to the southwest. The LSA consists of a chain of lakes beginning at the upstream end with Lac Amont in the southwest which is connected downstream to Lac A through Bibou Creek. Water then flows through several lakes and bodies of water to Lac Boisfort, approximately 10 km north (downstream) of the PDA. Located to the east of Lac Amont is a series of small lakes which serve as the headwaters of the main unnamed tributary to Bibou Creek. Bibou Creek dominates the west side of the PDA and the east side of the LSA also supports a series of lakes and watercourses which flow to the north and into lac A. A full description of the hydrologic regime is provided in Chapter 11 and Chapter 12.

The Project is located in the Nord-du-Quebec administrative region, and DFO (2017) provides recommended timing windows for conducting instream work and are prescribed to avoid disturbance of sensitive life periods for fish. The timing windows depend on the presence of: Atlantic salmon and landlocked salmon, other salmonids, and other species of interest. Based on the presence of fall spawning salmonids (e.g., lake whitefish [*Coregonus clupeaformis*], brook trout [*Salvelinus fontinalis*]) and spring spawning species of interest (e.g., walleye [*Sander vitreus*], northern pike [*Esox lucius*]), the recommended timing window for instream work extends from July 15 to August 31 of each year (DFO, 2017).

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18.2.2.1 Aquatic Species at Risk: Lake Sturgeon

Lake sturgeon is the only aquatic species at risk in the vicinity of the Project. The Southern Hudson Bay – James Bay populations, which includes the population in lac Avranches within the RSA, are listed as Special Concern under Schedule 1 of SARA.

The potential for lake sturgeon habitat within the LSA was evaluated through a desktop assessment which included review of field data collected by Wachih (2024) and concludes that there is a low likelihood of lake sturgeon presence within the LSA. Given the low likelihood of presence of lake sturgeon within the LSA and no historical records nor sampling efforts having identified lake sturgeon within the PDA, the species is not assessed further.

18.2.2.2 Aquatic Invasive Species

There are no records of aquatic invasive species in the RSA found during baseline assessments; however, the most likely species in the RSA that could be introduced include goldfish (*Carassius auratus*) and zebra mussels (*Dreissena polymorpha*) (DFO,2025c).

18.2.2.3 Historic Fish and Fish Habitat

This section addresses fish and fish habitat conditions prior to 1996 which is when the original mine was developed.

Fish Species Presence

Entraco (1993) set six-panel experimental nets (mesh from 2.5 cm to 10.2 cm) in August 1991 in six lakes, including lac A (PE43) and lac. Nets were set for one night in each lake and captured, in highest to lowest abundance, lake whitefish (*Coregonus clupeaformis*), walleye (*Sander vitreus*), longnose sucker (*Catostomus catostomus*), northern pike (*Esox lucius*), and white sucker (*Catostomus commersoni*). In the tributary to lac A (PE43), northern pike and brook trout (*Salvelinus fontinalis*) were sampled. Previous studies evaluated by Entraco (1993) indicate that the James Bay watersheds have historical presence of approximately 30 fish species; however, no list is provided. In addition to the six species captured in 1991, Entraco (1993) indicated that lake trout (*Salvelinus namaycush*), yellow perch (*Perca flavescens*), and brook trout are species frequently encountered in the RSA. Occasionally, tallymen fish in lac A (PE43) (Entraco 1993).

Benthic Invertebrates

Benthic invertebrate sampling was completed in several lakes in the pre-1996 period including lac Amont (PE2), lac A (PE43), PE48, PE50, and lac Boisfort and determined that the benthic community was comprised predominately of arthropods (73 to 88%) including Diptera, Ephemeroptera, and Tricoptera. Molluscs (5 to 7%), annelids (3 to 7%), and nematodes (1 to 15%; absent in lac A) were also present (SEDAC and JGCEF 1997).

Lac Amont (PE2) had the greatest taxonomic richness, with 35 families counted, followed by lakes A (PE43) (29 families), PE48 (30 families) and PE50 (30 families). Although it is specified that the sampling

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effort was lower in the case of Lac Boisfort, the number of families found in the samples (average of 15 families) indicates that richness appears to be greater in smaller lakes (SEDAC and JGCEF 1997). Additional monitoring was completed as part of Environmental Effects Monitoring by Genivar (2004, 2008, 2010).

Fish Habitat

In the PDA, substrates were dominated by sand, bedrock and cobbles/boulders of various sizes, with some organic matter accumulation in some areas. Clay and silty substrates were rare or absent, and water bodies were rather nutrient-poor, with the exception of those located downstream of the former mine operations site. Surface water quality samples collected in several lakes recorded pH values from 5.6 to 6.8 (Entraco 1993). Bibou Creek (CE2) has been extensively modified over the course of the site's various mining episodes, with diversions, watercourse realignments, and recontouring in several areas near the current pits. In general, mining operations have altered the area, with the construction of roads, borrow pits, tailings pits, sedimentation basins, and stockpiles of various kinds occurring over the years. In addition, there has been logging in the area and around the lakes at the southern end of the Troilus mine site.

18.2.2.4 Fish and Fish Habitat Existing Conditions

Fish Species Presence

A total of 22 fish species have been identified in the RSA. Table 18.4 provides a summary of the available data, including results of Project-related field sampling and identified during the desktop literature review. The RSA supports important local subsistence fishing for various species, particularly in lac A and lac Amont. Detailed information regarding fisheries resources identified by Aboriginal groups engaged on the project are presented in Chapter 4.

As noted in Section 18.2.2.1, the RSA overlaps the distribution of lake sturgeon (Southern Hudson Bay – James Bay populations; Special Concern) (DFO, 2025b), which is considered of special concern by COSEWIC and is vulnerable according to Centre de données sur le patrimoine naturel du Québec (CDPNQ). The distribution of lake sturgeon overlaps the RSA in lac Avranches which is located on the southwest edge of the RSA; however, there are no historical records of lake sturgeon within the LSA.

Tissue sampling was conducted in the summer of 2024 (Appendix G5.1) in which key species were sampled including walleye, lake whitefish, northern pike, logperch, yellow perch, and white sucker. A total of 10 individuals from each species were sampled, with five individuals from each species from lac Amont and five individuals from each species from lac A (Appendix G5.1). Laboratory analysis found elevated metal concentrations in tissues, with the highest concentrations of zinc, copper and manganese. The most elevated parameters included:

- Zinc (maximum 80 mg/kg)
- Copper (maximum 33 mg/kg)
- Manganese (maximum 27 mg/kg)

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- Selenium (maximum 2.8 mg/kg)
- Cadmium (maximum 1.8 mg/kg)
- Silver (maximum 1.6 mg/kg)

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Table 18.4 Fish species documented in the RSA

Species Information			Legislated Protection		Scientific Review or Recommendation	
Family ^a	Common Name ^a	Scientific Name ^a	SARA (federal) ^b	Division 1 (provincial) ^c	COSEWIC (federal) ^d	CDPNQ (provincial) ^e
Acipenseridae	lake sturgeon	<i>Acipenser fulvescens</i>	Special Concern	No status	Special Concern	Susceptible
Catostomidae	longnose sucker	<i>Catostomus catostomus</i>	No status	No status	Not assessed	Not assessed
	white sucker	<i>Catostomus commersonii</i>	No status	No status	Not assessed	Not assessed
Cottidae	mottled sculpin	<i>Cottus bairdii</i>	No status	No status	Not assessed	Not assessed
	slimy sculpin	<i>Cottus cognatus</i>	No status	No status	Not assessed	Not assessed
Esocidae	northern pike	<i>Esox lucius</i>	No status	No status	Not assessed	Not assessed
Gadidae	burbot	<i>Lota lota</i>	No status	No status	Not assessed	Not assessed
Gasterosteidae	ninespine stickleback	<i>Pungitius pungitius</i>	No status	No status	Not assessed	Not assessed
Leuciscidae	blacknose dace	<i>Rhinichthys atratulus</i>	No status	No status	Not assessed	Not assessed
	fallfish	<i>Semotilus corporalis</i>	No status	No status	Not assessed	Not assessed
	lake chub	<i>Couesius plumbeus</i>	No status	No status	Not assessed	Not assessed
	longnose dace	<i>Rhinichthys cataractae</i>	No status	No status	Not assessed	Not assessed
	northern pearl dace	<i>Margariscus nachtreibi</i>	No status	No status	Not assessed	Not assessed
	spottail shiner	<i>Notropis hudsonius</i>	No status	No status	Not assessed	Not assessed
Percidae	logperch	<i>Percina caprodes</i>	No status	No status	Not assessed	Not assessed
	walleye	<i>Sander vitreus</i>	No status	No status	Not assessed	Not assessed
	yellow perch	<i>Perca flavescens</i>	No status	No status	Not assessed	Not assessed
Percopsidae	trout-perch	<i>Percopsis omiscomaycus</i>	No status	No status	Not assessed	Not assessed
Salmonidae	brook trout	<i>Salvelinus fontinalis</i>	No status	No status	Not assessed	Not assessed
	cisco	<i>Coregonus artedii</i>	No status	No status	Not assessed	Not assessed
	lake trout	<i>Salvelinus namaycush</i>	No status	No status	Not assessed	Not assessed
	lake whitefish	<i>Coregonus clupeaformis</i>	No status	No status	Not assessed	Not assessed

Notes :

^a Common and Scientific Names of Fishes from the United States, Canada, and Mexico (Page et al. 2023)

^b Species at risk public registry (GOC 2025)

^c Act respecting threatened or vulnerable species (GOQ 2024)

^d Committee on the Status of Endangered Wildlife in Canada (GOC 2025) ; considered a species of management concern if assessed as threatened

^e Centre du données sur le patrimoine naturel du Québec (CDPNQ 2024); considered a species of management concern if assessed as susceptible, vulnerable, or threatened

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Benthic Invertebrates

Benthic invertebrate sampling was conducted within various waterbodies within the RSA and results are provided in Wachiih 2024 (Appendix G1.3). The results for lac Amont, lac A, and Bibou Creek are summarized below:

- Lac Amont (PE2): A total of nine families were identified with the benthic community dominated by arthropods (89%) predominately comprised of crustaceans of the genus *Candona* and *Cyclocypris*. Molluscs from the genus *Pisidium* were identified;
- Lac A (PE43): A total of 30 families were identified and comprised of arthropods and molluscs in similar proportions. The dominant arthropods were Tanytarsus insects, diptera of the Chironomidea family. The most abundant molluscs were from the genus *Pisidium*;
- Bibou Creek (CE2): The benthic community was almost exclusively comprised of arthropods (92-98%) with the main taxa being *Pagastiella*, *Polypedium halterade*, and *Polypedium scalaenum*.

Calculations of Simpson's Diversity Index (Simpson, 1949) were used to measure the diversity the benthic community. Analysis of results indicated that Bibou Creek and lac A had the richest benthic invertebrate communities (Wachiih 2024). Overall, all three waterbodies were dominated by chironomids and a lack of Ephemeroptera (i.e., mayflies), Plecoptera (i.e., stoneflies), and Trichoptera (i.e., caddisflies), referred to as EPT taxa.

Fish Habitat

Waterbodies

A total of 50 waterbodies (e.g., lakes, ponds) were characterized by Wachiih (2024) within the LSA (Appendix G1.3). The main waterbodies within the LSA and PDA are lac Amont (PE2), which serves as the headwaters of Bibou Creek (CE2), at the south end of the PDA and lac A (PE43) at the north end of the PDA (Map 18.2). Lac Amont is connected to a chain of lakes to the southwest and there are some small intermittent or ephemeral watercourses that flow into the lake along the western edge of the lake. Lac Amont is the largest lake with a maximum measured depth of 4.7 m and a surface area of 113 ha and is located upstream of the existing mine. The shoreline is predominantly comprised of coarse substrates, with sandy beaches near the eastern edge of the lake and fine sediment at the west side. A full description of habitat is provided in Wachiih (2024) and Stantec (2025) (Appendices G1.3 and G5.1).

Lac A is not within the PDA but within the LSA, downstream of the existing mine. It is the second largest lake in the LSA with a measured maximum depth of 10 m and a surface area of 80 ha. Surface water flows into lac A from Bibou Creek on the west side of the lake as well as tributaries along the eastern shore. The tributaries along the eastern shore are connected to lac B, located just outside of the PDA along the eastern side of the mine. The western shore of lac A has a substrate comprised of fine sediments, the northern and southern shores are dominated by coarser substrates, while fine sediments and a large sandy beach are found on the northeastern shore. A full description of habitat is provided in Wachiih report (Appendices G1.3).

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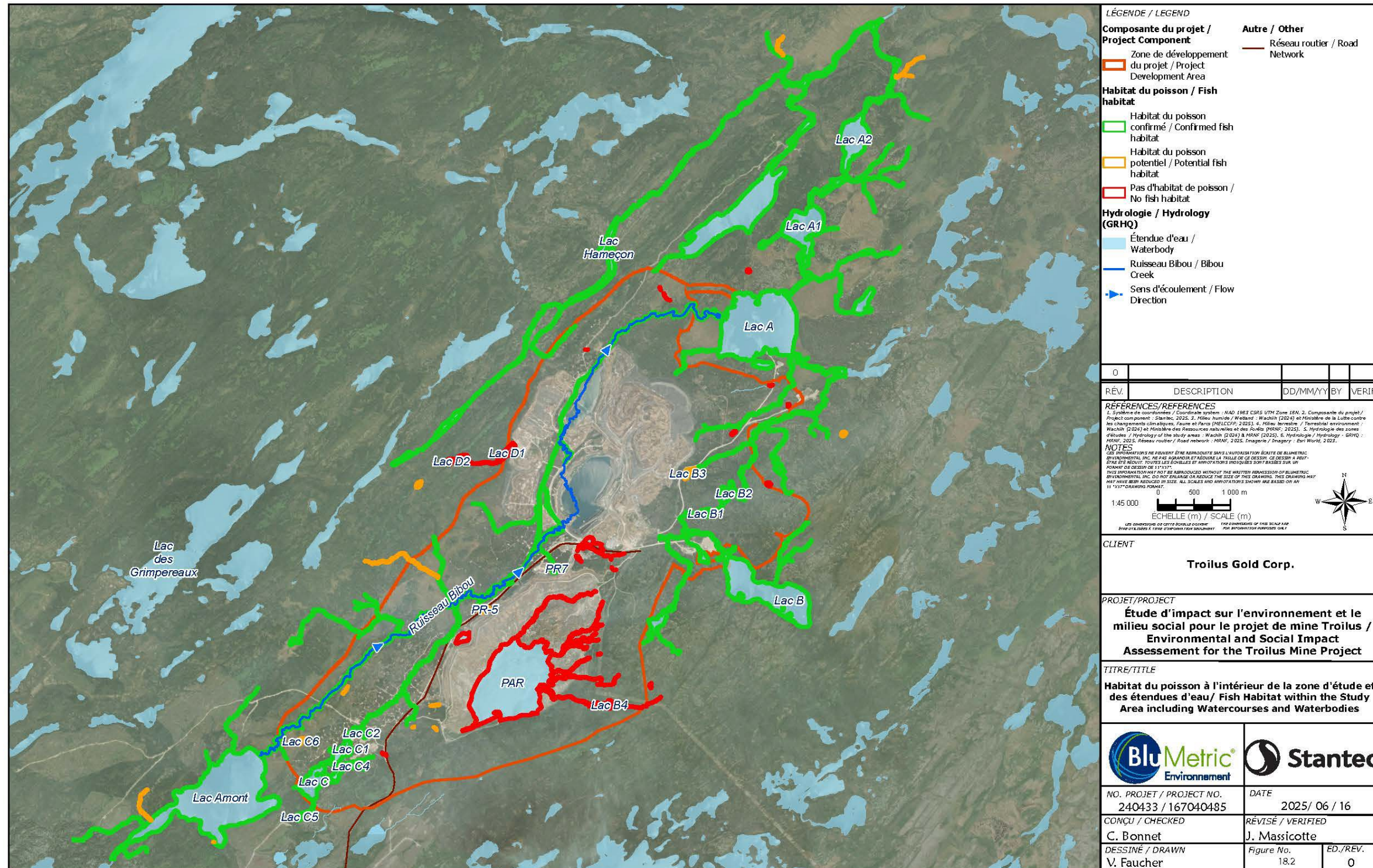
Watercourses

The area supports numerous watercourses, including permanent, intermittent and ephemeral watercourses. The main watercourse within the PDA is Bibou Creek (Map 18.2), which flows from lac Amont (PE2) north along the western edge of the PDA and discharges to lac A (PE43) at the north end. Downstream of lac Amont, the watercourse is predominantly comprised of run habitat with occasional rapids. Flows within the run and rapid habitat were measured up to 0.5 m/s with average depth of 0.4 m over several years of sampling (Appendix G1.3). Where habitat transitioned to flat habitat, water velocities were lower (i.e., 0.1 m/s or less) and was typically deeper (0.6 m) than the run habitat. Between 1994 to 2007, Bibou Creek was realigned to bypass pits 87 and J4. Along the realigned section, the channel is fairly straight with limited rapids with steep banks. The realigned banks are comprised predominately of sand and organics, with occasional boulders and cobbles. Erosion was noted along some segments of the watercourse. Within the realigned reach, the watercourse has variable flow (0.1 to 1.0 m/s) and has a channel width between 5 and 7 m wide. Downstream of the realigned reach, Bibou Creek resumes its natural alignment. This downstream reach is characterized by deep flat habitat with occasional rapids. The channel width is approximately 20 m with an average wetted width of 6 m and an average water depth of 0.6 m. Substrate is comprised of cobbles and boulders with sand and organics. Where the watercourse transitions to the mouth of lac A, Bibou Creek meanders through a bog with flat or glide habitat.

The other major watercourse within the PDA is an unnamed tributary to Bibou Creek (CE9). The CE9 tributary to Bibou Creek is fed by a series of upstream lakes, slightly northeast of lac Amont, and has its confluence with Bibou Creek approximately 2.5 km downstream of its headwaters. A segment of Bibou Creek was realigned around pit 87 between 1994 and 2007 and the realigned reach tends to be comprised of flat or glide habitat with a channel width that varies between 15 and 20 m with an average depth of 0.4 to 0.8 m. The naturalized reaches are generally more confined, with a channel width of approximately 6 m with an average depth of 0.8 m. Substrate throughout is comprised of organic material and sand, and this is typical of watercourses along the western side of the PDA. There is another small tributary to Bibou Creek, which may have been part of the watercourse initially, and is an outlet for a small lake (PE12) which is a historic sediment pond.

Along the eastern side of the study area within the LSA, there is a series of interconnected watercourses and waterbodies, the largest of which is lac B (PE29). Lac B (PE29) and associate watercourses drain into lac A to the north.

Map 18.2 Fish Habitat within the Study Area including watercourses and waterbodies



LÉGENDE / LEGEND

Composante du projet / Project Component

- Zone de développement du projet / Project Development Area

Autre / Other

- Réseau routier / Road Network

Habitat du poisson / Fish habitat

- Habitat du poisson confirmé / Confirmed fish habitat
- Habitat du poisson potentiel / Potential fish habitat
- Pas d'habitat de poisson / No fish habitat

Hydrologie / Hydrology (GRHQ)

- Étendue d'eau / Waterbody
- Ruisseau Bibou / Bibou Creek
- Sens d'écoulement / Flow Direction

0			
RÉV.	DESCRIPTION	DD/MM/YY	BY VERIF.

REFERENCES/REFERENCES

1. Système de coordonnées / Coordinate system - NAD 1983 CRS UTM Zone 18N, 3. Composante du projet / Project component - Stantec, 2025, 3. Milieu humide / Wetland - Wachin (2024) et Ministère de la Lutte contre les Changements Climatiques, Faune et Forêts (MELCCFP, 2023), 4. Milieu terrestre / Terrestrial environment - Wachin (2024) et Ministère des Ressources naturelles et des Forêts (MRNF, 2023), 5. Hydrologie des zones d'études / Hydrology of the study areas - Wachin (2024) & MRNF (2023), 6. Hydrologie / Hydrology - GRHQ : MRNF, 2023. Réseau routier / Road network - MRNF, 2023. Topographe / Topography - Eau World, 2022.

NOTES

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CLIENT

Troilus Gold Corp.

PROJET/PROJECT

Étude d'impact sur l'environnement et le milieu social pour le projet de mine Troilus / Environmental and Social Impact Assessment for the Troilus Mine Project

TITRE/TITLE

Habitat du poisson à l'intérieur de la zone d'étude et des étendues d'eau / Fish Habitat within the Study Area including Watercourses and Waterbodies

BluMetric Environnement **Stantec**

NO. PROJET / PROJECT NO. 240433 / 167040485	DATE 2025 / 06 / 16
CONÇU / CHECKED C. Bonnet	RÉVISÉ / VERIFIED J. Massicotte
DESSINÉ / DRAWN V. Faucher	Figure No. 18.2
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18.3 Project interaction with Fish and Fish Habitat

Table 18.5 summarizes the potential interactions and impacts of the various Project activities during each phase with the fish and fish habitat VC. Interactions are identified with a check mark (potential impact) or a dash (not applicable) and are evaluated in detail in Section 18.4 in the context of Project activities, application of mitigation measures, and residual effects.

Table 18.5 Project interactions with fish and fish habitat

Physical Activities	Change in Fish Habitat	Change in Fish Health, Growth or Survival
Construction		
Labour, equipment and materials transport to the site.	–	√
Vehicles and equipment operation and maintenance within the PDA.	–	√
Tree cutting, vegetation clearing, soil stripping and earthworks.	√	√
Handling and use of explosives, including blasting	–	√
Construction of temporary and permanent buildings, including wastewater treatment system and drinking water collection and distribution system.	√	√
Construction of mining infrastructures such as stockpiles, pits and the raising of tailings management facility.	√	√
Construction of roads and preparation of construction surfaces including the crushing of material used for construction. Relocation of a section of the access road and power line.	√	√
Construction of water management systems including ditches, diversion channel, sedimentation ponds and the water treatment plant.	√	√
Dewatering of natural water bodies and pits, lowering water level in tailings management facility and management of contact water.	√	√
Diversion of Bibou Creek (CE2).	√	√
Management of waste materials, including hazardous waste.	–	√
Purchase of goods and services.	–	–
Employment and expenditures.	–	√
Operation		
Labour, equipment and materials transport to the site.	–	√
Movement and maintenance of vehicles and heavy equipment on site.	–	√
Handling and use of explosives, including blasting.	–	√
Ore extraction from pits including drilling and hauling of waste rock.	–	√
Ore, waste rock and tailings storage.	–	√
Ore processing including conveyor, crushing, loading and hauling on site.	–	√
Transportation of concentrate to a smelter or a wharf.	–	√
Management and treatment of water on the mine site and to the environment, including drainage and contact water.	–	√
Progressive reclamation of disturbed areas.	–	√
Management of waste materials, including hazardous waste.	–	√
Purchases of goods and services.	–	–
Employment and expenditures	–	√

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Physical Activities	Change in Fish Habitat	Change in Fish Health, Growth or Survival
Decommissioning and Closure		
Labour, equipment and materials transport to the site.	–	√
Vehicles and equipment operation and maintenance within the PDA.	–	√
Decommissioning, dismantling and disposal of buildings and equipment.	–	–
Pits flooding, surface and groundwater management.	√	√
Reclamation of disturbed areas, including earthworks, placement of overburden and revegetation.	√	√
Management of waste materials, including hazardous waste.	–	√
Purchases of goods and services.	–	–
Employment and expenditures.	–	√

Note:

√ = Potential interaction

– = no interaction

Activities during construction that will not interact with fish or fish habitat are:

- Mobilization of construction equipment and materials onsite;
- Vehicle and equipment operation within the PDA;
- Waste management, including collection, temporary storage, and hauling of solid hazardous and non-hazardous waste to offsite facilities;
- The purchase of goods and services.

These activities will not interact with fish or fish habitat because they will occur on land, involve the use of vehicles on roads (not the construction of the roads), and will not result in any discharge of contaminants to water unless a result of an accident or malfunction.

Activities during operations that are not expected to interact with fish or fish habitat are :

- The transportation of ore to a process facility.
- Waste management activities.
- Vehicle and equipment operation within the PDA.

None of these activities will interact with fish and fish habitat because they will occur on land and, except in the case of an accident or malfunction, will not occur near water, require water, or have the potential to produce run-off that may contaminate any fish-bearing or non-fish-bearing waterbody.

Activities associated with maintenance and management of mine rock stockpiles, overburden, and the tailings management facility, ore processing, and progressive reclamation of disturbed areas during operations have the potential to affect fish health, growth, or survival due to their potential contribution of contaminants to the mine effluent. However, none of these activities will affect fish habitat because none of these activities require the alteration, disturbance, or destruction of any new habitat that has not already been disturbed during construction.

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Activities that are not expected to interact with fish or fish habitat during decommissioning and closure are those involved in:

- The removal of mine infrastructure, powerlines, and potable water and sewage systems.
- The operation of vehicles within the PDA.

None of these activities will interact with fish and fish habitat because they will occur on land. Further, these activities will not directly affect fish habitat and can be conducted without increasing erosion or sediment transport to fish-bearing watercourses. Reclamation activities will require placement and grading of topsoil. While this activity has the potential to increase sediment loads and TSS concentrations in nearby fish-bearing watercourses, this is a potential effect to fish health, growth, and survival and not to fish habitat.

The employment of the labour workforce activity has the potential to interact with fish and fish habitat because of the potential for increased fishing pressure created by the presence of the labour workforce during all mine phases. This activity only has the potential to affect the health, growth, or survival of fish.

18.4 Assessment of Residual Impact on Fish and Fish Habitat

18.4.1 Analytical Assessment Techniques

18.4.1.1 Change in Fish Habitat

Potential effects of the Project on fish and fish habitat were assessed quantitatively where numerical data and model results were available, and/or qualitatively when numerical data was not available.

Quantitative assessment methods included:

- Geographic information system (GIS) analysis of the PDA overlain on habitat maps of watercourses and waterbodies which provide fish habitat, both direct and indirect, to delineate and calculate potential habitat losses under the mine footprint.
- Comparison of hydrology predictions to the historical climate conditions projected over 21 years of operations and the climate change scenarios predicted for 21 years of operations (Chapter 11).
- Comparison of surface water model flow predictions to the federal Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada (DFO, 2013). As per DFO (2013), flow increases or decreases over 10% of current baseline conditions were further assessed by comparing predicted flood flows (100-year return period, 24-hour duration event; Q_{100}) to the baseline condition flood flow to assess potential flooding and erosion. Flow reductions over 10% were compared with environmental flows, which were adjusted to account for climate change.

Qualitative assessment methods were conducted using a weight-of-evidence approach. This entailed the use of professional judgement based on an understanding of the potential effect, the habitat preferences and life histories of potentially affected fish species in the LSA, and the likely effectiveness of mitigation measures, supported by scientific literature, industry best management practices, and regulatory guidelines, as applicable.

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18.4.1.2 Change in Fish Health, Growth, or Survival

Potential effects of the Project on fish health, growth, and survival were assessed quantitatively when model results were available, and/or qualitatively when model results were not available. Quantitative assessment methods included:

- Comparison of predicted concentrations of Parameters of Potential Concern (PoPCs) to provincial and/or federal water quality guidelines for the protection of freshwater aquatic life.

Predicted PoPCs identified in the Water Quality Assessment (Chapter 12), were assessed for their potential effects on fish health, growth, and survival. This is because PoPCs are, by definition, the water quality parameters predicted to exceed provincial and/or federal water quality guidelines for the protection of freshwater aquatic life and be higher than baseline concentrations.

Predicted PoPCs do not necessarily mean that adverse effects will occur in fish or aquatic biota. This is because guidelines are typically developed to protect the most sensitive species at a provincial or federal level (which may not be present at the site) and often incorporate uncertainty factors and include conditions that may not be relevant at a local or regional level. In addition, some guidelines do not incorporate the most recent science about the toxicity of a parameter to fish or aquatic biota. Therefore, PoPCs were used to flag parameters that required evaluation to determine whether adverse effects to fish and aquatic biota are likely to occur at the concentrations predicted by the water quality models. Methods to assess potential effects of PoPCs on fish health, growth, and survival were applied in the following order:

- Assess the appropriateness of the guideline to the aquatic biota and fish species present in the LSA;
- Evaluate co-occurrence of parameters that may influence the toxicity of the PoPCs (e.g., water hardness, temperature, pH) based on the scientific literature and the site-specific concentrations of these factors at the site;
- For PoPCs known to bioaccumulate (e.g., mercury and selenium), use available scientific literature on bioaccumulation in aquatic biota and fish species, or appropriate analogs, present in the LSA;
- Assess the potential acute and/or chronic toxicological effects of the PoPCs exceeding guidelines, focusing on effects to survival, reproduction, development, or growth that could have population-level effects.

Qualitative assessments were conducted using a weight-of-evidence approach for other potential Project interactions with fish health, growth, or survival. This entailed the use of professional judgement based on an understanding of the potential effect, the habitat preferences and life histories of potentially affected focal fish species in the LSA, and the likely effectiveness of mitigation measures, supported by scientific literature, industry best management practices, and regulatory guidelines, as applicable.

The assessment of potential effects of the Project on fish health, growth, and survival were assessed quantitatively when model results were available, or qualitatively when model results were not available. Two models (Chapter 11 and 12) were considered for estimating the hydrological regime: 1) HST - Historical climate conditions projected for year 21 of operations, and 2) CC - Climate change scenarios predicted for year 21 of operations (Chapter 11 and 12). It is expected that future climate conditions

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provide conservative model results. Where required, baseline surface water quality parameters (e.g., hardness, pH, DOC concentrations) were used as inputs.

The analytical assessment was completed by comparing predicted concentrations of water quality parameters with applicable guidelines. The developed models do not provide individualized concentrations for each of the designed mine structures during year 21, or the applicable hydrological regime of each structure. Rather, the model provides the maximum concentrations of the water quality parameters that are expected for all mining effluent regardless of origin and hydrological regime (i.e. no differentiation between waste rock effluent, pit walls, or tailings seepage). Therefore, the composition of all contact water (i.e., water in contact with the waste rock and ore deposits, and seepage water from the tailings facility) was defined by the outcome of the model, regardless of the projected mine infrastructure (Chapter 12).

Canadian water quality guidelines for the protection of aquatic life used in this assessment are derived to protect the most sensitive species and, therefore, the assessment is considered conservative.

18.4.2 Change in Fish Habitat

18.4.2.1 Project Pathways

Ten Project components or activities were identified as having the potential to affect fish habitat in lac Amont, lac A, and Bibou Creek and its tributaries: eight (8) during construction, one (1) during operations, and one (1) during decommissioning and closure. They include activities that require the removal of riparian vegetation (e.g., trees, shrubs), the excavation, removal, and deposition of topsoil and overburden material, the diversion and storage of surface water runoff, the draining and infilling of watercourses and waterbodies, the storage of tailings, ore, and waste rock, and the construction and decommissioning of stream crossings (including physical crossing structures and spanning waterbodies for transmission lines). These activities fall under the following pathways of effects (DFO 2024):

- Use of machinery on land/alteration of riparian vegetation;
- Use of machinery in water;
- Placement of materials in water;
- Removal of materials and aquatic vegetation from water;
- Water level/flow modification;
- Water diversion;
- Dewatering;
- Detonation in or near water;
- Introduction of underwater noise.

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When taken together, these activities may affect fish habitat in the following ways:

- Alteration, disruption of fish habitat beneath mine infrastructure;
- Alteration of stream flows downstream of the Project due to diversion or storage of surface water runoff;
- Alteration of fish passage at new stream crossings.

Potential effects of these Project activities, prior to mitigation, are described under these headings in the following subsections, organized by Project phases.

Alteration, Disruption, or Destruction of Fish Habitat

Alteration and loss of fish habitat will occur during the construction phase of the Project. Various Project activities, including vegetation clearing, stripping, grading, excavation, and dewatering of waterbodies and watercourses within the PDA are required to build various Project components, including waste dumps, pits, drainage ditches, and sedimentation basins. These activities will result in the loss of fish habitat within the PDA, the dewatering of fish habitat in tributaries of Bibou Creek, and the dewatering of fish habitat affected by water management infrastructure. Potentially affected fish habitat is located primarily in Bibou Creek and the main unnamed tributary of Bibou Creek, which is fed by a series of small lakes upstream.

Alteration or loss of fish habitat may reduce the productivity in fish populations that use the habitat for either some or all of their life history. A reduction or loss of wetted habitat area, through direct overprinting or through loss of connectivity, can lead to lower amounts of area suitable for fish occupancy, recruitment, growth, and survival. Various scientific papers have established that fish population and carrying capacity are proportional to the size of the wetted area available to fish (Bradford et al. 2014).

Alteration or loss of fish habitat in riverine systems can also affect fish habitat downstream through changes in sediment transport, nutrients, and food supply. Changes in sediment transport resulting from upstream habitat loss or changes in flow regime can alter the dynamic equilibrium of a river's channel morphology and the physical habitat it provides to fish and other aquatic biota (Montgomery 1996). The loss of vegetation, including instream and riparian vegetation, associated with habitat loss can also reduce nutrient, carbon, and invertebrate inputs which can reduce the productivity of fish populations in downstream areas (Bradford et al. 2014).

The pathways of effects on fish habitat as it relates to the alteration, disruption or destruction of fish habitat are described by Project phase and activity in the following subsections.

Construction

Generally, road construction, including surface water preparation can affect fish habitat through direct and indirect disturbance. The proposed relocation of the mine site access road will include the development of new watercourse crossings and may require clearing of riparian vegetation. But the proposed relocation will realign the existing mine site access road to the east of the tailings storage facility which does not afford fish habitat (Appendix G1.3). Similarly, the transmission line relocation is not predicted to affect fish habitat. Transmission lines typically span watercourses overhead but may affect fish habitat through

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removal and maintenance of riparian vegetation or through temporary vehicle/equipment crossings. Similar to the mine site access road, no new watercourse crossings as part of the transmission line are proposed in fish habitat and therefore, no disturbance to fish or fish habitat is predicted. The relocation of the mine site access road and of the transmission line are not assessed further.

Construction of permanent and temporary buildings within the PDA, water management infrastructure (including domestic wastewater treatment systems, collection and distribution of drinking water, drainage ditches, sedimentation basins, and the tailing management facility water treatment plant), development of mining infrastructure (including waste stockpile, pits, and raising the tailing management facility) will include various activities such as vegetation clearing, stripping, grading, and excavation earthworks, and water management that will result in the permanent loss of fish habitat within Bibou Creek and its tributaries as well as some tributaries to lac A at the northeast end of the PDA. These habitat losses may negatively affect the productivity of local fish populations by reducing the amount of available habitat for various life stages (e.g., spawning, rearing, overwintering, migration) and altering sediment transport, nutrients, and/or flood supply to fish habitat downstream of the PDA.

Construction of the Bibou Creek Diversion Channel will involve vegetation clearing, stripping, grading, and dewatering of fish habitat in the mainstem and tributaries of Bibou Creek in the PDA. The diversion of Bibou Creek will connect the Bibou Creek to an existing watercourse, which has a confluence with the outflow of lac A north of the PDA. Similarly, the PDA at the northeast will result in the loss of fish habitat in the watercourses which convey flows from lac B (PE29) to lac A (Map 18.3). Loss of fish habitat associated with Bibou Creek and tributaries of lac A may negatively affect the productivity of local fish populations by reducing the amount of available habitat for various life stages (i.e., spawning, rearing, overwintering, migration) as well as reducing sediment transport, nutrients and/or food supply to areas of fish habitat downstream of the PDA.

Operations

Changes to fish habitat related to flow reduction are predicted in the Bibou Creek Diversion Channel and at the outlet of Lac A through a reduction of flow (Chapter 11). The outlet of lac Amont is not expected to be affected, with reduction/increase in flow to be 10% or less in the modeled scenarios and the outlet of the sub-basin is also predicted to be less than a 10% reduction (Chapter 11). As described in Chapter 11, the reduction of flow in Bibou Creek Diversion Channel at lac A is predicted to be a reduction of 35% and the outlet of lac A will experience a reduction in flow from 10 to 15%. A change in flows can affect fish migration and passage between habitats and prevent fish from completing part of their life history strategies. Connectivity may be maintained hydrologically; however, water depths or flows may be unsuitable for fish to successfully use the watercourse or a change in flow could affect access to and use of spawning habitat.

Decommissioning and Restoration

No Project activities during the decommissioning and closure phase of the Project are anticipated to result in loss of fish habitat not already impacted by activities occurring during the construction or operation phases.

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Alteration of Stream Flows

The Project has the potential to alter stream flows in Bibou Creek, lac A, the waterbody that will be connected to the Bibou Creek diversion, and waterbodies downstream of the PDA during construction, operations, and decommissioning and closure phases. Project activities that may affect stream flows include construction and operation of water storage infrastructure (e.g., ditches), dewatering of natural watercourses and waterbodies within the PDA, and construction and operation of water diversion channels (Chapter 11).

Alteration of the natural flow regime has the potential to affect the timing and magnitude of spawning migrations, alter the timing of access to habitat, alter the amount of available wetted habitat, and alter the hydraulic variables (i.e., water depth, water velocity) important to various fish life stages (e.g., spawning adults). For example, reductions in stream flows in the summer (i.e., low flow conditions) may decrease habitat availability and increase barriers to fish passage. Alternatively, increases in stream flows in the winter (i.e., high flow conditions) can cause scouring, bank erosion, and increased sediment suspension which may reduce primary production and nutrient loading in watersheds (Clarke et al. 2008).

White suckers and walleye that use habitat potentially affected by changes in flows may be more than other fish species because walleye, and occasionally white sucker, spawn in swift-flowing riffles; habitats are vulnerable to changes in stream flow (Clarke et al. 2008).

Construction

During construction, the water management infrastructure, including ditches, sumps, and sedimentation ponds, will be constructed to collect, manage, treat and discharge contact water from mine components to the Bibou Creek Diversion Channel and downstream to lac A. The Project is anticipated to have up to five final discharge points for treated effluent, which will include discharge of effluent into a tributary of lac A and into the Bibou Creek Diversion Channel (Figure 18.3).

Construction of the Bibou Creek Diversion Channel will result in the diversion of flows out of lac Amont and out of the mainstem of Bibou Creek and around the PDA. The channel will convey non-contact water from lac Amont around mine infrastructure and contact water through up to three discharge points before reconnecting with lac A downstream of the PDA. Similarly, construction of mine infrastructure on the northeast end of the PDA will change flows out of lac A by up to -15%.

Other construction activities within the PDA are not expected to require instream or near-stream works and should not alter flows through culverts or existing crossing structures along the existing alignments.

Operations

Flows in Bibou Creek and in the tributaries to lac A may be affected by storage of surface water runoff captured in the collection ditches, ponds, and sumps for use in the processing plants, truck washes, dust suppression, and the tailings management facility. The primary source of potential water losses to waterbodies from the Project are in the tailings deposited in the tailings management facility.

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Decommissioning and Closure

During decommissioning and closure, the open pits will be filled with water from direct precipitation, local run-off, and gravity-fed contact water from the site, as well as groundwater, until a pit lake is formed.

Alteration of Fish Passage

The diversion of Bibou Creek will maintain connectivity between lac Amont and lac A. Within the LSA to the west of the PDA there is a series of waterbodies and watercourses that are oriented from southwest to northeast with flow to the northeast. This series of waterbodies and watercourses has a confluence of the tributaries that outlet from lac A approximately 4.5 km north of the PDA.

Fish swim performance data is available (Katopodis and Gervais 2016) which is necessary to support evaluation of effects of potential barriers on fish passage. Fish size, morphology, and life stage influence the swimming abilities of fish (Koehn and Crook 2013). Juvenile and small-bodied fish possess weaker swimming abilities than adult and large-bodied fish (Domenici 2001, Rodgers et al. 2014) as larger fish have more muscle to propel them through the water (Tillinger and Stein 1996). Fish communities in the LSA include various small-bodied fish and large-bodied fish species and life stages. It is expected that small bodied species and early life stages (e.g., juvenile burbot) in these areas will be more susceptible to potential adverse effects of stream realignments.

18.4.2.2 Mitigation Measures

Mitigation measures to avoid or reduce potential effects to fish and fish habitat were selected based on provincial and federal regulations and policies, best management practices and guidelines, and relevant peer-reviewed literature. References to the following documents were made in identifying appropriate mitigation measures for this Project:

- Measures to Protect Fish and Fish Habitat (DFO 2025d);
- Code of practice: Beaver dam breaching and removal (DFO 2023a);
- Interim code of practice: Temporary cofferdams and diversion channels (DFO 2020a);
- Interim standard: In-water site isolation (DFO 2023b).

The Project followed a hierarchical approach to reduce changes in fish habitat as outlined by DFO's Fish and Fish Habitat Protection Policy Statement (DFO 2019). This hierarchy involved implementing avoidance measures that eliminated potential change in fish habitat in space or time before applying mitigation measures to reduce any effects.

Mitigation measures designed to avoid or reduce potential changes in fish habitat caused by the Project are:

- Reduce the Project footprint within the Bibou Creek watershed and the tributaries of lac A to the extent possible;
- Avoid placement of mine infrastructure within tributaries to lac A and within the headwaters of the Bibou Creek watershed, south of the PDA;

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- Construct the Bibou Creek Diversion Channel to reduce potential for flow reductions in lac A, downstream of the PDA;
- Maintain flow from lac Amont on the east side of the PDA to lac A through Bibou Creek or its Diversion Channel through natural channel design (e.g., Rosgen 2011);
- Maintain fish passage through Bibou Creek and its Diversion Channel to support fish movement between lac Amont and lac A (Appendix C.4);
- Develop a site-wide Water Management Plan for the Project (Appendix C.14). This Plan will include measures to:
 - Divert clean, non-contact water around the Project site so that it reports to its natural watershed, to the extent possible
 - Capture run-off in collection ponds during construction (reducing potential for contamination of watercourses) to provide start-up water for the operation activities
 - Recycle water between the processing plant and water collection ponds
- Develop an Environmental Protection Plan for the construction phase of the Project. This plan will include measures to:
 - Isolate instream work areas and implement erosion and sediment control measures suitable for the local site and flow conditions;
 - Maintain downstream flow when conducting in-water construction activities;
 - Maintain riparian buffers around fish-bearing watercourses and waterbodies near construction activities to the extent possible.
- Development of a Fish Habitat Offset Measures Plan to counterbalance all unavoidable losses of fish habitat in Bibou Creek, its tributaries, and headwater lakes of the unnamed tributary to Bibou Creek. A Conceptual Offset Measures Plan will be developed with input from Indigenous nations, agency staff, provincial fisheries managers, and local stakeholders. This conceptual plan will provide a suite of “in-kind” and “out-of-kind” options that are likely to form the basis for the final Fish Habitat Offset Measures Plan that Troilus will include as part of the Project’s paragraph 35(2)(b) *Fisheries Act* Authorization application to DFO. An overview is provided in Section 18.4.2.3.

18.4.2.3 Project Residual Effects

Alteration, Disruption, or Destruction of Fish Habitat

Spatial Area

Based on field data (Appendix G1.3), waterbodies were evaluated for their potential to support aquatic life either directly or indirectly. It is estimated that the PDA supports a total area of 1,241.6 ha of fish habitat. The Project is anticipated to result in the unavoidable HADD (both temporary and permanent) of approximately 164.2 ha of fish habitat (Table 18.6). The majority of affected habitat is located within Bibou Creek and its tributaries, with a smaller proportion on the east side of the LSA in tributaries to lac A. Maps depicting the location of potentially affected habitat are provided in map 18.3.

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Table 18.6 Initial Estimate of HADD Associated with the Project

Description	Residual Effect	Area Affected (ha)
Habitat alteration and destruction as a result of Project structures or overprinting	Permanent change in fish habitat	156.9
Habitat alteration as a result of instream temporary construction activities	Temporary change in fish habitat	7.2
Total Change in Fish Habitat		164.2

In Bibou Creek, potentially affected fish habitat includes existing natural channel, and the reach realigned during previous mine operations, is approximately 9.7 km long. The main unnamed tributary to Bibou Creek will be lost along its entire reach, approximately 2.7 km and the chain of associated headwater lakes. A portion of the upper reaches of tributaries along the west side of Bibou Creek will be maintained and support the Bibou Creek Diversion Channel.

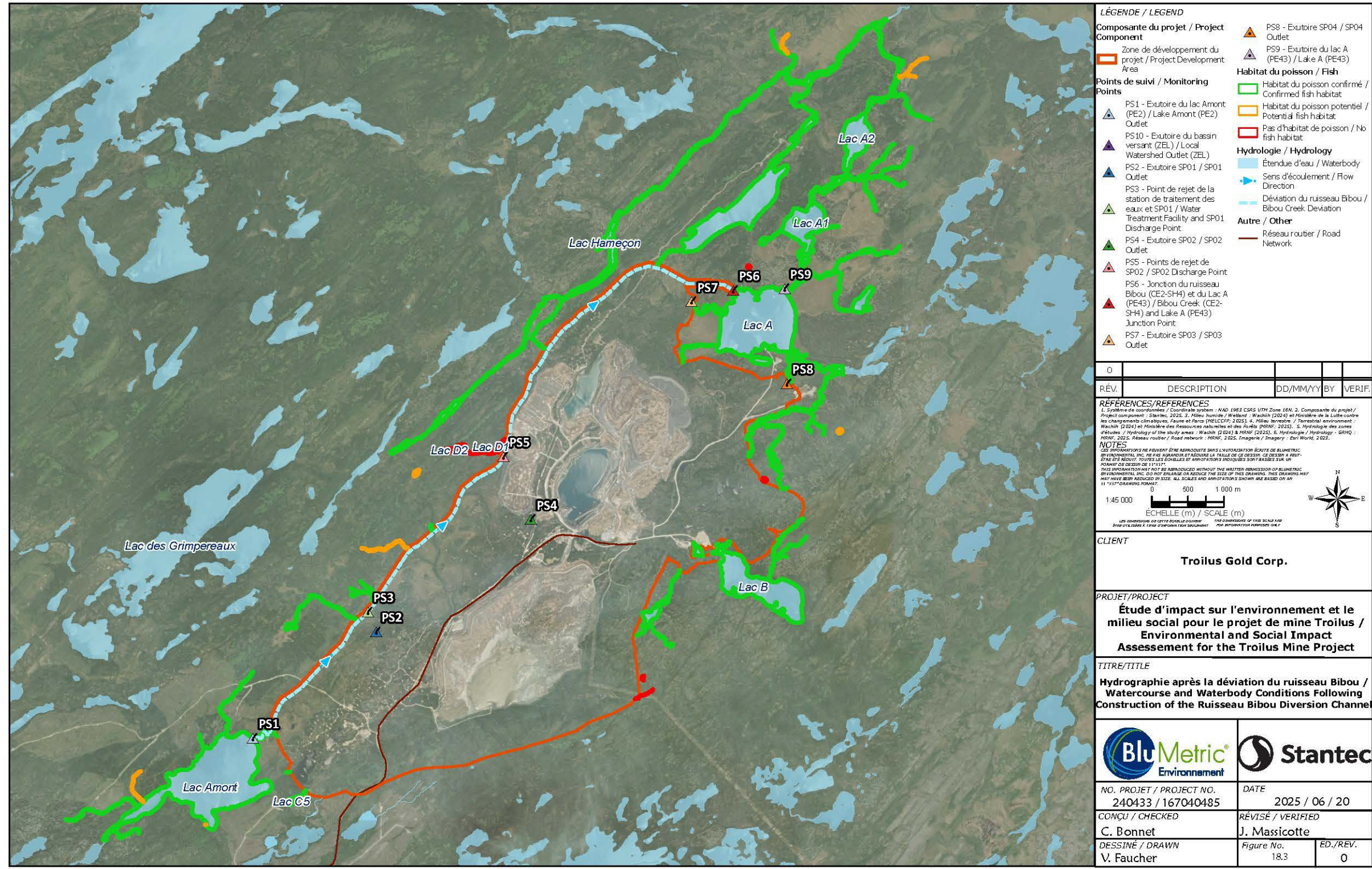
Similarly, along the eastern side of the PDA, the watercourse that flows from the outlet of lac B (PE29) north to lac A will be affected. A reach of approximately 2.4 km will be affected between lac B (PE29) and lac A as well as a reach approximately 1.7 km in length which is a tributary to lac A and will be overprinted by mine infrastructure, including sediment pond 04.

The Bibou Creek Diversion Channel will be designed to support fish habitat and maintain habitat access between lac Amont and lac A. The Bibou Creek Diversion Channel will serve as partial compensation of the HADD associated with construction of the Project. Table 18.7 provides the areas expected to experience HADD and areas that will be developed as part of the Bibou Creek Diversion Channel. It is anticipated that the development of an Offset Management Plan as part of the *Fisheries Act* Authorization process will involve the development of additional concepts to further contribute to compensation of HADD associated with the Project.

Table 18.7 Initial Quantitative Analysis of Project Effects and Habitat Gains

Description	Habitat Alteration (ha)	Habitat Gained (ha)
Permanent HADD	-156.9	+54.8
Temporary HADD	-7.2	
Totals	-164.1	+54.8
Net Habitat Area		-109.3

Map 18.3 Watercourse and Waterbody Conditions Following Construction of the Bibou Creek Diversion Channel



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Alteration of Stream Flows

Flows used for the assessment were based on existing conditions following decommissioning of the previous mining operation against which Project-related changes to stream flows during construction, operations, and decommissioning and closure phases were compared (see Chapter 12).

The Project has the potential to affect northern pike in particular due to the reduction of flow during spring freshet (Figure 11.13 of Chapter 11). The typical annual cycle suggests freshet typically occurs from early to late May with flows up to 7 m³/s. During construction, the predicted reduction in flow will see the timing of freshet remaining relatively similar to existing conditions; however, peak flows are predicted to be reduced to approximately 6 m³/s (Figure 11.13, Chapter 11). This change in freshet magnitude is not predicted to occur at the outlet of lac A and is therefore likely mostly dependent upon habitat use and access in Bibou Creek (Figure 11.14, Chapter 11). Northern pike tend to spawn shortly after the ice comes off in the spring and usually select weedy bays or flooded riparian vegetation. A reduction in flow could limit the area of available flooded riparian vegetation and suitable spawning areas for northern pike, ultimately resulting in a loss of spawning habitat for northern pike.

The reduction in flow may affect fish passage through overall reduced water levels making some barriers identified as passable during high flows, impassable with the reduced flows as a result of the Project. This will result in a loss of fish habitat as fish cannot migrate past these barriers which could prevent them from accessing spawning, rearing, or feeding habitat. Reduced flows have the potential to result in a loss of fish habitat due to a lack of access. This effect is predicted to be predominantly on the east side of the Project because Bibou Creek will be diverted into a constructed channel and will bypass existing barriers.

Finally, the overall reduction in water levels may affect overwintering habitat. Given the shallow depths of Bibou Creek, it may not be used for overwintering by fish in the area as it may freeze to bottom. Few pools were noted (Appendix G1.3) and therefore, the most suitable overwintering habitat is likely located in lac A and lac Amont. If fish are still able to access both lakes, there is potential that the overall reduction in water levels could result in a smaller water volume under ice. This could limit the amount of dissolved oxygen in the water column over winter and could result in a loss of suitable overwintering habitat, particularly for fish that are not as tolerant of low dissolved oxygen. In addition to this, a reduction in water levels could reduce spawning habitat for species such as burbot which rely on shallow sandy shoals for successful spawning. The reduction in flows could result in a loss of spawning habitat for burbot in lac A. This littoral habitat is also valuable rearing and nursery habitat for small-bodied fish and a reduction of water levels could affect rearing and nursery habitat for all fish species.

Alteration of Fish Passage

The Project has the potential to alter fish passage through the construction of mine infrastructure such as water diversions associated with the water management infrastructure.

Alteration of fish passage on the east side of the PDA is not anticipated to occur due to the construction of haul and access roads or the realignment of the transmission line because no new watercourse crossings in fish habitat are proposed, and any transmission line crossings will span waterbodies so will not affect fish passage. In addition, the Bibou Creek Diversion Channel will be designed to allow

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unobstructed fish passage along its entire length and will maintain connectivity between lac Amont and lac A.

Alteration of fish passage on the east side of the PDA is expected as a result of the alteration of the watercourse between lac B (PE29) and lac A. Changes to this habitat as a result of overprinting by the Project infrastructure will prevent fish from migrating between the two lakes as the watercourse will no longer be present or accessible to fish that may move between the lakes or utilize the watercourse.

18.4.3 Change in Fish Health, Growth, or Survival

18.4.3.1 Project Pathways

Seventeen different Project components or activities have the potential to affect fish health, growth or survival in the watershed: seven activities during construction, seven activities during operations; and three activities during decommissioning and closure . They include activities that require the removal of riparian vegetation, the excavation, removal and deposition of topsoil and overburden material, the diversion and storage of surface water runoff, the draining and infilling of watercourses and waterbodies, the drilling, blasting, transportation, and processing of rock, the storage of tailings, ore, and waste rock, the release of air-borne contaminants, and the discharge of mine effluent. These activities fall under the following pathways of effects (DFO 2024):

- Use of machinery on land/alteration of riparian vegetation;
- Use of machinery in water;
- Removal of materials and aquatic vegetation from water;
- Water level/flow modification;
- Water diversion;
- Dewatering;
- Detonation in or near water.
- Introduction of underwater noise (including sensory disturbance as a result of continuous or impulsive sound nearby fish-bearing watercourses and waterbodies)

Potential effects of these Project activities, prior to mitigation, are described in the subsections below, organized by Project phase.

Increase in Total Suspended Solid Concentrations

Increases in TSS created by Project activities or components may occur during all phases of the Project. Increases in the concentration of suspended solids in the receiving environment may result from the disturbance and resuspension of bed material during in-water construction, through land disturbance (e.g., grading, vegetation clearing), or dust deposition generated from blasting in a pit, crushing of rock in the processing plant, and/or road traffic.

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Exposure to increased TSS can affect the health of fish and lower trophic organisms, with effects ranging from minor physiological stress to mortality. The nature and extent of the adverse effects to fish and other aquatic organisms are influenced by the concentration of TSS, particle size, and length of exposure (Bash et al. 2001; Kjelland et al. 2015; Fondriest Environmental Inc. 2013). If TSS concentrations are elevated for an extended period of time, TSS can result in adverse effects on fish and other aquatic organisms as a result of gill abrasion, reduced feeding efficiency, and avoidance of impacted areas (Newcomb 1994; Kejelland et al. 2015; Bash et al. 2001; Miner and Stein 1996). Increased TSS can also result in diminished water clarity and light attenuation, slowing growth rates and decreasing the abundance of photosynthetic organisms (i.e., periphyton in streams, phytoplankton in lakes, and aquatic vegetation in streams and lakes), organisms that form the basis of the aquatic food web and provide habitat for some fish species such as northern pike and yellow perch.

Suspended sediments may also affect fish and aquatic organisms when particles settle out of suspension and may physically cover substrates and accumulate in interstitial spaces between substrate particles. This can result in the death of fish eggs by smothering and preventing the exchange of gases (e.g., dissolved oxygen, carbon dioxide) between the fish membrane and the water column. Deposition of sediment within interstitial spaces can result in adverse effects to benthic invertebrates and algae as this is typically where they reside and grow. If the rate and/or level of sediment deposition is sufficiently high, it may cover attached algae (i.e., periphyton) and aquatic vegetation which can slow or impair photosynthesis. This can reduce food availability for benthic invertebrates and, subsequently, fish that depend on benthic invertebrates or algae as a food source. Accumulation of suspended sediment in interstitial space may further result in changes to the benthic community composition and decreased feeding rates (Newcombe 1994; Kjelland et al. 2015; Bash et al. 2001) and may be detrimental to the use of impacted habitat for spawning, rearing, and foraging by fish (Bash et al. 2001; Muck 2010).

Given the potentially harmful effects of increased TSS, the CCME Water Quality Guidelines for the Protection of Freshwater Aquatic Life stipulate that an increase in TSS for short-term exposure (i.e., 24 hours or less) should not exceed 25 mg/L above background concentrations and for longer term exposures (i.e., 24 hours to 30 days) should not exceed 5 mg/L above background concentrations during clear flow (CCME 2025). Maximum TSS increases during high flows should not exceed 25 mg/L above background levels when background levels are between 25 and 250 mg/L and not increase more than 10% of background levels when background is greater than 250 mg/L (CCME 2025).

Construction

Project activities and components that require in-water construction have the potential to directly increase TSS concentrations by disturbing and suspending sediment from the bed of the waterbody. Specifically, activities associated with the installation of water management infrastructure, including construction of collection ponds, and diversion channels for contact and non-contact water may disturb sediments and have the potential to increase TSS concentrations. In addition, increases in TSS concentrations may occur due to the construction of the Bibou Creek Diversion Channel. Site preparations and activities on land (e.g., clearing, grading) also have the potential to increase TSS in the receiving environment through erosion and site runoff.

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Operations

During operations, there is potential for an increase in TSS concentrations through the operation of water management infrastructure such as the collection and diversion ditches, collection ponds, and discharge of contact water from mine components to the receiving environment. Discharge of effluent into the Bibou Creek Diversion Channel and the unnamed tributary to lac A also has the potential to result in an increase in TSS in the receiving environment. Changes in natural erosion and sedimentation conditions in the Bibou Creek watershed and the lac A watershed may also occur during operations due to alteration of their natural flow regimes within and downstream of the PDA.

Decommissioning and Closure

During decommissioning and closure, dismantling and removing infrastructure near water may temporarily increase TSS concentrations in watercourses downstream of the PDA. This phase will focus on reclamation, establishing physical, chemical, and biological stability at the site and to meet desired end land functions and uses. Pit lake discharge is not expected to be a substantial source of TSS because suspended sediment is expected to settle to the bottom of the pit over the years required to fill the pit.

Change in Surface Water Quality

Changes in water quality in the downstream receiving environment because of Project activities or components may occur during all phases of the Project. Changes in water quality in Bibou Creek and lac A may result from the discharge of mine effluents. Discharge of the mine effluent may introduce contaminants currently absent from the surface water prior to the start of the Project or increase concentrations above the effect threshold for an aquatic species such that it may negatively affect the health, growth, and survival of individuals that are part of the populations in the downstream receiving environment. Mine effluent may also introduce contaminants in groundwater into surface waters and, ultimately, fish habitat.

Contaminants that bioaccumulate (i.e., mercury, selenium, arsenic) have the potential to increase in individual organisms as they age and grow and to increase in higher trophic organisms such as predatory fish. At high enough concentrations, these contaminants can become toxic to the aquatic organisms exposed to the effluent causing adverse effects to their growth, survival, and reproduction. High concentrations of bioaccumulated contaminants in fish can pose health risks to wildlife and humans that consume fish as part of their diet. For this reason, the CCME and Health Canada have developed tissue quality guidelines for fish for the protection of wildlife consumers of fish and human consumers of fish, respectively.

Change in Water Temperature

Project activities and components during all Project phases, such as vegetation clearing, pumping and storage of contact water, discharge of treated effluent, and other activities associated with the water management system and site preparations have the potential to alter the temperature regime of the downstream receiving environment.

Changes to water temperature may occur through the mixing of groundwater and effluent with ambient waters downstream or through changes in environmental conditions or processes that mediate

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physicochemical characteristics of surface water. For example, the disturbance or loss of riparian vegetation, increases in nutrient concentrations, and changes to surface water levels and flow can be factors affecting the temperature regime of freshwater environments.

Water temperature influences the rate of chemical and biological processes that occur in freshwater watercourses and lakes. This includes photosynthesis in algal communities, bacterial decomposition of organic matter, and reduction and oxidation reactions in bottom sediments. Fish and other aquatic biota are ectotherms whose internal temperatures match those of the water they reside in. Each species has a range of preferred and tolerable temperatures in which they have evolved to grow and reproduce. Changes in water temperature that exceed these temperature ranges can result in lower growth rates, lower reproduction success, or mortality if water temperatures exceed these ranges for long enough or if fish cannot move to areas with more favorable temperatures for that species. This can therefore affect spawning periods, and available habitat, and result in fish avoiding certain areas as thermal barriers.

Production of Underwater Noise and Vibration

Project activities have the potential to produce underwater noise and vibration through drilling and blasting during construction and operations. Blasting produces high-velocity spherical shock waves as well as introducing high-intensity noise into the aquatic environment through the air and vibrations in the substrate that can affect fish species and their habitats (Popper et al. 2014). Injury or mortality to fish can occur due to shock waves (e.g., instantaneous pressure change) created by explosive detonations, which can rupture internal organs and damage swim bladders. Particle velocities caused by detonation of explosives can also cause injury or death of fish eggs or larval fish. In many fish species, the primary site of damage is the swim bladder, but rupture or hemorrhaging to internal organs (e.g., kidney, liver, and spleen) may also occur.

The water volume affected by the pressure wave produced from blasting is complex and is a function of the depth of the explosion, the water depth, and substrate type (Popper et al. 2014, Faulkner et al. 2006). There are two areas within the affected water volume that pose the highest risk to fish. The first is the immediate vicinity of the explosion where the compressive forces of the shock wave produced from the blast dominate. The second is a more distant area where negative pressure from the overshoot of the gas bubble created from the blast and the reflection of the shock wave from the water surface which can cause cavitation and negative pressures low enough to cause injuries to the swim bladders and other barotraumas, including mortality (Popper et al. 2014). The range of potential effects on fish from blasting include physical injuries and mortality, temporary or permanent hearing loss, changes in behaviour, and mechanical shock to developing embryos.

The effects of underwater noise from blasting on aquatic life are dependent on many factors, including the life history and physiological characteristics of fish species. Fish species most susceptible to injury from blasting are species with swim bladders that function with hearing (e.g., suckers, cyprinids). There is evidence that little to no damage occurs to fish without swim bladders except at very short ranges from in-water blasting (Goertner et al. 1994; Stephenson et al. 2010; Halvorsen et al. 2012).

Body shape and size of fish can influence the degree of injury. Fish that have laterally compressed bodies have a greater surface area to receive shock waves than cylindrically shaped fish. Smaller fish may also

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be more susceptible than larger fish, making early life stages and juveniles more vulnerable (Yelverton et al. 1975).

DFO has developed the Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters (Wright and Hopky 1998), which includes two thresholds to protect fish and fish eggs from the use of confined or unconfined explosives: a 100 kPa peak overpressure threshold to prevent the death of fish and a 13 mm/second PPV to prevent the death of fish eggs. However, DFO now recommends a 50 kPa overpressure threshold based on more recent data from monitoring of seismic exploration in the Mackenzie Delta in 2002 (Cott et al. 2003).

Construction

Blasting may occur near fish-bearing watercourses and waterbodies during construction in areas where bedrock may be at or near the surface. It is expected that there may be drilling and heavy equipment use near fish-bearing watercourses and waterbodies such that noise and vibrations could affect fish in these areas, even if the activity does not occur directly in the waterbody.

Operations

During operations, mining activities will include the development of the open pit and ore extraction. This work is expected to occur in Pit J4 and Pit 87, which are located near the Bibou Creek Diversion Channel and lac A. It is expected that open pits will be excavated by drilling and blasting successive benches and removing the broken rock using large mobile equipment. Blasts will be planned and implemented to optimize the number of explosives used. It is expected that as operations progress, benches will continue down deeper into the pits and the setback distance to fish-bearing waterbodies on the surface will increase as a result.

Impingement and Entrainment of Fish

The Project will require construction of water diversions, dewatering of natural watercourses and waterbodies, and operation of water management systems. These Project activities and components will require the use of temporary water intakes and pumps to dewater from or divert water around fish-bearing waterbodies and watercourses. Freshwater for the processing plant will be from recycled contact water in the collection ponds, while potable water will be supplied by groundwater sourced from water wells. Since these are not fish-bearing water sources, they will not require water intakes or fish screens.

Use of water intakes has the potential to impinge or entrain fish that could result in mortalities. Impingement occurs when a fish becomes trapped against an intake screen and the fish is unable to free itself. Entrainment occurs when a fish is drawn completely into an intake, this may be through a screen or through an unscreened intake.

The effects of impingement and entrainment are influenced by the location and flow rate of the intake (Fedorenko 1991). Survival from impingement is species and life stage specific, with physiological features playing a key role (Hogan 2015). Planktonic species, including larval fish or fish eggs, are particularly vulnerable to impingement and entrainment due to their limited ability to swim against the intake current (Fedorenko 1991). Whether an organism becomes impinged or entrained depends on the

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size of the intake screen compared to the size of the organism, the flow rate through the intake screen, and the swimming ability of the fish.

DFO has developed an interim code of practice: end-of-pipe fish protection screens for small water intakes in freshwater (DFO 2020b). This code of practice provides guidance on the design, installation, and maintenance of small end-of-pipe water intake fish screens to prevent impingement and entrainment of fish. This code of practice only applies to small water intakes up to 0.150 m³/s and if no aquatic SAR are present in the area.

Death of Fish or Fish Eggs from Stranding or Physical Injury

Project activities during construction and operations have the potential to increase the risk of death of fish or fish eggs from stranding or physical injury. These potential effects are expected to be localized to the watercourses and waterbodies in the PDA that will be dewatered prior to construction of mine infrastructure and in areas where in-water construction below the high water mark needs to be conducted, including construction of the water management system. Effects may also occur if there are changes in the flow regime such that areas used for certain life processes (e.g., egg incubation) become exposed.

Dewatering of watercourses and waterbodies within the Project footprint is required for construction of the pits, stockpiles, and tailings management facilities. Fish present in the watercourses and waterbodies within the PDA will be at risk of stranding, burial, or physical injury during dewatering activities. Species that are slow-moving or weak swimmers and fish eggs and larvae of all species are at greater risk of injury from these activities than adult fish due to their inability to move away from these activities.

Introduction of Aquatic Invasive Species and Disease

Potential change in fish health, growth, and survival due to the introduction of aquatic invasive species and disease may occur during construction, operations, and closure and decommissioning phases of the Project when equipment and machinery are brought onsite from outside the watershed. Similarly, personal equipment (e.g., boots, waders) and sampling gear (e.g., fish salvage equipment) can be contaminated. If this equipment and machinery are contaminated with sediment or with fragments, eggs, spores, rhizomes, seeds, or individuals of aquatic invasive species or diseases prior to their arrival onsite, and if this equipment or machinery is then introduced to watercourses and waterbodies within the PDA, these aquatic invasive species or disease may become established in the watershed to the detriment of native species (e.g., algae, invertebrates, fish populations).

Large amounts of sediment and plant material can accumulate in the tread and machinery of construction equipment if not properly cleaned and decontaminated between work areas. Additionally, construction of water diversions can connect watercourses and waterbodies, which can allow aquatic invasive species to move into new areas (DFO 2024).

Aquatic invasive species can grow quickly once introduced as they often do not have natural predators in their new environment. As a result, invasive species can reduce biodiversity and habitat quality, outcompete and harm native species (DFO 2024), introduce pathogens and parasites, decrease water quality, reduce nutrient transport, and increase eutrophication.

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Increased Fishing Pressure

Improvements to the mine site access road and introduction of a workforce during construction, operations, and decommissioning and closure has the potential to increase fishing pressure on local fish populations. Although it is unlikely that all Project workers are anglers, it is expected that some proportion of the workforce will be, and this influx of anglers has the potential to increase fishing pressure in fish-bearing watercourses and waterbodies within the LSA, including lac Amont, lac A, and Bibou Creek if they are awarded a fishing licence by the Nibiischii Corporation.

Change in Aquatic Invertebrate Communities

The benthic invertebrate community within the PDA will be lost when the watercourses and waterbodies within the PDA are dewatered or diverted during construction of mine infrastructure and ongoing operations of the mine. This loss will lead to elimination of benthic invertebrate biomass in the PDA and lowering the overall benthic invertebrate biomass in the LSA.

Benthic invertebrate communities downstream of the PDA may be affected by changes in water quality, sediment quality, and/or changes in flow. Physiochemical variables related to temperature, sediment particle size, and water chemistry are known to have a considerable effect on benthic invertebrate community composition (Faith and Norris 1989). Changes in water quality in Bibou Creek Diversion Channel, lac A, and watercourses and waterbodies downstream of lac A and the PDA may occur due to discharge of mine effluent. Any change in water quality or sediment quality has the potential to reduce species diversity, with an increased dominance of pollution-tolerant taxa such as chironomids and oligochaetes (Canfield et al. 1994), and/or benthic invertebrate abundance.

Changes in the magnitude, timing, or duration of flows in Bibou Creek Diversion Channel and operation of mine infrastructure and water management infrastructure, and/or filling of the open pit during Closure and Reclamation, has the potential to alter the abundance, diversity, composition, and rate of downstream drift of benthic invertebrates downstream of the PDA. Species that persist in shallow, fast-flowing habitats such as riffles would be more susceptible than species that occupy deeper, slow-flowing habitats, such as runs.

Changes in the aquatic benthic invertebrate community can ultimately affect fish health, growth, or survival since benthic invertebrates serve as a food source for many species of fish. Loss of aquatic invertebrate biomass and changes in species composition can alter the availability and type of food available to fish species. This may result in changes in fish movement to source suitable prey items or in eventual mortality of fish if there is no suitable food source.

18.4.3.2 Mitigation Measures

Mitigation measures to avoid or reduce potential effects to fish health, growth, or survival were selected based on federal regulations and policies, best management practices and guidelines, and relevant peer-reviewed literature. Mitigation measures to avoid or reduce potential effects on fish health, growth, or survival considered the following sources:

- Measures to Protect Fish and Fish Habitat (DFO 2025d);

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- Interim code of practice : End-of-pipe fish protection screens for small water intakes in freshwater (DFO 2020b);
- Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters (Wright and Hopky 1998);
- CCME Surface Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME 2025);
- Decontamination Protocol to prevent the spread of aquatic invasive species (DFO 2025c).

The Project followed the approach outlined in DFO's Fish and Fish Habitat Protection Policy Statement (DFO 2019) to reduce potential changes in fish health, growth, or survival. This approach involved implementing avoidance measures that eliminated potential change in fish health, growth, or survival in space or time before applying mitigation measures to reduce any remaining effects. The following mitigation measures have been incorporated into the design of the Project or are proposed to avoid or reduce Project-related effects on fish health, growth, and survival:

- Limiting the construction footprint (i.e., PDA) to the extent possible to limit the number of watercourses and waterbodies displaced by the Project and avoid larger waterbodies (e.g., lac Amont, lac A). The Project is described in Chapter 3 and the selection of Project alternatives in Chapter 4;
- Constructing the Bibou Creek Diversion Channel under dry conditions to accommodate construction, stabilization, and vegetation growth within the new channel prior to diverting flow from Bibou Creek;
- Prohibiting maintenance or refueling of machinery within 30 m of a fish-bearing waterbody or watercourse;
- Conducting any in-water construction activities during periods of low risk defined by DFO for the Nord-du-Quebec administrative region (DFO 2017) which extends from July 31 to August 31 of each year, unless otherwise approved by DFO. This timing is recommended to protect sensitive life stages of lake whitefish, brook trout, walleye, northern pike, and yellow perch;
- Designing water intakes to reduce disturbance of the beds of watercourses and waterbodies and fitting all intakes with screens that comply with DFO's end-of-pipe fish screen requirements;
- Isolating and dewatering any work areas within watercourses or waterbodies;
- Conducting fish salvages prior to dewatering by a qualified aquatic biologist and releasing captured fish to areas within the same watercourse, outside of the work area, where suitable habitats exist, or in accordance with appropriate permits;
- Requiring machinery, vehicles, and equipment to be clean and in good working order prior to coming to site. Equipment, including personal gear (e.g., work boots), will be decontaminated before entering the watershed and decontaminated when leaving the watershed to prevent the spread of aquatic invasive species;
- Implementing a no-fishing policy in watercourses and waterbodies within or adjacent to the PDA by all Project personnel while on-shift;
- Installing and maintaining appropriate temporary erosion and sediment control measures during construction in accordance with the Project Erosion and Sediment Control Plan;

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- Developing and implementing a site-wide Water Management Plan for the Project (Appendix C.14). This plan will include the following mitigation measures :
 - Divert clean, non-contact water around the Project site so that it reports to its natural watershed, to the extent possible
 - Capture run-off in collection ponds during construction to provide start-up water for the processing plant
 - Use contact water from the open pits and other areas of the active mine as source water for the use in the processing plant
 - Recycle water between the processing plan and the water collection ponds
- Developing and implementing a Construction Environmental Protection Plan that will describe the steps that will be taken to limit environmental impacts during mine construction;
- Developing and implementing an Air Quality Management Plan that will describe the management efforts to be taken to manage the effects of the Project on ambient air quality;
- Developing and implementing an Erosion and Sediment Control Plan that will describe the measures and best management practices to be implemented to protect the environment through reduction of site erosion and protection of nearby watercourses and/or waterbodies from sedimentation;
- Developing and implementing a Vegetation Management Plan that will describe the mitigation approaches for reducing effects on vegetation (including riparian vegetation) and include an Invasive Species Management Plan;
- Developing and implementing a Waste Management Plan that will include procedures for the handling and storage of chemical and hazardous materials;
- Developing and implementing a Spill Prevention and Contingency Plan that will describe the means (internal corporate procedures) by which the spill contingency plan is activated and steps to be taken to report, contain, clean up and dispose of contaminants following a spill, including appropriate contacts for responding to spills;
- Developing an Explosives Management Plan that will describe the safe use and storage of explosives at the Project site. This plan will include consideration of the Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998).

18.4.3.3 Project Residual Effects

Increase in Total Suspended Solid Concentrations

Increased TSS concentrations due to Project activities may occur during all phases of the Project. Potential residual effects are discussed by the Project phases below.

Construction

The main Project activities and components that may result in sediment releases to watercourses and waterbodies are in-water construction activities associated with the water management systems, including drainage ditches, sedimentation basins, the tailings management facility water treatment plant and the

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Bibou Creek Diversion Channel, as well as run-off from land-based activities (e.g., vegetation removal, deforestation, soil stripping, earthworks).

Erosion and sediment control measures will be installed, maintained, repaired, and upgraded, if needed, for the various earthworks and construction activities including clearing, stripping, and grubbing of vegetation, excavation and storage of overburden, preparation of surfaces for infrastructure construction, ditch construction, and dewatering pit excavations to reduce environmental effects. The erosion and sediment control measures will be provided in a Project-specific Erosion and Sediment Control Plan. The PDA, which includes riparian vegetation clearing, will be limited to the smallest practical amount to limit the amount of exposed soils. Vegetation clearing limits will be identified and clearly marked prior to the start of clearing activities and only designated areas will be cleared to limit the potential for erosion and migration of sediment into waterbodies and watercourses. The installed erosion and sediment control measures will be inspected regularly to confirm that the measures are functioning as intended.

Construction of in-water structures are expected to require temporary isolation measures (e.g., cofferdam, turbidity curtain, or other equivalent barrier) to isolate the instream workspace and pumps will maintain downstream flow during in-water works. Isolation methods produce short duration sediment pulses when installing and removing isolation structures resulting in potential changes to fish habitat and plankton abundance and mortality risk due to increased concentrations of TSS. However, these pulses are typically small and can be mitigated using erosion and sediment control measures and by following the applicable measures in DFO's Interim code of practice: Temporary cofferdams and diversion channels (DFO 2020a). A Project Turbidity Monitoring Plan will be developed and followed. If monitoring indicates that TSS concentrations are approaching threshold values, corrective actions will be implemented. If corrective actions are not successful, instream activities may be temporarily suspended until TSS concentrations meet threshold values and effective mitigation solutions can be identified.

With the implementation of mitigation measures and best management practices to reduce the potential introduction of sediment to waterbodies and watercourses downstream of the Project, it is anticipated that the residual effect to fish health, growth, and survival due to increase in TSS from construction of the Project is expected to be adverse, low in magnitude, confined to the LSA, have moderate timing sensitivity, short-term in duration, occur as multiple irregular events, and be reversible.

Operations

During operations, potential sources of elevated TSS concentrations include discharge of effluent into Bibou Creek and a tributary to lac A as well as natural erosion due to altered site runoff conditions.

The Project Site Water Management Plan will be implemented during operations to divert clean, non-contact water around the Project and separate contact water before discharge into Bibou Creek and a tributary to lac A. Non-contact water will be managed separately from contact water to reduce TSS from site runoff entering waterbodies and watercourses, as well as maintain natural flows to the extent possible.

Contact water from runoff, precipitation events, and groundwater inflows will be collected using ditches and sumps. The ditches and sumps will be constructed around Project infrastructure and will direct water into a system of collection and sedimentation ponds for management. The sediment ponds have been

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designed to outlet into the Bibou Creek Diversion Channel and Lac A. It is anticipated that residual effects will be adverse, low in magnitude, confined to the LSA, have moderate timing sensitivity, short-term in duration, occur as multiple irregular events, and be reversible.

Decommissioning and Closure

Decommissioning and Closure of the Project may result in the temporary mobilization of sediments in the receiving environment (e.g., the removal of water management infrastructure). Erosion and sediment control measures will be implemented for decommissioning and closure activities. In addition, the decommissioning and closure phase will focus on reclaiming and stabilizing the site, thereby reducing the erosion and sedimentation potential. Monitoring and maintenance will continue until the physical and chemical characteristics of the site are deemed acceptable and can be closed out in accordance with the MDMER. Therefore, potential increases in TSS during the decommissioning and closure phase are anticipated to have a negligible effect on fish health, growth, or survival.

Change in Surface Water Quality

The evaluation of surface water quality (Chapter 12) predicts exceedances of several surface water quality parameters. Each of these PoPCs are assessed below for the potential to cause lethal or sub-lethal effects to fish and aquatic biota within the LSA. Sulphate and hardness are predicted to increase by an order of magnitude during operations and pH is predicted to be between 7 and 8 (Chapter 12). The surface water quality models uses several stations (or Junctions) to evaluate changes in surface water quality parameters. The stations are provided in Chapter 12. Various PoPCs are dependent upon hardness and pH and are therefore considered in the subsections below.

Potential Effects due to Aluminum

Aluminum concentrations are predicted to exceed the CCME Water Quality Guidelines for the Protection of Aquatic Life – Freshwater Aquatic Long Term (CWQG-FAL) that at all three stations (i.e., Junction 2, Junction 3, and Junction 28) and the station in lac A during operations. This suggests an exceedance prior to and following mixing of effluent with surface water is predicted to occur (Chapter 12). The CCME CWQG-FAL is dependent upon pH; where pH is below 6.5 the aluminum guidelines is 5 µg/L and where pH is equal or greater than 6.5, the aluminum guideline is 100 µg/L (CCME 2025). Existing conditions (Chapter 12) indicate that there are currently exceedances at all four stations; however, once the Project is included, the exceedances are predicted to increase up to over 600 µg/L in lac A following mixing of effluent with the environment.

Aluminum is considered a non-essential element because it does not play an important biological function or provide any beneficial properties to life. Fish and invertebrates can be exposed to aluminum as it can accumulate as a thin layer on external gills and body surfaces. It is also possible for aluminum to accumulate within internal organs over time (e.g., liver, muscle) and is toxic to aquatic life (e.g., Sterling et al. 2020; Closset et al. 2022; Botté et al. 2022). While aluminum is not considered to bioaccumulate, it can result in mortality of aquatic life (Closset et al. 2022). It is therefore predicted that high concentrations of aluminum in lac A could affect the associated fish population by reduction in health as a result of aluminum adsorption and potential mortality.

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Potential Effects due to Copper

Copper concentrations are predicted to exceed the MDMER and Directive 019 concentrations (i.e., 100 µg/L) if effluent has a pH of 6.5; however, if effluent has a pH of 8, then it will meet the MDMER and Directive 019 requirements (Chapter 12). Effluent released at lac A is predicted to meet the MDMER and Directive 019 guidance; however, all four stations are predicted to exceed the CCME CWQG-FAL (Chapter 12). The CCME CWQG-FAL is dependent upon water hardness; where the water hardness is between 0 and 82 mg/L, the CWQG-FAL is 2 µg/L, at a hardness greater than 180 mg/L, the CWQG-FAL is 4 µg/L, and where the hardness is unknown, the CWQG is 2 µg/L (CCME 2025). Hardness is predicted to range from 0 to over 1,300 mg/L, depending upon the scenario. Given this range, a CWQG of 4 µg/L was considered. Therefore, it is predicted that the CWQG will be exceeded at Junction 2, Junction 3, and lac A (with maximum copper concentrations up to nearly 100 µg/L). It is expected that there will be sufficient mixing in the receiving environment such that the station at Junction 28 will be within the CWQG-FAL. Based on the existing hardness (i.e., less than 100 mg/L), the corresponding CWQG would be approximately 2.4 µg/L (CCME 2025). Based on this guidance value, there are current exceedances at all four stations for CWQG-FAL. It is expected that increasing hardness by an order of magnitude will result in exceedances of copper CWQG-FAL during operations.

Copper is a micronutrient essential for metabolic processes and is taken up by aquatic organisms through their diet. Insufficient copper can result in increased larval mortalities and deformities and reduced growth; however, elevated copper concentrations can have acute and chronic effects in aquatic organisms including reduced reproduction and death for algae, macrophytes, invertebrates, and fish. At low concentrations, copper can have sub-lethal effects (e.g., reduced fish swimming abilities, challenges avoiding predators or capturing prey) (Liao et al. 2023) and can result in mortality. It is expected that increased copper concentrations downstream of the PDA may result in sub-lethal effects (e.g., reduced health) or mortality during Project operations.

Potential Effects due to Selenium

Selenium concentrations are predicted to exceed the CCME Water Quality Guidelines for the Protection of Aquatic Life – Freshwater Aquatic Long Term (CWQG-FAL), including the station at lac A. This suggests an exceedance prior to and following mixing is predicted to occur (Chapter 12). The CCME CWQG-FAL is 1 µg/L (CCME 2025) and predicted selenium concentrations reach the highest concentrations, up to 3.9 µg/L in lac A and up to 1.6 µg/L in Bibou Creek. Existing conditions (Chapter 12) indicate that there are not currently exceedances at the monitoring station; however, once the Project is included, the exceedances are predicted to increase up to 3.9 µg/L in lac A following mixing of effluent with the environment.

Selenium can bioaccumulate in the food web, affecting invertebrates and fish, and can result in potential food safety concerns for humans that consume affected fish (e.g., Hamilton 2004; Uddin et al. 2024; Palace et al. 2025). There are no provided CWQC-FAL for acute exposure to selenium; however, chronic exposure can affect fish growth, reproduction, and metabolism (Uddin et al. 2024; Palace et al. 2025). In addition, selenium is neurotoxic, affecting behaviour, and a teratogen which may induce developmental deformities which can persist across generations (Uddin et al. 2024). Hamilton (2004) noted that where aquatic ecosystems have been exposed to elevated selenium concentrations, some have been slow to recover.

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It is expected that exposure to elevated concentrations of selenium over the Project life could affect the food web within the LSA resulting in suboptimal health or death of invertebrates and fish.

Potential Effects due to Cadmium

Cadmium concentrations are predicted to exceed the CCME CWQG-FAL at monitoring stations in Bibou Creek and the station in lac A. This suggests an exceedance prior to and following mixing is predicted to occur (Chapter 12). The CCME CWQG-FAL is dependent upon hardness for both acute and chronic exposure and, as previously discussed, hardness is predicted to increase by an order of magnitude up to a maximum over 1,300 mg/L (Chapter 12). Where water hardness is greater than zero but less than 17 mg/L, the corresponding CWQG-FAL for cadmium is 0.04 µg/L and where hardness is between 17 to 280 mg/L, the corresponding CWQG-FAL for cadmium is developed using the calculation $CWQG (mg/L) = 10^{0.83(\log[\text{hardness}] - 2.46)}$. Where water hardness is greater than 280 mg/L, the CWQG-FAL is 0.37 µg/L (CCME 2025). These exceedances are predicted to exceed the CWQG-FAL of 0.37 µg/L with concentrations above 1.6 µg/L (Chapter 12).

Cadmium can affect aquatic plants (e.g., macrophytes, algae) inhibiting photosynthesis and in both invertebrates and fish cadmium may have sub-lethal effects, such as reduced growth, reduced reproductive success, and reduced metabolic activity, and increased mortality (e.g., Liu et al. 2022; Taysi 2024). Taysi (2024) noted that at 1 mg/L, rainbow trout (*Oncorhynchus mykiss*) experienced oxidative stress in liver and kidney tissue after 24 hours of exposure and that changes in enzymes may result in behavioural abnormalities. Cadmium may also bioaccumulate in fish tissue, particularly gills, liver, kidney, skin, and muscle (Das et al. 2023). It is therefore predicted that exposure of fish populations within the LSA will increase potential sub-lethal and lethal effects during the operation of the Project and could affect the food web within the LSA.

Potential Effects due to Uranium

Uranium concentrations are predicted to exceed the CCME CWQG-FAL (15 µg/L) and the CVAC (14 µg/L) at several stations with an average of 19.4 µg/L (Chapter 12). Invertebrates, a food source for fish, tend to be more sensitive to elevated uranium concentrations than fish (Robertson and Lieber 2007) and this sensitivity has the potential to reduce their abundance (SENES 2009) which has the potential to result in sub-lethal effects in fish due to reduced food abundance (Sherwood et al. 2002a, b).

Potential Effects due to Ammonia

Ammonia is predicted to exceed the CCME CWQG-FAL of 19 µg/L (2025) at stations downstream of the PDA with concentrations up to 132.5 µg/L (Chapter 12). Ammonia toxicity is heavily dependent on pH in which alkaline waters tend to increase toxicity (Ip et al. 2001). Fish can be impacted by ammonia through their central nervous systems which can result in hyperventilation, convulsions and death (Ip et al. 2001). It is therefore predicted that elevated ammonia concentrations will have sub-lethal and lethal effects on fish.

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Change in Water Temperature

Water temperatures in Bibou Creek have the potential to be altered by effluent discharged from the sediment ponds. The water from the sediment ponds will be discharged to the Bibou Creek Diversion Channel. There is potential that the sediment ponds could become thermally stratified in the summer with cooler temperatures at the bottom of the pond and warmer temperatures near the surface. In addition, there are multiple effluent discharge points from the sediment ponds; effluent discharged at night would be cooler than effluent discharged during the day, and the magnitude of this would depend on the difference between ambient air temperatures and temperature of the water in the ponds. It is not expected that water will be discharged through multiple outlets over a period of time so should not affect water temperatures in the Bibou Creek Diversion Channel or lac A. For these reasons, water temperatures of the effluent are not expected to alter water temperatures in the receiving environment.

Deposition of Airborne Contaminants

The deposition of airborne contaminants and their potential to lead to eutrophication and/or acidification of receiving waterbodies is not assessed further; however, potential adverse residual effects on the health, growth or survival of fish and other aquatic biota due to eutrophication and acidification from the deposition of airborne contaminants are predicted to be minimal.

Production of Underwater Noise

Production of underwater noise because of Project activities is anticipated to occur from drilling and blasting for pit development during construction and operation phases and from movement of heavy equipment and drilling during all phases of the Project. Fish species known to be present near the Project have varying sensitivities to underwater noise; white suckers and forage fish species have the greatest sensitivity to underwater noise compared to other focal fish species. This is because they have swim bladders that are mechanically connected to the inner ear by structures called Weberian apparatus (Popper and Hawkins 2018). The Weberian apparatus enhances auditory sensitivity (i.e., wide frequency range and low hearing threshold) by conducting pressure changes produced by externally originating sound waves from the swim bladder to the ear.

All Project blasting would occur on land and not take place within fish-bearing waterbodies or watercourses. Applicable DFO-recommended measures to avoid causing harm to fish from the use of explosives near fish-bearing waters would be followed (Wright and Hopky 1998; DFO 2025d).

Setback distances required to meet DFO's 50 kPa overpressure threshold and the 13 mm/sec PPV threshold for the protection of fish and fish eggs will be calculated using the formula in Wright and Hopky (1998) depending on the charge sizes to be used in the pits during construction and operations. Therefore, residual effects on the health, growth, or survival of white suckers and forage fish due to blasting in the pits are not expected to occur during construction or operation phases of the Project. It is expected that with the application of mitigation measures effects will be negligible.

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Impingement and Entrainment of Fish

The Project will not require any permanent freshwater intakes during construction, operations, or decommissioning and closure. Any temporary water intakes required for dewatering activities or other purposes will have intake screens designed and installed in accordance with DFO's Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater (DFO 2020b). Screens would be sized for the weakest swimming life stage of the weakest swimming fish species present in the affected area (i.e., juvenile burbot). With this mitigation, the number of fish becoming impinged or entrained in the pumps is expected to be low and the potential residual effects to focal fish species are expected to be negligible.

Death of Fish due to Stranding or Physical Injury

Forage fish were chosen as the focal fish species to assess the potential residual effects of death of fish due to stranding or physical injury on fish health growth or survival because:

- Forage fish (i.e., trout-perch, longnose dace, mottled sculpin, and lake chub) because they are small-bodied fish and can persist in pools and interstitial spaces of existing armoured banks to hide and potentially become stranded, which is less likely than large-bodied fish, and these small-bodied individuals can evade fish capture methods such as electrofishing.
- These small-bodied species spend all life stages within the affected areas (e.g., spawning, rearing, overwintering), and would therefore have the greatest potential for all life stages to be susceptible to injury or mortality during in-water construction, including those at greatest risk of injury or mortality (i.e., fish eggs and larvae).

Fish salvages will be completed prior to any in-water construction or dewatering activities within the PDA. Fish salvages will relocate individuals away from impacted areas to limit the likelihood of injury or mortality. It is anticipated that some individuals (e.g., buried eggs, larvae) may not be salvaged and may be affected by Project activities despite mitigation. Therefore, where possible, dewatering and in-water construction activities within fish-bearing watercourse or waterbody would occur during the DFO timing window for work in the Nord-du-Quebec region, which will extend from July 31 to August 31 (DFO 2017) to protect spring, fall, and winter spawning species. Limiting dewatering and in-water construction work during sensitive times will reduce potential interactions between Project activities and important biological activities/life stages occurring within these periods.

With the implementation of mitigation measures, potential residual effects on the health, growth, or survival of forage fish due to stranding or physical injury is expected to be adverse, and low in magnitude. The geographical extent of residual effects will be limited to the PDA. Any residual effects would be short-term, would occur as multiple irregular events, and would not have sensitive timing effects as in-water works will be completed during the recommended timing window. The consequences of death of fish or fish eggs from stranding or physical injury is expected to be permanent at an individual level but reversible at the population level.

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Introduction of Aquatic Invasive Species and Disease

Movement of equipment as well as use of personal gear (e.g., work boots) and sampling equipment has the potential to transfer aquatic invasive species (e.g., organisms, parasites, disease, pathogens) from outside of the watershed. Aquatic invasive species can affect fish health and result in increased mortality. The introduction of aquatic invasive species and disease during construction and decommissioning and closure is not predicted to occur with the implementation of mitigation measures and best management practices, including:

- Equipment will be clean when it arrives at the Project site (i.e., clean of mud/sediment, no vegetation or organisms). Should equipment arrive onsite in a dirty condition, it will be cleaned and reinspected prior to use;
- Equipment that is moving into or between watersheds, will be clean. Should equipment arrive onsite in a dirty condition, it will be cleaned and reinspected prior to use. Cleaning equipment prior to use in and around watercourses and waterbodies will help to remove hydrocarbons, aquatic invasive species, and pathogens potentially present on the equipment;
- A designated area for cleaning and decontaminating equipment will be established located at least 100 m away from a watercourse or waterbody in order to prevent material from flowing into the aquatic environment;
- DFO guidance to decontaminate equipment and gear (DFO 2025c) will be followed.

By implementing the above mitigation measures, the risk of introducing aquatic invasive species and disease to the Project watershed is low. The consequences of potential introduction of aquatic invasive species and disease to the local ecosystem are high. Troilus will develop an Aquatic Invasive Species and Disease Management Plan that will include best industry practices that can be incorporated into all aspects of construction, operations, and decommissioning and closure activities, monitored for compliance and effectiveness, and regularly updated as required.

Increased Fishing Pressure

During all phases of the Project, there will be a workforce present onsite above current staffing levels and this presence provides increased access to fish-bearing waters during the open water season if they are awarded a fishing licence. Increased personnel with increased access may lead to increased fishing pressure, resulting in reduced stock levels. This effect is expected to occur at watercourses and waterbodies that support large-bodied fish, particularly sport fish (e.g., cisco, lake whitefish, brook trout, burbot, northern pike, and walleye) which are desirable species likely to be targeted by recreational angling. Recreational angling can result in mortality of fish due to retaining fish or accidental mortality during angling.

Implementing and adhering to a no-fishing policy by Project personnel in alignment with existing regulations for category 3 lands of the James Bay and Northern Quebec Agreement is expected to be effective in reducing fish mortality due to fishing. The result of this policy will result in personnel having limited opportunities to participate in angling activities near the Project. No angling will be permitted within

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the PDA and no fishing by Project personnel will be permitted near the PDA while on shift, regardless of the Project phase.

Change in Aquatic Invertebrate Community

Aquatic invertebrate habitat within the LSA is dominated by slow-flowing flat habitat comprised of fine-grained substrate and this habitat can support a variety of species, but is typically dominated by the larvae of species of chironomids (non-biting midges) which are small, burrowing taxa well suited to the overall fine substrate in lac Amont, lac A, and Bibou Creek. This habitat and these organisms are relatively insensitive to changes in flow and water quality compared to fast-flowing erosional habitat dominated by EPT taxa. Simpson's Diversity Index for Bibou Creek, lac A, and lac Amont are all relatively low (i.e., less than 0.4), which suggests low diversity; however, substrate within these three waterbodies is dominated by fine material and lower flows, which is generally not preferred by EPT taxa.

Predicted changes in flow are expected to result in decreases of flow from Bibou Creek Diversion Channel into lac A and at the outlet of lac A (Chapter 11). This change in hydraulic characteristics is unlikely to affect chironomids, which are the most abundant taxa (Appendix G1.3); however, available habitat is expected to be reduced as a result of a decrease wetted area through a decrease in flows and through the loss of Bibou Creek, its tributaries, and headwaters (see section 17.4.2). The loss of habitat will result in the death of invertebrates within watercourses to be dewatered and infilled. Ultimately, there is a predicted loss of 109.3 ha of aquatic habitat following construction of the Bibou Creek Diversion Channel, which is expected to result in an overall loss of benthic invertebrate density.

In addition, predicted changes in surface water quality (Chapter 12) are likely to affect benthic invertebrate communities due to exceedances of chronic CCME CWQG-FAL for various parameters (i.e., aluminum, copper, selenium, cadmium, uranium, and ammonia). These CCME CWQG-FAL exceedances are anticipated to reduce overall abundance of invertebrate communities through sub-lethal (e.g., reduced growth) and lethal effects.

Potential residual effects on the health, growth, or survival of fish species in the PDA due to potential changes in the abundance, diversity, and dominance structure of benthic invertebrates are expected to be adverse, moderate sensitivity timing, limited to the LSA, occur for the duration of the Project, and be irreversible.

18.4.4 Summary of Project Residual Impacts

Table 18.8 summarizes Project residual effects on fish and fish habitat. Changes in fish habitat in the LSA will be high in magnitude following implementation of offsetting measures required to counterbalance the unavoidable habitat alterations or losses within the PDA. The magnitude of the residual effect on fish habitat to fish populations is expected to be high but may be reduced following implementation of the offsetting measures within the Bibou Creek Diversion Channel. It is expected that other offsetting measures may be required as part of the Diversion Channel given desktop analysis suggests an area of 109.3 ha will be altered or lost following compensation of the Diversion Channel. Changes to fish habitat within the PDA will be irreversible because the Diversion Channel will remain in place following completion of operations, will be continuous and long-term. Changes to fish habitat within the PDA will be irreversible.

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Changes in fish health, growth, and survival are expected to be driven by the potential effects of changes in water quality due to effluent discharge and changes to the aquatic invertebrate community associated with changes in water quality, changes in flow, and loss of habitat. Together, these effects are expected to result in changes in fish health, growth, and survival that are high in magnitude, long-term, continuous, and extend to the RSA. The residual effect on fish health, growth, and survival is considered irreversible, as effluent discharge will cease at the end of the Project; however, chronic exceedances of multiple water quality parameters will likely have long term consequences to fish populations given the teratogenic nature of some parameters and the known toxicity of others.

Table 18.8 Project Residual Impact on Fish and Fish Habitat

Residual Impact	Residual Impact Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility
Change in Fish Habitat	C, O, D	A	H	LSA	MS	LT	C	I
Change in Fish Health, Growth, or Survival	C, O, D	A	H	RSA	MS	LT	C	I

KEY

See Chapter 7 for detailed definitions

Project Phase

C: Construction
O: Operation
D: Decommissioning and Closure

Direction:

P: Positive
A: Adverse

Magnitude:

NMC: No Measurable Change
L: Low
M: Moderate
H: High

Geographic Extent:

PDA: Project Development Area
LSA: Local Study Area
RSA: Regional Study Area

Timing

NS: No sensitivity
MS: Moderate sensitivity
HS: High sensitivity

Duration:

ST: Short-term
MT: Medium-term
LT: Long-term
N/A: Not applicable

Frequency:

S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:

R: Reversible
I: Irreversible

18.5 Prediction Confidence

18.5.1 Change in Fish Habitat

Confidence in the predicted effects of the Project on fish habitat is moderate. This is because habitat losses under the Project footprint were calculated using aerial imagery and a GIS calculation, which relied on the banks mapped by Wachih (2024). In addition, there are additional habitat evaluations required to be completed in order to understand the distribution of macrohabitat units and how the habitat suitability for each species may change.

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Potential changes in fish habitat due to predicted changes in flow were based on comparison to the thresholds identified in DFO's Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada (DFO 2013). This method is based on comparison of predicted stream discharge to baseline stream discharge. However, this approach does not predict the hydraulic variables that are important to fish (i.e., water depth, water velocity). Therefore, the effect on fish of predicted changes in stream flows greater than these thresholds cannot be predicted with certainty.

18.5.2 Change in Fish Health, Growth, or Survival

Confidence in the predicted effects of the Project on fish health, growth and survival is moderate. This is because the Project mine effluent will exceed provincial and federal effluent standards (Directive 019 and MDMER, respectively) because the models projecting non-compliance at occasional individual stations; however, the parameters that will exceed CCME CWQG-FAL have been studied and described in the scientific literature and predicted by the surface water quality model (Chapter 12). Therefore, potential impacts to fish as a result of elevated concentrations of toxic substances are well understood (e.g., selenium, aluminum, cadmium) which typically result in sub-lethal and lethal effects which can reduce the overall health of fish populations, their reproductive success, and their ability to survive.

Predicted changes in the aquatic invertebrate community are made with moderate confidence, in the absence of detailed hydraulic modelling that would more accurately predict the extent of potential changes in wetted areas and a better understanding of the benthic invertebrate community throughout the entire reach of Bibou Creek. It is also understood that a reduction invertebrate productivity, which is a food source for fish, can affect fish health or result in fish leaving the area to an established food source.

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