5.7 Freshwater and Estuarine Fish and Fish Habitat

5.7.1 Introduction

Freshwater and estuarine fish and fish habitat is a VC because it is recognized by Haisla Nation, the public, and the scientific community to be part of commercial, recreational, and Aboriginal (CRA) fisheries, or species that support such fisheries as defined by the *Fisheries Act*. These fisheries play a role in the local culture, livelihood, lifestyles, and history of Haisla Nation, as well as other Aboriginal Groups and local communities. The Pacific salmon fishery is important to socio-economic activities in the region, including neighboring Aboriginal Groups, local recreation, and larger-scale commercial fisheries that are part of the Pacific Salmon Treaty (1985) between Canada and the U.S.

Freshwater and estuarine fish and fish habitat includes anadromous and non-anadromous fishes and their respective habitats. In the context of the *Fisheries Act*, freshwater and estuarine fish includes:

- parts of fish
- shellfish, crustaceans, and any parts of shellfish or crustaceans, and
- eggs, sperm, spawn, larvae, spat, and juvenile stages of fish, shellfish, and crustaceans.

Fish habitat includes spawning grounds and other areas, such as nursery, rearing, food supply, and migration areas on which fish depend to carry out their life processes. Overwintering fish habitat is a type of rearing habitat that is important for consideration of effects on productivity. Attributes that influence fish life history processes include stream habitat characteristics (e.g., deep pools, undercut banks, large woody debris, overhanging vegetation, instream vegetation, and spawning substrate), riparian vegetation, food production (e.g., small crustaceans and invertebrates), and other potentially limiting factors such as stream temperature, dissolved oxygen (DO), and pH. Shellfish and crustaceans are types of fish according to the *Fisheries Act*, but were not observed in the freshwater environments in the LSA (Figure 5.7-1). Crustacean species observed in estuarine environments are not fisheries; rather, these species exist as a food source to fish species of CRA importance observed in estuarine habitats.

Non-salmonid fishes recognized are species of Aboriginal importance (e.g., eulachon), federally designated species at risk under SARA, and species listed in the BC Conservation Data Centre (CDC) (e.g., cutthroat trout).

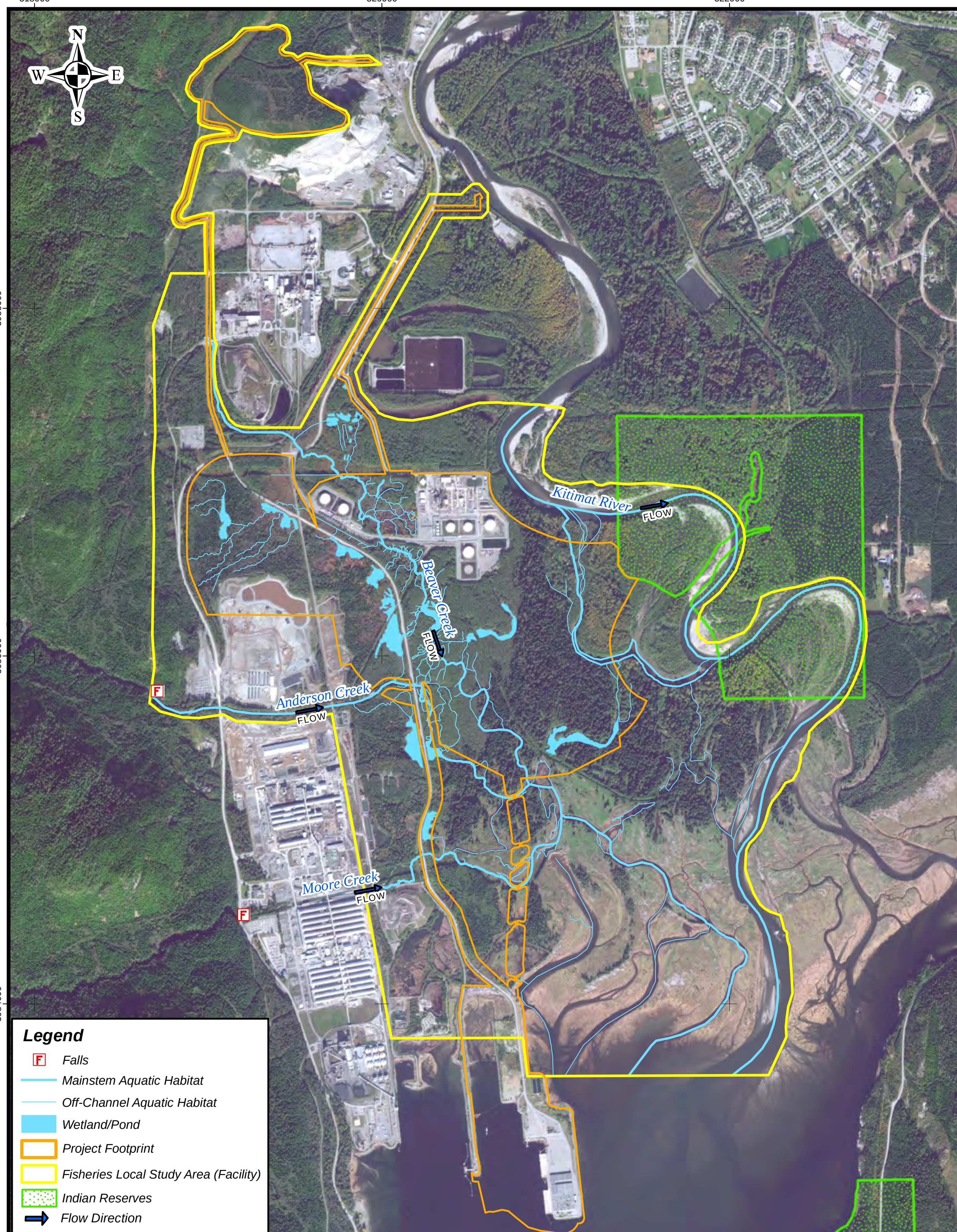

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Figure 5.7-1 - Local Study Area Overview Map

Basemap Source: Orthophoto	1 0.5 0 1 2 Kilometers **Scale:** 1:30,000	**Map Datum:** UTM NAD 83 Zone 9	
Project No: 6018	**File No:** Map#: N:\ACTIVE\6018_Kitimat_ Creeks\MXD\ Fig5.7-1_LSAOverview.mxd	**Date:** Aug 25, 2014	TRITON ENVIRONMENTAL CONSULTANTS LTD.

This freshwater and estuarine fish and fish habitat assessment draws on information from the following VC assessment chapters and associated TDRs, which are linkages and are presented in Section 5.7.5:

- Section 5.2, Air Quality
- Section 5.8, Marine Resources, and
- Section 5.9, Surface Water Quality.

A Water Availability Report (Stantec 2014a) has been prepared to support development of the Operational Water Management Plan (OWMP) and has informed this assessment of Project effects on freshwater and estuarine fish and fish habitat.

5.7.2 Scope of Assessment

5.7.2.1 Regulatory and Policy Setting

Federal and provincial legislation and regulations that apply to the assessment of effects on freshwater and estuarine fish and fish habitat are listed in Table 5.7-1. Policies and guidelines considered during the assessment are listed in Table 5.7-2.

5.7.2.2 Consultations' Influence on the Identification of Issues in the Assessment Process

LNG Canada submitted the draft AIR to the EAO for review by the members of the EAO Working Group, which consists of provincial and federal regulators, Aboriginal Groups, and local government. Comments, concerns, and identification of issues by the Working Group, Aboriginal Groups and the public, as they pertain to freshwater and estuarine fish and fish habitat, have improved the assessment.

In addition to consultation on the draft AIR, LNG Canada has had a comprehensive consultation program with Aboriginal Groups, and in particular Haisla Nation, with respect to freshwater and estuarine fish and fish habitat. Workshops have been initiated to assist with consultation for addressing Project effects and providing guidance to LNG Canada in its Application for Authorization under paragraph 35(2)(b) of the *Fisheries Act*. Potential adverse effects on Aboriginal Interests that relate to freshwater and estuarine fish and fish habitat are also addressed in Section 14 of this Application.

Table 5.7-1: Legislation and Regulations Applicable to the Freshwater and Estuarine Fish and Fish Habitat VC

Legislation	Description	Relevance to the VC
Fisheries Act (continued onto next page)	Section 6: consideration by the Minister of factors that outline the structure for the regulatory review process: a) the contribution of the relevant fish to the ongoing productivity of CRA fisheries b) fisheries management objectives c) whether there are measures and standards to avoid, mitigate or offset *serious harm to fish* that are part of a CRA fishery, or that support such a fishery d) the public interest Sections 20 and 21: state the Minister may ensure the free passage of and prevent harm to fish by the removal of obstructions, installation of fish-guards, construction of fish-ways, and maintenance of minimal flows of water for the purposes of enabling the safe passage of fish around obstructions, barriers, and dams. Section 34(1): defines deleterious substance, deposit, and water frequented by fish. Section 35(1): prohibits any work, undertaking or activity that results in *serious harm to fish* that are part of a CRA fishery, or to fish that support such a fishery. Serious harm is defined as the death of fish or any permanent alteration to, or destruction of, fish habitat. Section 35(2): allows for an Authorization to be issued for work or activities that result in *serious harm to fish*. Section 36(3): prohibits the deposition of deleterious substances of any type in water frequented by fish. Section 37: allows the Minister to request plans and specifications for projects that may cause *serious harm to fish* and to make orders to modify restrict or close these projects. Anyone proposing to carry on a work, undertaking or activity in an ecologically significant area (as defined in regulations) is required, on request of the Minister or in circumstances set out in regulations, to provide information on their project to the Minister.	The AIR states that fish are defined as a VC under the *Fisheries Act* for the environmental assessment, which emphasizes that it is an offense to commit *serious harm to fish* that are part of a CRA fishery. The AIR states that section 5 of CEAA 2012 requires an assessment of environmental effects on fish and fish habitat as defined under the *Fisheries Act* Federal legislation to protect fish and fish habitat. Baseline studies have been conducted to ascertain species presence and distribution in the LSA. An assessment of fish habitat has been undertaken for hydraulically connected wetted habitats in the LSA. Habitats accessible to fish are evaluated in terms of habitat suitability. A commitment must be made to uphold the applicable statutory requirements during all phases of the Project, as identified in the development of acceptable environmental management plans (EMPs).

Legislation	Description	Relevance to the VC
Fisheries Act	Section 38: imposes an obligation to notify an inspector, fishery officer, or a prescribed authority, for project activities that cause or contribute to occurrences that result in *serious harm to fish* that are part of, or support a CRA fishery. The *Fisheries Act* imposes duties to take corrective measures and to provide written reports of such occurrences that may result in *serious harm to fish*.	The AIR states that fish are defined as a VC under the *Fisheries Act* for the environmental assessment, which emphasizes that it is an offense to commit *serious harm to fish* that are part of a CRA fishery. The AIR states that section 5 of CEAA 2012 requires an assessment of environmental effects on fish and fish habitat as defined under the *Fisheries Act*. A commitment must be made to uphold the applicable statutory requirements during all phases of the Project, as identified in the development of acceptable EMPs.
Species at Risk Act (2003)	Section 6: prevents wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened. Section 32: prohibits killing, harming, harassing, capturing or taking an individual of a species listed as endangered, threatened or extirpated. Section 33: prohibits damage or destruction of the residence of a species listed as *endangered*, *threatened*, or *extirpated*. Section 58(1): prohibits destruction of any part of the critical habitat of listed *endangered*, *threatened*, or *extirpated* aquatic species, if a registered recovery strategy or action plan identifies the critical habitat and there is an order from the Governor in Council protecting it. Section 79 requires federal agencies carrying out assessments under CEAA 2012 (including the Agency) to identify adverse effects from the project on all listed species and their critical habitat, and to ensure measures are taken to avoid or lessen the effects. Measures must be consistent with any registered recovery strategies and action plans.	The AIR states that section 5 of CEAA 2012 requires an assessment of environmental effects on aquatic species defined in subsection 2(1) of Species at Risk Act. Federal legislation to protect species listed under Schedule 1 of the Act and their critical habitats. Baseline studies and an assessment of fish habitat have been conducted to ascertain *at risk* presence and distribution in the LSA.
Wildlife Act (1996)	*Freshwater Fish Regulation* prohibits possession or transportation of live freshwater fish unless authorized under a permit.	A permit is required to conduct fish collection and/or fish salvage activities.

Legislation	Description	Relevance to the VC
Water Act (1996)	Section 9: requires that a person may, only under an Approval or under a Water Licence or Order, or under Part 7 of the *Water Regulation*, make changes in and about a stream, defined as: 1. any modification to the nature of the stream including the land, vegetation, natural environment or flow of water within the stream, or 2. any activity or construction within the stream channel that has or may have an impact on a stream. Sections 40 to 44 of the *Water Regulation* establishes the requirements for notification prior to making changes in and about a stream for activities that do not require approvals. They also establish the conditions for protection of water quality and habitat when carrying out such works.	The AIR states that the *Water Regulation* requires the protection of water quality and habitat during works occurring in and about a stream. Provincial legislation governing all work conducted in or about a stream, which either requires an approval under section 9 of the Act or notification and compliance with the regulation, depending upon the type of work being carried out. Approvals will be needed during the construction phase of the Project. Biophysical stream data within the Project footprint and associated safety zone have been collected as part of the fish habitat assessment. Diversion of water from Kitimat River during construction (hydro testing of pipelines and vessels) and operation (cooling for the liquefaction processes) will require a water licence under the act. Effects to fish passage along Kitimat River downstream of the proposed intake are part of the assessment.
Environmental Management Act (2003)	Section 6(2): prohibits the introduction of waste to the environment in the course of conducting a prescribed industry, trade or business. Section 6(3): prohibits the introduction, cause or allowance of waste to the environment, produced by a prescribed industry, trade or business. Both prohibitions are subject to exceptions for operations carried out in accordance with permits issued under section 12. *Waste Discharge Regulation* prescribes the industries which are subject to the prohibitions and which consequently may require waste discharge permits. The LNG facility is a prescribed activity.	Provincial legislation governing the discharge of wastewater from the facility which requires a waste discharge permit under the Act. Effects from wastewater discharge into Kitimat Arm are examined as part of the assessment in consideration of the assessment of the Marine Resources, Section 5.8.
Oil and Gas Activities Act (OGAA 2008)	*Environmental Protection and Management Regulation* (EPMR) establishes conditions that a person carrying out an oil and gas activity must take or refrain from taking to protect or effectively manage the environment.	The AIR states the EPMR requires protection of water quality and habitat during works occurring in and about a stream. Provincial legislation to protect and manage fish habitat (water quality, quantity, and timing of flow) and riparian values. Requires classification, identification, and management of aquatic values important to freshwater and estuarine fish: water quality and release of deleterious substances; water quantity and timing of flows; stream and wetland crossings; and stream and wetland riparian areas.

Table 5.7-2: Policies and Guidelines Applicable to the Freshwater and Estuarine Fish and Fish Habitat Valued Component

Policy/Guideline	Description	Application to VC
Practitioners Guide to Risk Management Framework for DFO Habitat Management Staff (DFO 2010)	The guide supports the DFO Habitat Management Program in making transparent and consistent decisions during the regulatory review of works or undertakings that affect fish and fish habitat across Canada.	Basis for determining the pathway of effects for freshwater and estuarine fish and fish habitat applicable to each phase of the Project.
Fisheries Protection Policy Statement (DFO 2013a)	Identifies threats to fisheries and sets out how DFO and its regulatory partners apply the fisheries protection provisions of the *Fisheries Act*. Provides regulatory aspects of DFO's Fisheries Protection Program and offers guidance to proponents of projects on the application of the fisheries protection provisions that ensure compliance with the *Fisheries Act*. Enables enhanced partnerships with stakeholders such as other agencies of government and local groups to ensure a comprehensive approach to fisheries protection.	Proponent must demonstrate that measures and standards have been fully applied to first avoid, then mitigate, and then finally, to offset any residual *serious harm to fish* that are part of or support CRA fisheries in the LSA.
An Applicant's Guide to Submitting an Application for Authorization under Paragraph 35(2)(b) of the Fisheries Act (DFO 2013b)	Under Paragraph 35(2)(b) of the *Fisheries Act*, the Minister may issue an authorization with terms and conditions in relation to a proposed work, undertaking or activity that may result in *serious harm to fish*.	Describe the fish and fish habitat at the location of the proposed work, undertaking or activity and within the area to be affected. Describe the effects and how they will result in *serious harm to fish* that are part of a CRA fishery, or fish that support such a fishery. Describe the measures and standards that will be implemented to avoid or mitigate the *serious harm to fish*, including an analysis of the expected effectiveness of those measures and standards. Describe monitoring and contingency measures to be put in place to assess the effectiveness of the measures and standards. Quantitatively assess the *serious harm to fish* to result from the work, undertaking or activity despite avoidance measures and mitigation standards, including an analysis of the expected effectiveness of the measures and standards.

Policy/Guideline	Description	Application to VC
Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting (DFO 2013c)	Outlines the Proponent's role in enhancing the sustainability and ongoing productivity of CRA fisheries. Defines the responsibilities of the Proponent to make the necessary investments to protect fisheries and offset any residual effects that may result from a project.	Provide an offsetting plan in respect of the *serious harm to fish*. Provides guidance on undertaking effective measures to offset *serious harm to fish* that are part of or that support a CRA fishery, consistent with the fisheries protection provisions of Canada's *Fisheries Act*.
Measures to Avoid Harm (DFO 2013d)	Advice to proponents conducting a project near water, which applies to all project types. Listed measures include: ▪ project planning ▪ erosions and sediment control ▪ shoreline re-vegetation and stabilization ▪ fish protection, and ▪ operation of machinery.	Replaces the former DFO "Operational Statements" produced for different project types in all regions.
Standards and Best Practices for Instream Works (MWLAP 2004)	Provincial standards and recommended BMPs that appropriately address fish populations and habitat protection in the proposal and implementation of instream works in keeping with the *Water Act*.	Provides an outline for the planning, design, and construction of all instream works requirements for the Project.
Fish-stream Crossing Guidebook (MFLNRO et al 2012)	Provincial standards and recommended BMPs that appropriately address fish populations and habitat protection in the construction of fish-stream crossings as they relate to the *Forest and Range Practices Act* and the *Fisheries Act*.	Standard BMPs for the placement of crossings over fish streams affected by the Project.
Environmental Protection and Management Guide (EPMG; OGC 2013)	Chapter 2: Aquifers and Groundwater Recharge Areas Chapter 3: Riparian Values and Classifying Waterbodies	Works conducted in or about a stream must follow BMPs outlined in section 9 of the *Water Act*.

Comments provided by the Working Group, Aboriginal Groups, and the public identified several components of freshwater and estuarine fish to be addressed in the Application:

- benthic invertebrates and periphyton, as an assessment of stream health
- water quantity as affected by Project water withdrawal from Kitimat River
- sediment quality as affected by Project-caused flow restriction activities that could change substrate composition
- water quality (Section 5.9) for lakes and streams due to potential acidification and eutrophication effects
- conceptual pathway of effects model indicating sources-pathways-receptors, and
- amended *Fisheries Act* policy provisions, which came into force November 25, 2013.

5.7.2.3 Traditional Knowledge and Traditional Use Incorporation

The inclusion of TU information and TK in this assessment considered information from Project-specific studies provided by Aboriginal Groups as well as through a literature review of available public documentation. Haisla Nation provided a TUS to LNG Canada in October 2013 for consideration in this assessment (Powell 2013).

Pacific salmon and eulachon are species are of high importance to Haisla Nation for food, social, and ceremonial (FSC) purposes (Powell 2013) identified in the LSA (see Section 5.7.2.6 and Figure 5.7-1). Available historically documented information on freshwater and estuarine fisheries management is largely exclusive to these species (Powell 2013). Kitamaat Village Council provided an unpublished report of the status of Kitimat River eulachon for use in the assessment (Jacobs 2013, pers. comm.). In addition to Pacific salmon and eulachon, Powell (2013) also cites steelhead trout (i.e., anadromous resources), as well as herring, crab, and seals (see Section 5.8, Marine Resources) as important fisheries in these areas.

Information about Pacific salmon, steelhead trout, and eulachon is largely from the Haisla Nation TUS (Powell 2013) and the Aboriginal Fisheries Strategy (AFS)—a fisheries management collaboration between Fisheries and Oceans Canada (DFO) and the Haisla Fisheries Commission (HFC). The additional traditional fisheries identified include crab and herring, which are marine fisheries and are included as part of the marine resources assessment (Section 5.8). DFO's fisheries managers integrate TK about fishery resources into conventional stock assessment methods by working with members of the Haisla Nation through the AFS.

Previous escapement information and historical Aboriginal catch data for Pacific salmon and eulachon are incorporated into this assessment, where available. This assessment also considers historical Aboriginal catch information for Pacific salmon prior to the operation of a hatchery on Kitimat River.

Recent catch data from Haisla Nation are useful in the context of the state of the fisheries, but may convey a limited understanding of TU with respect to freshwater and estuarine fisheries in the LSA. Replacement of traditional fishing methods with more conventional technologies, capture methods, and stock assessment procedures implemented by HFC in collaboration with DFO, has probably improved catch rates such that they may no longer be directly comparable to previous catch rates based solely on traditional methods (see Section 14 for more information about traditional use).

5.7.2.4 Selection of Effects

A major emphasis in this assessment is on effects that potentially cause *serious harm to fish,* as defined under recent revisions to the federal *Fisheries Act.* Subsection 35(1) of the *Fisheries Act* prohibits any work, undertaking, or activity that leads to *serious harm to fish* that are part of a CRA fishery, or fish that support such a fishery. In this respect, fish species are discussed in terms of the issues and concerns raised by

- Aboriginal Groups, in particular Haisla Nation
- the public
- stakeholders, and
- AIR for freshwater and estuarine fish and fish habitat.

Potential effects on the freshwater and estuarine fish and fish habitat are determined by activities associated with construction, operation, and decommissioning of the Project; legislative and regulatory requirements (Section 5.7.2.1); issues identified through consultation with Aboriginal Groups (in particular Haisla Nation), the public, the Working Group, and other interested parties (Section 5.7.2.2); and professional judgment and experience of the environmental assessment team. The following potential effects are assessed:

- changes in fish habitat (i.e., permanent alteration to or destruction of freshwater or estuarine fish habitat, including changes in habitat quality and quantity)
- change in risk of physical injury or mortality to fish (i.e., harm to fish by way of physical injury or mortality to freshwater or estuarine species), and
- change in fish health.

According to the *Fisheries Act* and associated policies, changes in fish habitat may involve quantity (i.e., area) or quality (i.e., productivity). Changes in fish habitat are measurable as the net change of the quantity and quality of fish habitat from all Project activities and works. This recognizes both habitat losses (e.g., related to infilling) and habitat gains (e.g., related to habitat creation or enhancement) in consideration of subsection 5(1) of CEAA 2012, subsection 35(1) of the *Fisheries Act* (Table 5.7-1), and concerns identified through consultations with Aboriginal Groups, the public, and the Working Group (Section 5.7.2.2).

Harm may occur directly (e.g., burial, entrainment, impingement) or indirectly (e.g., flow disruptions that result in stranding and desiccation of fish) due to Project activities. Consideration of this effect addresses subsection 5(1) of CEAA 2012, subsection 35(1) of the *Fisheries Act* and section 79 of SARA (Table 5.7-1).

Change in fish health can result from potential Project effects on water quality related to release of contaminants or effluent that may lead to toxicity to fish, including both air emissions and wastewater discharge. Toxins and effluent may be dispersed due to Project activities and works. Uptake by fish, either directly or through consumption of contaminated prey, may result in acute or chronic declines in health. Consideration of this effect addresses regulatory requirements related to fish habitat under subsection 5(1) of CEAA 2012 and subsections 35(1) and 36(3) of the *Fisheries Act* (Table 5.7-1).

Changes in surface water quality may result from longer-term acidification and eutrophication, which is addressed in Section 5.9, Water Quality by considering MOE critical load screening thresholds or short-term sediment release events leading to increases in total suspended solids (TSS) during the initial clearing and construction phase. The MOE guidance defines critical load screening thresholds for nitrogen and sulphate (15 meq/m^2/y) and for nitrogen alone (35.7 meq/m^2/y) to identify areas in which watercourses have the potential to be affected by acidification and eutrophication. These areas require Level 1 (quantitative) assessments (see Section 5.9); baseline details are included in the associated Surface Water Quality TDR (Stantec 2014b). The short-term events of sediment loading are assessed in Section 5.7.4.1.

5.7.2.5 Selection of Measurable Parameters

Measurable parameters provide the framework for the characterization of the magnitude of potential effects. Assessment of these effects takes into consideration the factors identified in Section 5.7.2.2 through consultation. Measurable parameters associated with each of the three potential effects are listed in Table 5.7-3.

For changes in fish habitat, measurable parameters evaluate how productivity may be affected by the Project. Productivity is an empirically-determined evaluation of the area of fish habitat in mainstem freshwater streams, based on habitat suitability for relevant fish species in the LSA. Habitat parameters are determined both quantitatively (i.e., stream depth and velocity) and qualitatively (i.e., cover and substrate characteristics) in the Freshwater and Estuarine Fish and Fish Habitat TDR (Triton 2014a, Appendix F). Surface hydrology and water quality parameters, particularly dissolved oxygen (DO), are also seasonal determinants of available off-channel freshwater fish habitat in the LSA. The area of estuarine habitat considers the tidal channels that support fish, either seasonally or perennially, and at individual or multiple life stages. An understanding of these parameters is necessary to address subsection 35(1) of the *Fisheries Act* and the *Fisheries Protection Policy Statement* (DFO 2013a).

Table 5.7-3: Potential Effects on Freshwater and Estuarine Fish and Fish Habitat and Measurable Parameters

Potential Adverse Effects	Measurable Parameters
Changes in fish habitat (i.e., permanent alteration to or destruction of freshwater or estuarine fish habitat including changes in habitat quality and quantity)	▪ Area of fish habitat potentially affected (m^2) ▪ Quality (i.e., productivity) of fish habitat potentially affected (habitat units; HU)
Change in risk of physical injury or mortality to fish (i.e., harm by way of physical injury or mortality to freshwater or estuarine fish species)	▪ Likelihood[a] of harm to fish that are part of CRA fisheries, or those considered *at risk* (includes likelihood of harm to fish as a result of reduced water flow in Kitimat River)
Change in fish health	▪ Water quality parameters for fish and fish habitat (e.g., RIC 2001) ▪ Water chemistry compared to CCME and MOE guidelines for protection of aquatic life

NOTES:

[a] The term ‘likelihood’ is used in this context as a qualitative measure of reasonably predicted or expected harm or change in behaviour, based on current scientific understanding, use of thresholds and modelling (where applicable) and professional judgment. It is not meant to imply statistical likelihood or results of a quantitative risk assessment.

For harm to fish, the measurable parameter considers the likelihood of physical injury or mortality to fish species that support or are part of CRA fisheries, as well as to species at risk. Likelihood of harm is a function of the distribution, abundance, and life stage of freshwater and estuarine species relevant to the Project and specific sensitivities of fish to Project activities, which may affect sustainability of fish populations in the LSA. An assessment of harm to fish that are either part of or support CRA fisheries addresses subsection 35(1) of the *Fisheries Act* and section 79 of SARA.

For change in fish health as a result of changes in surface water quality, the measurable parameters are water quality parameters for fish and fish habitat (RIC 2001) and water chemistry compared to CCME and MOE guidelines for protection of aquatic life and critical load exceedances. This reflects the potential for acute or chronic effects on fish that may affect sustainability of populations, depending on the number of individuals affected. Because the guidelines are based on protection of aquatic life, conservative safety factors are implicitly incorporated in the assessment.

5.7.2.6 Boundaries

5.7.2.6.1 Spatial Boundaries

Project Footprint

The Project footprint refers to the physical area to be cleared for the LNG facility and will contain all Project works and related infrastructure, including:

- main LNG facility and ancillary buildings, including tankage
- offices, service areas, administration buildings, and laydown area
- workforce accommodation centre(s)
- rights-of-way (ROW) and other linear corridors (e.g., heavy haul road during construction, LNG loading line corridor, boil off gas return line, and water intake line), and
- marine terminal.

The area of the Project footprint is approximately 430 ha, of which 39 ha is below the high tide mark. The final footprint of the LNG loading line corridor is still being considered, so the area of the Project footprint may change slightly. Potential effects from marine shipping are not included in the assessment of freshwater and estuarine fish and fish habitat (effects on the marine environment are discussed in Section 5.8, Marine Resources).

Local Study Area

The LSA is wholly contained within Haisla Nation traditional territory. The LSA includes freshwater and aquatic riparian habitat in a portion of the Kitimat River mainstem channel from the marine environment upstream to the location of the existing Methanex water intake, its side channels downstream of the intake, and streams affected by the LNG facility. It also includes estuarine habitat in the tidally influenced channels west of the Kitimat River mainstem that have the potential to be affected by Project development activities, including the LNG facility, LNG loading line, and workforce accommodation centre(s) (Figure 5.7-1). A portion of the marine terminal and wastewater disposal area is located in the marine environment and is outside the LSA for freshwater and estuarine fish and fish habitat.

Regional Study Area

The RSA is wholly contained within Haisla Nation traditional territory. The RSA consists of the Kitimat River mainstem and side channels, direct tributaries to Kitimat Arm and estuarine habitats, including those found in Minette Bay. The RSA generally extends east and west to the Kitimat River valley walls south of Highway 37 and Kitimat, extending to Emsley Cove on the west shore of Douglas Channel and Clio Bay on the east shore (Figure 5.7-2). The RSA includes all associated freshwater streams and estuarine areas. Freshwater and estuarine habitats contained in the RSA are those areas above the average low-tide water mark.

The RSA comprises all freshwater and estuarine habitats where residual effects might contribute to historical, current, or future effects from existing or planned projects in the area.

5.7.2.6.2 Temporal Boundaries

Based on the current Project schedule, the temporal boundaries are:

- construction, Phase 1 (trains 1 and 2) to be completed approximately five to six years following issuance of permits, the subsequent phase(s) (trains 3, 4) to be determined based on market demand
- operation, minimum of 25 years after commissioning, and
- decommissioning, approximately two years at the end of the Project life.

There are also reduced risk work windows associated with fish species of interest, when important life stages of fish species may overlap with construction activities and require consideration (e.g., in designing mitigation) when planning Project work in a watercourse (MWLAP 2005).

5.7.2.6.3 Administrative Boundaries

District of Kitimat

Municipal administrative boundaries include the planning and management boundaries located in the District of Kitimat and administered under the provincial *Local Government Act*. Land use is locally governed by the current zoning types in the district, which are residential, commercial, industrial, and greenbelt.

Economic development and environmental responsibility both figure prominently in the Official Community Plan (OCP) of the District of Kitimat (Stantec 2008). Industrial lands generally occur on the western side of Kitimat River valley in the municipal boundary. The Project will be located in industrial zoning designated as M1, manufacturing (District of Kitimat 2014), which permits manufacturing, marine activities, storage, and temporary construction camp uses.

Much of the Project infrastructure is directly downstream of existing industrial infrastructure and development lands and is located on private land adjacent to the RTA facility and the former Eurocan Pulp and Paper mill. A portion of the infrastructure is located on land in the Kitimat River estuary previously designated by DFO as an environmentally sensitive area (Figure 5.7-3) as identified in Schedule A of the District of Kitimat OCP as important habitat for juvenile salmon (coho, chinook, and chum), eulachon, capelin, and herring (Stantec 2008).

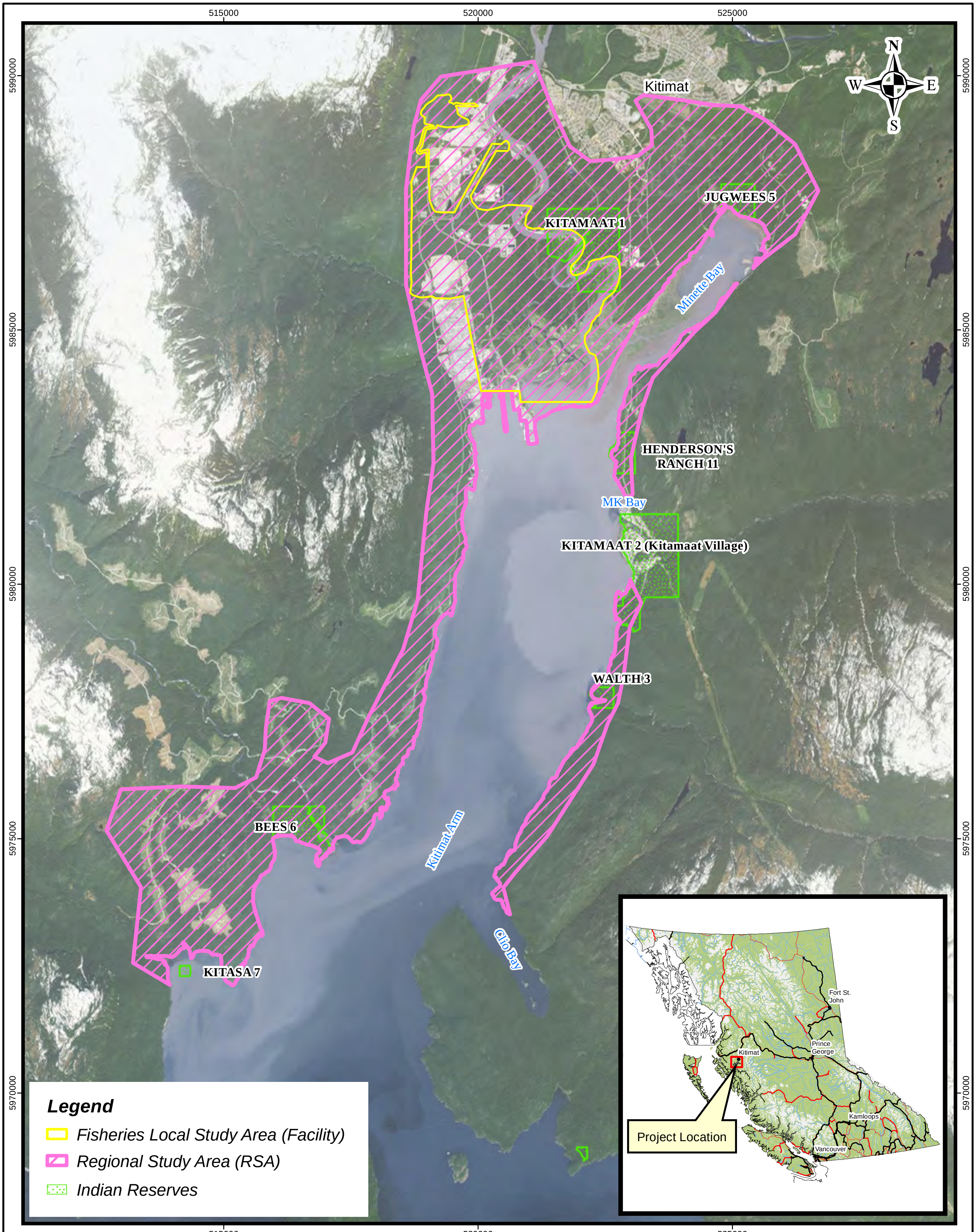

Figure 5.7-2 - Regional Study Area Overview Map

Basemap Source: Orthophoto	Scale: 1:100,000 (0.75 0.375 0 0.75 1.5 2.25 3 Kilometers)		**Map Datum:** UTM NAD 83 Zone 9
Project No: 6018	**File No:** Map#: N:\ACTIVE\6018_Kitimat_Creeks\MXD\FishRSA.mxd	**Date:** Jul 11, 2014	

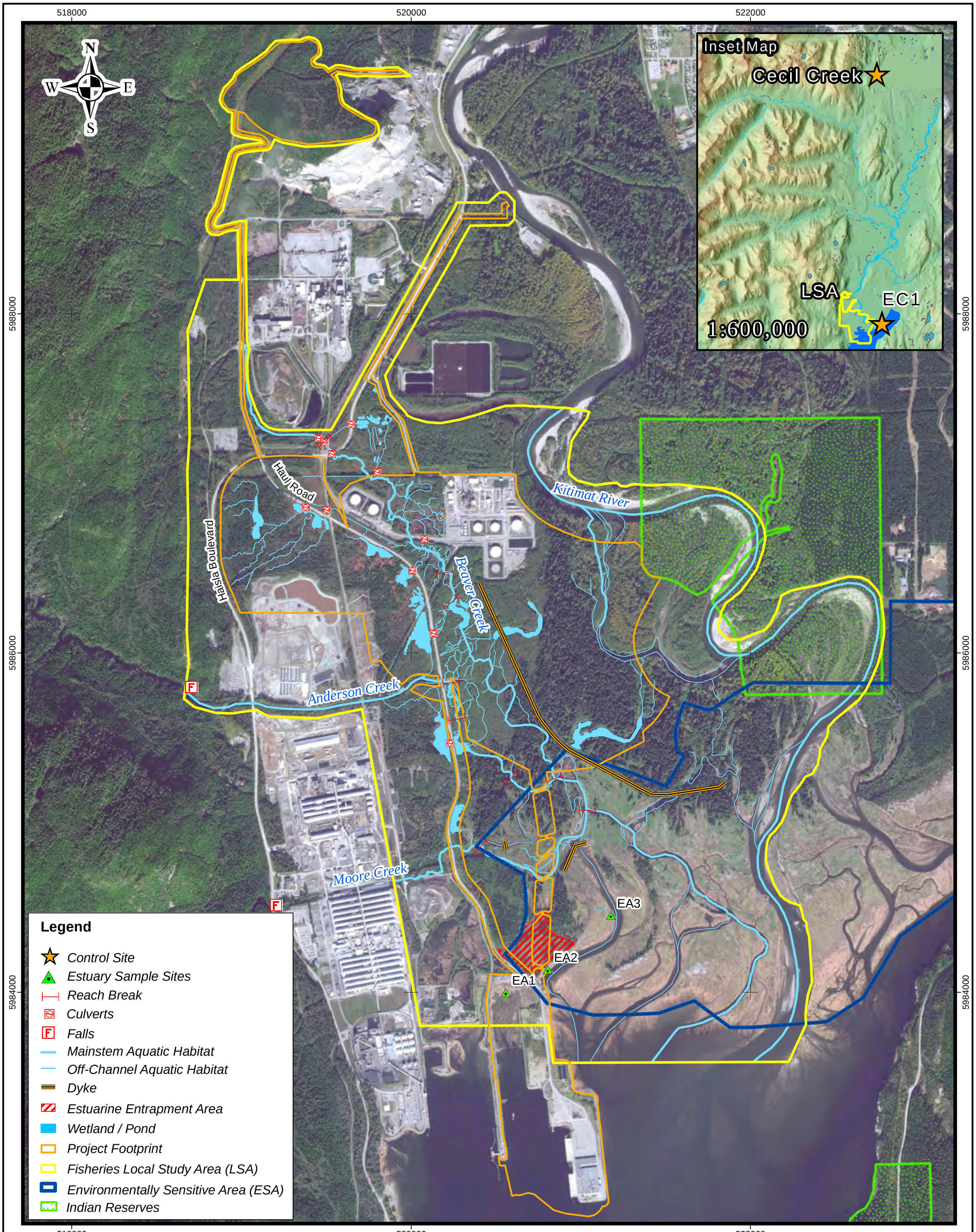

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Figure 5.7-3 - Freshwater and Estuarine Aquatic Habitats

Basemap Source:	Scale: 1:30,000 (0.5 0.25 0 0.5 1 Kilometers)	Map Datum:
Orthophoto		UTM NAD 83 Zone 9

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Haisla Nation

The Project site is located in Haisla Nation traditional territory. Four federally established Indian Reserves (IR) exist in the municipal boundary of the District of Kitimat (Kitamaat IR Nos. 1, 5, 6, and 7; Stantec 2008). Kitamaat IR 1 is the largest of these reserves (i.e., *Miyan'exaas*; Powell 2013) and is partially located within the LSA (Figure 5.7-4).

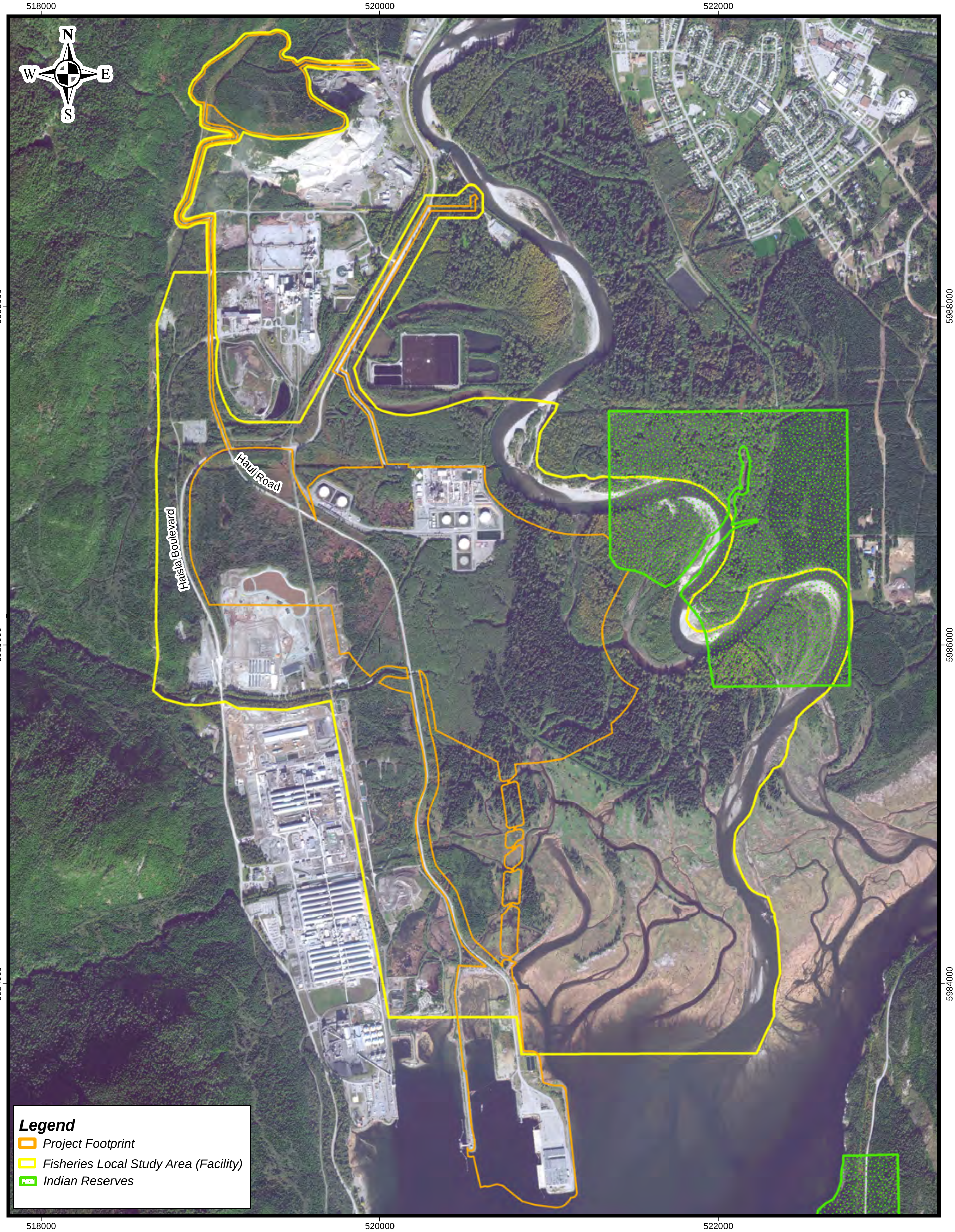
5.7.2.6.4 Technical Boundaries

A technical boundary is the duration of field studies undertaken for the Project, which occurred from April 2012 through December 2013 and included all four seasons and use of reference sites outside the LSA.

The level of data collection involved in the assessment provides a robust understanding of the characterization and use of habitat by freshwater and estuarine fish species in the LSA. However, a degree of uncertainty remains in respect of fish population dynamics over a longer time and the ecological processes occurring at a larger spatial scale. Consideration of baseline conditions in the LSA is combined with background information from numerous sources beyond the period of study and outside of the LSA. These include DFO annual hatchery release data, salmon escapement surveys, and surveys conducted by Haisla Nation, among other sources. Refer to Section 5.7.3 and the Freshwater and Estuarine Fish and Fish Habitat TDR (Triton 2014a).

5.7.2.7 Residual Effects Description Criteria

Residual effects are characterized, where possible, using the criteria listed in Table 5.7-4. These criteria describe the potential residual effects that remain after mitigation measures, including habitat offsetting, have been implemented.



Basemap Source: Orthophoto

Scale: 1:30,000

Map Datum: UTM NAD 83 Zone 9

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Figure 5.7-4: Spatial Boundaries

Project No:	File No:	Date:
6018	Map#: N:\ACTIVE\6018_Kitimat_Creeks\MXD\Fig5.7-4_Boundaries.mxd	Aug 25, 2014

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Table 5.7-4: Characterization of Residual Effects for Freshwater and Estuarine Fish and Fish Habitat

Characterization	Description	Definition of Qualitative Categories
Characterization of Residual Effects		
Magnitude	The expected size or severity of effect. Low magnitude effects might have negligible to little effect, while high magnitude effects might have a substantial effect.	**Negligible**—no measurable change **Low**—a measurable change from existing baseline conditions that is below environmental or regulatory thresholds and does not affect the sustainability of fish populations **Moderate**—a measurable change from existing baseline conditions that is above environmental and/or regulatory thresholds but does not affect the sustainability of fish populations **High**—a measurable change from existing baseline conditions that is above environmental and/or regulatory thresholds and might adversely affect the sustainability of fish populations
Geographic Extent	The spatial scale over which the residual effects of the Project are expected to occur. The geographic extent of effects can be local or regional. Local effects might have a lower effect than regional effects.	**PF**—residual effects extend into the Project footprint only **LSA**—residual effects extend into the LSA **RSA**—residual effects extend into the RSA
Duration	The length of time the residual effect persists. The duration of an effect can be short term or longer term.	**Short-term**—no measurable residual effect exists beyond construction or decommissioning phases (i.e., < 6 years). **Medium-term**—measurable residual effect persists beyond construction or decommissioning phases for 6 to 25 years **Long-term**—measurable residual effect persists beyond operational phase (>25 years), but is not permanent. **Permanent**—measurable residual effect is a permanent condition
Frequency	How often the effect occurs. The frequency of an effect can be frequent or infrequent. Short-term or infrequent effects might have a lower effect than long term and/or frequent effects.	**Single event**—residual effect occurs once, typically during construction phase **Multiple irregular event (no set schedule)**—residual effect occurs more than once, but infrequently **Multiple regular event**—residual effect occurs more than once and frequently **Continuous**—residual effect occurs continuously
Reversibility	Whether or not the residual effect on the VC can be reversed once the physical work or activity causing the disturbance ceases. Effects can be reversible or permanent. Reversible effects may have a lower effect than irreversible or permanent effects.	**Reversible**—residual effect is expected to cease and conditions are expected to recover to baseline during or after the Project is completed. **Irreversible**—residual effect is expected to persist and conditions are not expected to recover to baseline after the life of the Project, even after reclamation and the implementation of offsetting measures.

Characterization	Description	Definition of Qualitative Categories
Context	Refers primarily to the sensitivity and resilience of the VC. Consideration of context draws heavily on the description of baseline conditions of the VC, which reflect any cumulative effects of other projects or activities that have been carried out, and information about the impact of natural and human-caused trends on the condition of the VC. Project effects might have a higher effect if they occur in areas or regions that have already been adversely affected by human activities (i.e., disturbed or undisturbed) or are ecologically fragile and have little resilience to imposed stresses (i.e., fragile)	**Low resilience**—residual effect occurs in a fragile ecosystem or the level of baseline disturbance can be a contributing factor to reduced sustainability of a local or regional fish population **Moderate resilience**—residual effect occurs in a moderately stable ecosystem or level of baseline disturbance that does not contribute to reduced sustainability of a local or regional fish population **High resilience**—residual effect occurs in a highly stable ecosystem or the level of baseline disturbance does not contribute to reduced sustainability of a local or regional fish population
Likelihood of Residual Effects		
Likelihood	Whether or not a residual effect is likely to occur	**Low**—low likelihood that there will be a residual effect. **Medium**—moderate likelihood that there will be a residual effect. **High**—high likelihood that there will be a residual effect.

5.7.2.8 Significance Thresholds for Residual Effects

Thresholds for significance of residual effects are defined in consideration of applicable federal and provincial regulatory requirements, standards, objectives, and guidelines to reflect the limits of an acceptable state of a fishery as defined by the *Fisheries Act* or any fish species designated under Schedule 1 of SARA. Significance thresholds address subsections 35(1) and 36(3) of the *Fisheries Act*, section 79 of SARA, and the Fisheries Protection Policy Statement (DFO 2013a). In consideration of the *Fisheries Act*, net loss of fish habitat would be assessed as a significant adverse effect (i.e., permanent alteration to or destruction of CRA fish habitat that cannot be offset).

A residual effect is rated as either not significant or significant, considering the thresholds identified in Table 5.7-5. All residual effects identified are further considered in the cumulative effects assessment (Section 5.7.8).

Table 5.7-5: Residual Effects Significance Thresholds

Potential Adverse Project Effects	Measurable Parameters	Significance Thresholds
Changes in fish habitat (i.e., permanent alteration to or destruction of freshwater or estuarine fish habitat, including changes in habitat quality and quantity)	▪ Area of fish habitat potentially affected (m^2) ▪ Quality (i.e., productivity) of fish habitat potentially affected (HU)	Any permanent alteration to or destruction of freshwater or estuarine fish habitat that cannot be offset and is of a spatial scale, duration and intensity that limits or diminishes the ability of fish to use, or prevents fish from relying upon, such habitats as spawning grounds; as nursery, rearing or food supply areas; as a migration corridor; or any other area in order to carry out one or more of their life processes.
Change in risk of physical injury or mortality to fish (i.e., harm by way of physical injury or mortality to freshwater or estuarine fish species)	▪ Likelihood of harm to fish that are part of CRA fisheries, or those considered *at risk* (includes likelihood of harm to fish as a result of reduced water flow in Kitimat River)	Physical injury or death of freshwater or estuarine fish, after mitigation has been implemented, that could reasonably be expected to prevent the natural recovery of the fish population to baseline levels within five years of Project construction.
Change in fish health	▪ Water quality parameters for fish and fish habitat (i.e., RIC 2001) ▪ Water chemistry compared to CCME and MOE guidelines for protection of aquatic life	Wastewater discharge: exceedance of water quality guidelines for the protection of aquatic life (i.e., CCME and MOE), see Section 5.8, Marine Resources. Acidification: critical load exceedance of acceptable according to guidelines (i.e., MOE) for the protection of aquatic health, see Section 5.9 For change in trophic status causing eutrophication compared to baseline, see Section 5.9, Surface Water Quality.

5.7.3 Baseline Conditions

5.7.3.1 Baseline Data Sources

Baseline data sources include all background information collected through federal and provincial online databases and interactive map tools (Table 5.7-6) in support of the field studies conducted to assess the baseline conditions, as contained in the Freshwater and Estuarine Fish and Fish Habitat TDR (Triton 2014a).

Table 5.7-6: Primary Information Sources for Freshwater and Estuarine Fish and Fish Habitat

Data Source	Information Provided
Fisheries Information Summary System (FISS) internet database: http://www.env.gov.bc.ca/fish/fiss/	Spatial summary level fish and fish habitat data including fish distribution, escapement, life history, and timing. This tool also provides references to data sources.
Fisheries Inventory Data Queries: http://www.env.gov.bc.ca/fish/fidq/	Stream and fish data through a set of topic-based queries that extract information from the provincial Land and Resource Data Warehouse, which stores fisheries inventory data collected from the early 1900s through to present day.
Field Data Information System (FDIS): http://www.env.gov.bc.ca/fish/fdis/description.html	Public database of fish sampling activities undertaken as a requirement of scientific fish collection permits from MOE.
Ecological Reports Catalogue (EcoCat) reports database: http://www.env.gov.bc.ca/ecocat/	Publicly accessible digital reports and publications on previous fish and fish habitat assessments, as well as fisheries data and fish capture locations.
Habitat Wizard interactive mapping database: http://www.env.gov.bc.ca/habwiz/	Public database administered through MOE to provide spatial data on previous fish capture and habitat characteristics in the Province.
iMapBC, DataBC interactive mapping database: http://www.data.gov.bc.ca/dbc/geographic/view_and_analyze/imapbc/index.page	Publicly available database with spatial information on fish and fish habitat provided by consultants and government through FDIS, FISS, and EcoCat.
Fisheries and Oceans Canada Salmonid Enhancement Program – Kitimat River Hatchery: http://www.pac.dfo-mpo.gc.ca/sep-pmvs/projects-projets/kitimat/kitimat-eng.html	Publicly accessible DFO database with information on annual fish releases from the Kitimat River Hatchery.
Water Survey of Canada hydrometric database (Environment Canada); http://www.ec.gc.ca/rhc-wsc/default.asp?lang=En&n=4EED50F1-1	Real-time and historic hydrometric data for stream gauging stations located on Kitimat River and adjacent tributaries.
Terrain Resource Information Management (TRIM) internet database: http://archive.ilmb.gov.bc.ca/crgb/pba/trim/	Publicly accessible GeoBC database of TRIM data layers that provide topographical information and include features such as roads, streams, and forest openings.
BC Species and Ecosystems Explorer internet database: http://www.env.gov.bc.ca/atrisk/toolintro.html	Public database providing spatial and ecological conservation information (i.e., COSEWIC status, SARA listing, and CDC listing) on relevant fish species and ecosystems.
BC Freshwater Atlas: http://www.ilmb.gov.bc.ca/geobc/FWA	A standardized database of freshwater inventories in BC.

5.7.3.2 Field Survey Methods

5.7.3.2.1 Freshwater Fish

A complete description of the baseline data for freshwater fish is provided in the Freshwater and Estuarine Fish and Fish Habitat TDR (Triton 2014a). Fish presence in freshwater was determined using backpack electrofishing and minnow trapping. Minnow traps included smaller baited Gee traps and larger baited mesh traps. As seasonal conditions permitted, electrofishing included both open- and closed-site methods. Closed-site fish capture used a multiple-pass electrofishing depletion-removal method to estimate abundance (Schnute 1983; Walters and Martell 2004). Fish collection permit conditions under the *Wildlife Act* prohibit electrofishing in stream temperatures below 5°C. Consequently, winter sampling involved trapping. Data from fish sampling activities are combined with water quality data, particularly DO and temperature in freshwater habitat and salinity in estuarine habitat, to determine the physical limits of fish distribution in the LSA.

5.7.3.2.2 Freshwater Fish Habitat

A complete description of the freshwater fish habitat baseline data is provided in the Freshwater and Estuarine Fish and Fish Habitat TDR (Triton 2014a). Freshwater studies included an examination of mainstem and off-channel aquatic habitat accessible to fish. Seasonal sampling occurred over three trips in 2012 (i.e., May, June, and September). No fish sampling took place in July or August, but the September trip was intended to capture a seasonal understanding of habitat use by fish. The June 2012 (i.e., late spring/early summer) trip occurred during freshet flows with reduced habitat suitability in mainstem channels and reflected seasonal conditions (i.e., high depths and velocities with low fish densities). The second trip in September 2012 reflected contrasting conditions, with reduced flows and improved habitat suitability, yielding higher fish densities. September was also preferred because summer and fall are spawning periods for several Pacific salmon species. A single trip was optimal to reflect late summer/early fall conditions and allow for minimal disturbance to both spawners and redds. Additional sampling occurred over four trips in 2013 (i.e., January, March, May, and December) to examine winter and spring conditions.

Standard data collection methods were employed to map seasonal mesohabitats, or hydraulic channel unit types (i.e., pool, riffle, and run types; Johnston and Slaney 1996) in mainstem channels of the streams in the LSA. The presence an extent of side channels and other off-channel habitat was also noted. Transect-specific hydrometric surveys of stream depth and velocity measurements among each hydraulic unit type were used to determine habitat suitability indices (HSI) for observed species. Data collection considered both species distribution and relative abundance along with channel, substrate, and cover characteristics (RIC 2000, 2001).

Area estimates of hydraulic channel units, according to mesohabitat type, are combined with site-specific transect data taken in the mainstem channels of the following watercourses (Figure 5.7-3):

- Moore Creek, watershed code 910-674000
- Anderson Creek, watershed code 910-673500-03300
- Beaver Creek, watershed code 910-673500-03300, and
- Kitimat River side channel, watershed code 910-673500.

Transect sites included a station for measuring flow and fish habitat characteristics throughout each stream. Flow transects measured depth and velocity across the wetted channel and determined stream discharge using standard hydrometric survey methods that reflect seasonal variability of surface flows (Lewis et al*.* 2004). Transect-specific habitat information included the following Level 2 fish habitat assessment procedures (FHAP; Johnston and Slaney 1996):

- quantitative (i.e., measurable) channel and flow characteristics
- qualitative (i.e., categorical) channel and flow characteristics
- observed streambed characteristics
- observed cover characteristics, and
- observed salmonid habitat quality for different life stages.

Habitat evaluation of mainstem stream channels employed the transect-specific data along with HSI curves for relevant species of fish based on information from numerous sources (USFWS 1980; McMahon 1983; Raleigh et al. 1984, 1985; Raleigh and Nelson 1986; Ptolemy 2001; WDFW 2004). The Freshwater and Estuarine Fish and Fish Habitat TDR applied HSI information to the area estimates of mainstem aquatic habitat to derive the habitat units (HU) as an indicator of productivity in the LSA (Triton 2014a).

Assessment of the following off-channel fish habitat included an examination of hydraulic connectivity and water quality, particularly DO at seasonally accessible off-channel aquatic habitats:

- cross-channel habitat is a channel connecting separate watercourses
- side channel habitat is a smaller channel exiting the mainstem and reconnecting to it further downstream
- groundwater-fed blind channel, or slough habitat is a channel entering the mainstem from a groundwater source, and
- wetland complex habitat is the ponded area in a larger wetland ecosystem that is influenced by groundwater, but remains hydraulically connected to stream channels.

A functional relationship of seasonal off-channel aquatic habitat during known stages of stream discharge was described by the area (m^2) of available wetted off-channel stream habitat W_A, which is dependent on mainstem stream discharge Q (m^3/s). In the Freshwater and Estuarine Fish and Fish Habitat TDR, discharge was based on information collected from the hydrologic assessment (Triton 2014a). A discharge-dependent model provided a theoretical estimate of W_A based on the median monthly discharge in March 2013 (i.e., late winter) in Anderson Creek, based on the hydrograph developed by Triton (2014b). According to historic data, March has the lowest annual flows; and limits annual productivity in the aquatic ecosystem. The area of wetland complexes used by fish is also included in the estimate, but this is not dependent on stream discharge. These hydraulically connected ponded areas in wetland complexes of the floodplain are a function of the water table and are influenced by available groundwater. Availability of wetland complexes to fish is dependent on seasonal DO availability. The amount of estimated off-channel aquatic habitat was therefore combined with this ponded habitat and the mainstem HU to estimate the total affected freshwater fish habitat in the LSA.

5.7.3.2.3 Estuarine Fish and Fish Habitat

Monthly estuarine sampling in the tidal channels along the south end of the LSA was undertaken during fall and winter (September 2012 through March 2013). Sampling continued on a bi-weekly basis during spring (i.e., March 2013 through June 2013), and corresponded to annual seaward migrations of juvenile Pacific salmon (refer to Figure 5.7-3 for site locations). Survey design was developed based on historical information on fish use in the LSA (e.g., Slaney et al. 1982). Data were collected on fish species abundance and water quality parameters in the area upstream of the stop nets at each tidal channel site. Complete descriptions of the estuarine baseline data source are provided in the Freshwater and Estuarine Fish and Fish Habitat TDR (Triton 2014a).

5.7.3.3 Baseline Overview

Baseline conditions for freshwater and estuarine fish and fish habitat are described in detail in the TDR and summarized here with a focus on the fish resources relevant to this assessment.

5.7.3.3.1 Fisheries

Kitimat River supports all five species of Pacific salmon (Figure 5.7-5):

- chinook salmon (*Oncorhynchus tshawytscha*)
- chum salmon (*O. keta*)
- pink salmon (*O. gorbuscha*)
- coho salmon (*O. kisutch*), and
- sockeye salmon (*O. nerka*; river ecotype).

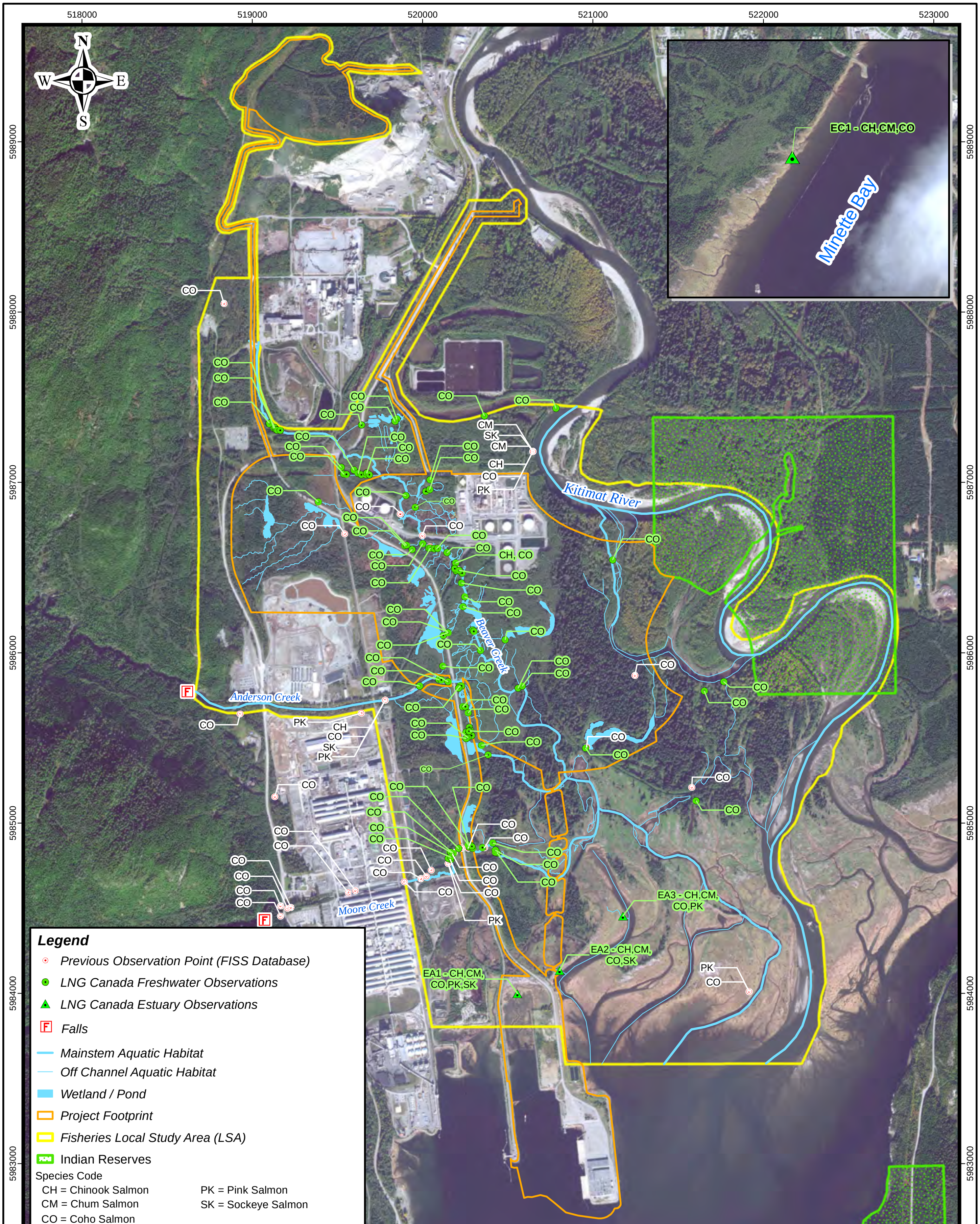

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Figure 5.7-5 - Pacific Salmon Observations in the Local Study Area

Basemap Source: Orthophoto	Scale: 1:30,000 (200 100 0 200 400 600 800 Meters)	Map Datum: UTM NAD 83 Zone 9
Project No: 6018	File No: Map#: N:\ACTIVE\6018_Kitimat_Creeks\MXD\Report_Mapping\Fish_BaseFig3.2-1.mxd	Date: Aug 25, 2014

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Additional salmonids include anadromous steelhead trout and stream resident, non-anadromous rainbow trout (*O. mykiss*), both of which are present in Kitimat River, along with cutthroat trout (*O. clarkii clarkii*). Cutthroat trout is on the provincial blue list as a species of *special concern* (CDC 2012a). Observations of trout species in the LSA have been included in Figure 5.7-6. Dolly Varden char (*Salvelinus malma*) is found in Kitimat River and tributaries of the LSA (Figure 5.7-7).

Eulachon (Thaleichthys pacificus) has historically been recorded in the lower 8 km section of Kitimat River (FISS 2013). A considerable amount of eulachon grease production took place at the “Old Village” (Moody 2008), located directly east of the LSA (i.e., Kitamaat IR No.1; Figure 5.7-2 and Figure 5.7-4). Eulachon harvest by Haisla on Kitimat River ceased in 1972 due to concerns about industrial pollution (Powell 2013 and Tirrul-Junes 1985), despite a sustained eulachon abundance in Kitimat River.

The central Pacific coast eulachon population found in Douglas Channel is on the provincial blue list (CDC 2012b), considered as *endangered* by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and is under consideration for listing in Schedule 1 of SARA (COSEWIC 2011). Eulachon was not observed during the baseline study, but has been historically observed in the lower Kitimat River in the LSA (Figure 5.7-8).

Freshwater Fish

Anderson, Beaver, and Moore creeks are confined by the presence of dikes that divert all surface flow into the estuary on the west side of Kitimat River (Figure 5.7-3). Fish species of CRA importance that are previously known to be supported by, and those observed in, LSA aquatic habitat are listed in Table 5.7-7.

All species listed in Table 5.7-7 are fisheries of CRA importance. Additional observed fish species include threespine stickleback (*Gasterosteus aculeatus*), sculpins (e.g., *Leptocottus sp.* and *Cottus spp.*), lamprey (*Lampetra sp.*), and starry flounder (*Platichthys stellatus*). These are species capable of supporting these fisheries.

Seasonal catch-per-unit-area (CPUA) data provided relative abundance estimates of freshwater fish in the LSA (Table 5.7-8). Additional catch-per-unit-effort (CPUE) data collected during winter used acceptable capture methods (i.e., minnow trapping) and are provided in Table 5.7-9. The *Freshwater and Estuarine Fish and Fish Habitat TDR* summarizes the total catch in the LSA using all capture methods (Triton 2014a).

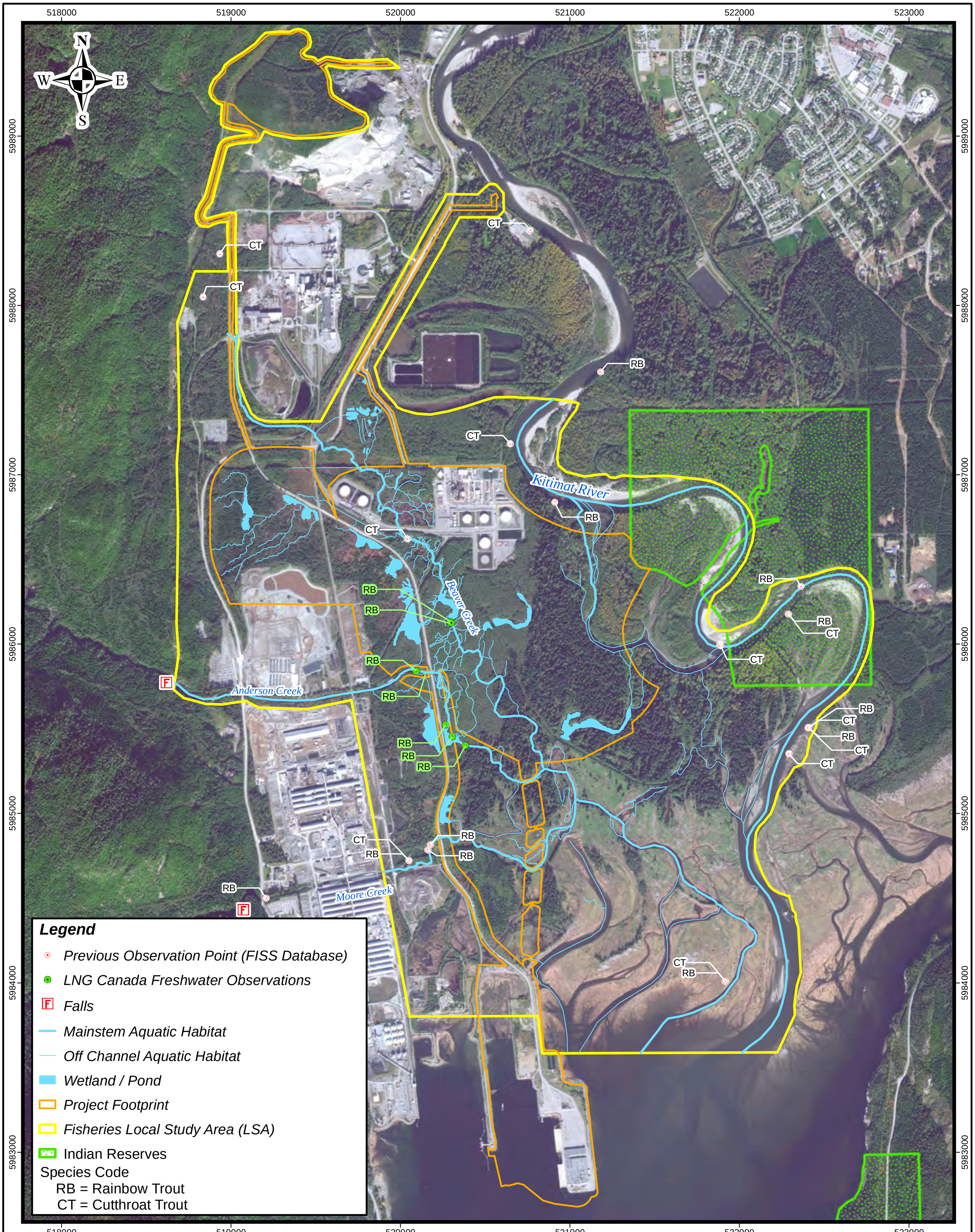

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Figure 5.7-6 - Trout Observations in the Local Study Area

Basemap Source: Orthophoto	Scale: 1:30,000	Map Datum: UTM NAD 83 Zone 9

Project No:	File No:	Date:
6018	Map#: N:\ACTIVE\6018_Kitimat_Creeks\MXD\Report_Mapping\Fish_BaseFig3.2-2.mxd	Aug 25, 2014

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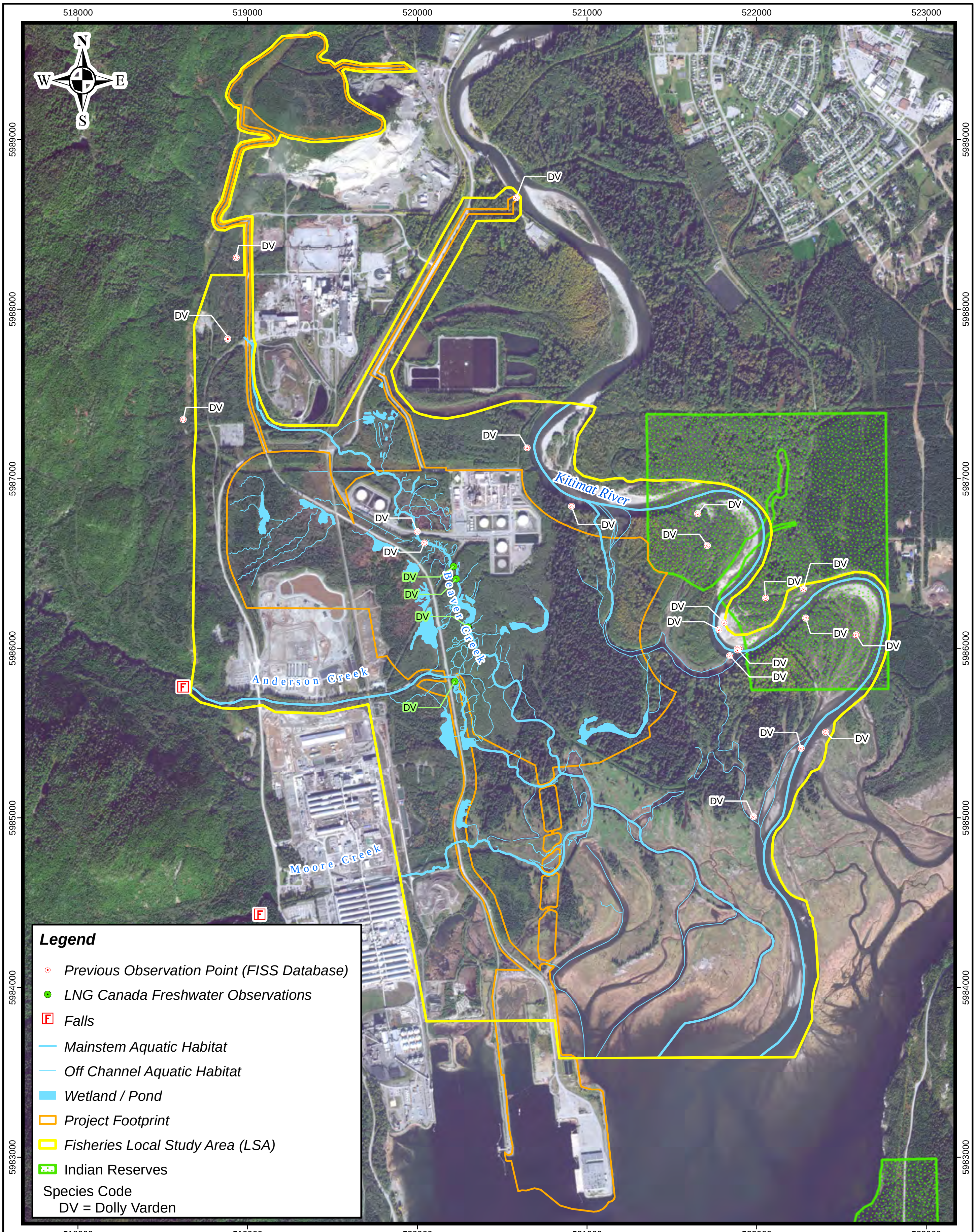

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Figure 5.7-7 - Dolly Varden Observations in the Local Study Area

Basemap Source:	Scale: 1:30,000	Map Datum:
Orthophoto	200 100 0 200 400 600 800 Meters	UTM NAD 83 Zone 9

Project No:	File No:	Date:
6018	Map#: N:\ACTIVE\6018_Kitimat_Creeks\MXD\Fish_Base.mxd	Aug 25, 2014

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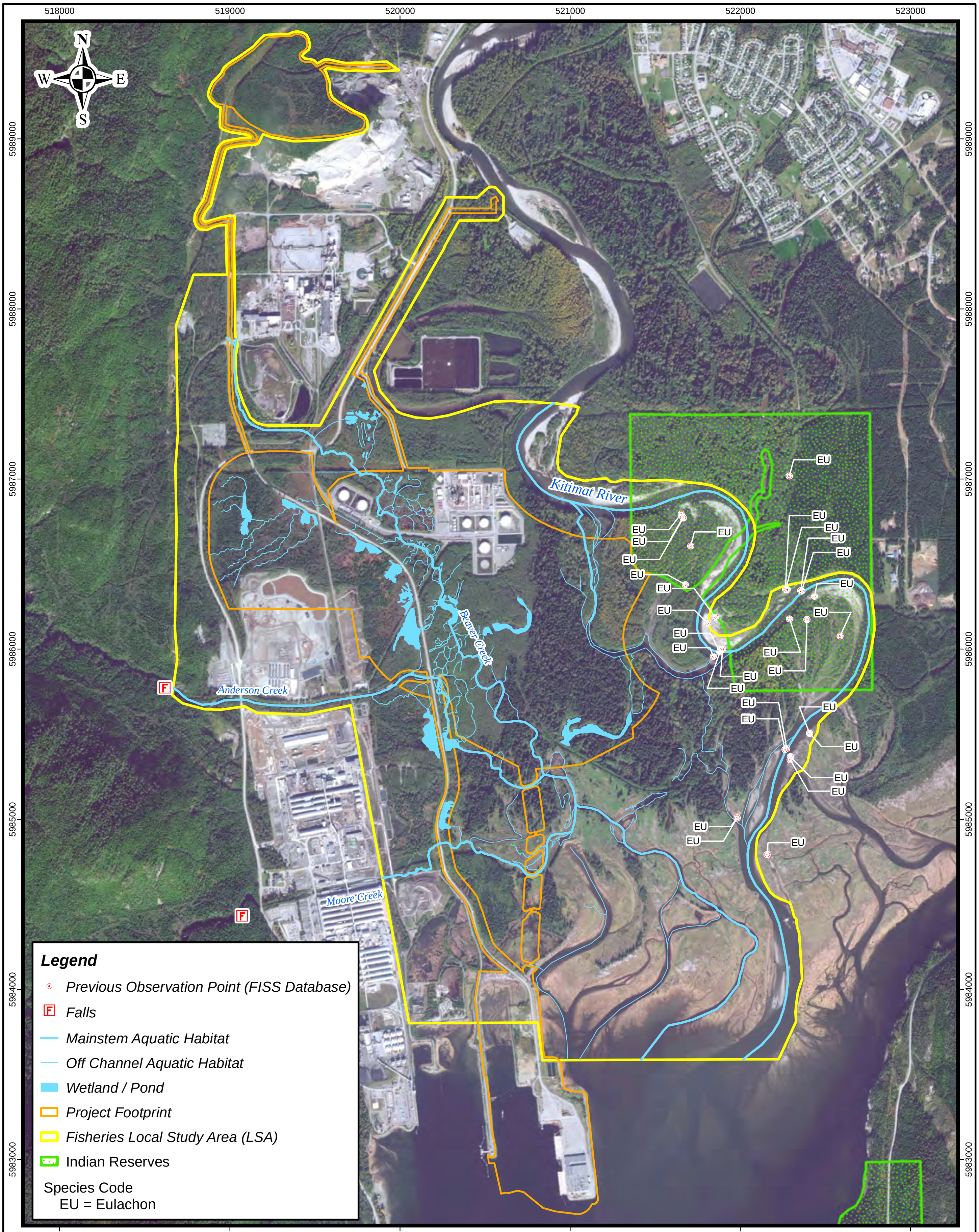

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Figure 5.7-8 - Eulachon Observations in the Local Study Area

Basemap Source:	Scale: 1:30,000	Map Datum:
Orthophoto	200 100 0 200 400 600 800 Meters	UTM NAD 83 Zone 9

Project No:	File No:	Date:	
6018	Map#: N:\ACTIVE\6018_Kitimat_Creeks\MXD\Fish_Base.mxd	Aug 25, 2014	TRITON ENVIRONMENTAL CONSULTANTS LTD.

Table 5.7-7: Fish Species of CRA Importance in Local Study Area Watercourses

Species	Life Stage	Estuary	Kitimat River	Moore Creek	Anderson Creek	Beaver Creek
Chinook salmon	Juvenile	✓	✓		✓	✓
	Adult		✓			
Chum salmon	Juvenile	✓	✓	✓	✓	
	Adult		✓	✓	✓	
Pink salmon	Juvenile	✓	✓	✓	✓	
	Adult		✓	✓	✓	
Sockeye salmon*	Juvenile	✓	✓			
	Adult		✓		✓	
Coho salmon	Juvenile	✓	✓	✓	✓	✓
	Adult		✓	✓	✓	✓
Steelhead trout	Juvenile		✓			
	Adult		✓			
Rainbow trout	Juvenile		✓	✓	✓	✓
	Adult		✓	✓	✓	✓
Cutthroat trout	Juvenile		✓	✓		✓
	Adult		✓	✓		✓
Dolly Varden	Juvenile		✓		✓	✓
	Adult		✓		✓	✓
Eulachon	Juvenile		✓			
	Adult		✓			

NOTE:
*Adults probably are strays from the Kitimat River run are not expected to have successfully spawned in Anderson Creek.

Table 5.7-8: Mainstem Closed-site Electrofishing Catch-per-unit-area Data for all Seasonally Sampled Streams

Stream	Season	Species	CPUA (fish/m^2)
Anderson Creek	June 2012	Coho salmon	0.13
		Coastrange sculpin	0.15
	September 2012	Coho salmon	0.51
		Coastrange sculpin	0.25
		Prickly sculpin	0.03
		Rainbow trout	0.03
Beaver Creek	May 2012	Coho salmon	0.14
		Threespine stickleback	0.02
		Lamprey	0.01
	June 2012	Coho salmon	0.17
		Threespine stickleback	0.12
		Lamprey	0.05
		Coastrange sculpin	0.01
Moore Creek	June 2012	Coho salmon	0.06
		Coastrange sculpin	0.25
	September 2012	Coho salmon	0.72
		Coastrange sculpin	0.63
		Starry flounder	0.03
		Rainbow trout	0.03
		Threespine stickleback	0.03
Cecil Creek (control stream)	June 2012	Cutthroat Trout	0.34
		Dolly Varden	0.04
		Coho salmon	0.03
	September 2012	Cutthroat trout	1.56
		Coho salmon	0.35

Table 5.7-9: Winter Minnow Trap Catch-per-unit-effort (Fish/hour) for Mainstem Streams and Overall Habitat

Minnow Trap Type	Location	December 2012		January 2013		March 2013	
		mean	σ	mean	σ	mean	σ
Coho salmon							
Small Gee trap CPUE	Anderson Creek	–	–	0.04	0.00	0.15	0.01
	Beaver Creek	–	–	–	–	0.47	0.49
	Moore Creek	–	–	–	–	0.14	0.13
	Kitimat River side channel	–	–	0.13	0.14	–	–
	Overall (including off-channel)	–	–	0.41	0.48	0.22	0.29
Large mesh trap CPUE	Anderson Creek	–	–	–	–	0.33	–
	Overall (including off-channel)	0.14	0.18	0.14	0.01	0.12	0.15
Threespine stickleback							
Small Gee trap CPUE	Beaver Creek	–	–	0.14	0.09	0.14	0.09
	Moore Creek	–	–	0.06	–	0.06	–
	Kitimat River side channel	0.17	0.21	–	–	–	–
	Overall (including off-channel)	0.32	0.30	0.11	0.08	0.11	0.08
Large mesh trap CPUE	Kitimat River side channel	0.05	0.00	–	–	–	–
	Overall (including off-channel)	0.05	0.01	0.04	0.01	0.04	0.01

NOTES:
σ – standard deviation
– not collected

Estuarine Fish

Juvenile pink salmon and chum salmon migrate downstream to the Kitimat River estuary following emergence. Juvenile chinook and coho salmon rear for up to two years in the lower Kitimat River mainstem and adjacent tributaries and were observed occupy estuarine channels directly following freshet events. Eulachon larvae passively drift to the estuary from freshwater areas of incubation immediately upon emergence (Hay and McCarter 2000; McPhail 2007). Threespine stickleback and Pacific staghorn sculpin (*Leptocottus armatus*) are found in estuary channels at all life stages year-round. Estuary catch data are summarized in Table 5.7-10 for all baseline sites in the LSA.

Table 5.7-10: Standardized Catch-per-unit-area by Species for all Estuarine Sampling Sites in the Local Study Area

Species	Site EA-1 (fish/m^2)		Site EA-2 (fish/m^2)		Site EA-3 (fish/m^2)		EC-1 (control site) (fish/m^2)	
	mean	σ	Mean	σ	mean	σ	mean	σ
Chinook salmon	0.0010	0.0035	0.0009	0.0021	0.0001	0.0004	0.0094	0.0004
Chum salmon	0.0230	0.0730	0.0220	0.0630	0.0075	0.0183	0.0033	0.0180
Coho salmon	0.0010	0.0019	0.0028	0.0065	0.0022	0.0068	0.0310	0.0070
Pink salmon	0.0001	0.0005	ND	–	0.0001	0.0002	0.0000	0.0002
Sockeye salmon	0.0001	0.0002	0.0005	0.0018	ND	–	ND	–
Threespine stickleback	0.0001	0.0003	0.2580	0.6780	0.0017	0.0041	0.0045	0.0041
Pacific staghorn sculpin	0.0042	0.0045	0.0230	0.0710	0.0038	0.0049	0.0210	0.0050
Starry flounder	0.0000	0.0001	ND	–	ND	–	ND	–

NOTES:

σ – standard deviation
ND – not detected
– not determined

Overall, coho salmon is the most abundant and widely distributed species relevant to CRA fisheries in the LSA. Annual coho salmon runs occur in all streams examined. A predominance of juvenile coho salmon throughout LSA freshwater and estuarine habitats might be influenced by additional recruitment from Kitimat River. Juvenile coho salmon displaced from Kitimat River during high flow events have more direct access to freshwater habitat in Moore, Anderson, and Beaver creeks from the estuary. Consequently, juvenile coho salmon are used as the species and life stage for which HSI-based productivity of fish habitat is determined in the effects assessment.

5.7.3.3.2 Fish Habitat

Freshwater Mainstem Habitat

Area measurements of mainstem aquatic habitat in the LSA from seasonal Level 1 FHAP data are listed in Table 5.7-11. Habitat suitability of the observed fish species was based on stream depth, velocity, substrate, and cover information from the discharge transects and Level 2 FHAP data. Productivity of mainstem habitat considered HSI values for juvenile coho salmon, given the habitat parameters in representative mesohabitats (Table 5.7-12). The combined information expressed productivity in HU based on the wetted area W_A of mainstem aquatic habitat available to fish during the winter season.

Table 5.7-11: Wetted Area (W_A) Measurements and Habitat Unit (HU) Estimates for Mainstem Aquatic Habitat

Mainstem Stream	W_A (m^2)				HU			
	Pool	Riffle	Run	Total	Pool	Riffle	Run	Total
Beaver Creek	6,914	1,680	14,175	22,769	6,509	766	9,037	16,312
Anderson Creek	112	875	385	1,372	108	309	164	581
Moore Creek	523	345	494	1,362	520	117	345	982
Kitimat River side channel	500	412	5,305	6,217	430	173	2,975	3,578
Total	**8,049**	**3,312**	**20,359**	**31,720**	**7,567**	**1,365**	**12,521**	**21,453**

Table 5.7-12: Habitat Parameters for Juvenile Coho Salmon in Mainstem Habitats

Habitat Parameter	HSI	Habitat Parameter	HSI
Depth Preference (m)		**Velocity Preference (m/s)**	
0.00	0.00	0.00	1.00
0.05	0.34	0.05	1.00
0.10	0.61	0.10	1.00
0.15	0.81	0.15	0.91
0.20	0.94	0.20	0.72
0.25	1.00	0.25	0.52
0.30	1.00	0.30	0.33
0.35	1.00	0.35	0.18
0.40	1.00	0.40	0.06
0.45	1.00	0.45	0.00
0.50	1.00	0.50	0.00
Substrate Preference		**Cover Preference**	
Rock	0.20	Undercut	1.00
Boulder	0.50	Instream Vegetation	0.40
Large Cobble	0.70	Emergent Vegetation	0.40
Small Cobble	0.80	Overhanging Vegetation	0.10
Large Gravel	1.00	Wood	1.00
Small Gravel	1.00	Boulder	0.50
Sand/Silt	0.45		
Detritus	0.30		

Mainstem channels in the LSA are generally dominated by run-type mesohabitats. Overall spawning capacity is limited by natural upstream fish barriers (i.e., falls) located along the western boundary of the LSA on Moore and Anderson creeks (Figure 5.7-3). Beaver Creek also supports limited spawning habitat within the Project footprint and associated safety zone. Coho spawning is known to occur further upstream in Beaver Creek, although this was not observed in the study period. Off-channel habitats of all streams in the LSA are seasonally important for rearing and overwintering, particularly on the west side of a previously constructed dike approximately 2 km in length (refer to Figure 5.7-3).

Freshwater Off-channel Habitat

Cross-channel habitats link individual mainstem streams and an extensive side channel and groundwater-fed blind channel network, which provide additional points of access to habitats between Anderson and Beaver creeks. No interaction of surface flow occurs between the streams to the west of the dike and the Kitimat River side channel system east of the dike (Figure 5.7-3). Beaver Creek has limited spawning potential, but holds a high capacity for rearing and overwintering of juvenile coho salmon, given extensive undercuts, vegetative cover, and large woody debris. At least a portion of these fish are able to migrate between Beaver, Anderson, and Moore creeks at all times of the year, but remain upstream of the estuary during winter, due to elevated salinity levels.

Seasonal factors appear to restrict the availability of off-channel habitat and this influences the timing of fish distribution throughout the LSA. Low flows in late summer and late winter reduce overall available freshwater habitat and can lead to fish being stranded when they become trapped in ephemeral pools. A combination of seasonally elevated water temperatures and reduced flows can lead to hypoxic or anoxic conditions. This has been documented in off-channel habitats during low flows in spring (Triton 2014a). Dissolved oxygen was not sampled in off-channel habitat in September 2012, but it is also likely to be the case for late summer low flow periods, especially in isolated wetland complexes and ephemeral pools. The observed pH for 98% of all freshwater samples was between 6.05 and 8.35, with a mean of 7.1 (n = 98), with two locations in the LSA displaying abnormal pH (min = 4.7; max = 10.4). Overall, pH does appear to be a determinant of habitat use by fish in the LSA.

Peak flow events during spring and fall freshets reduce the habitat suitability in the mainstem channels for juvenile fish due to unfavorable stream velocities and water quality conditions (i.e., high turbidity). Flooding of off-channel habitats provides temporary refuge for juvenile coho salmon. Estimates of seasonally available wetted habitat W_A in the LSA are listed in Table 5.7-13. The functional relationship of surface discharge Q (m^3/s) and available wetted area W_A (m^2) of off-channel aquatic habitat provided an estimated area of off-channel aquatic habitat available to fish during late winter. In the Freshwater and Estuarine Fish and Fish Habitat TDR, this was based on the median monthly discharge extrapolated for March using the hydrograph developed for Anderson Creek (Table 5.7-14; Triton 2014a).

Table 5.7-13: Seasonal Estimates of Available Off-channel Freshwater Aquatic Habitat in the Local Study Area

Season	Off-channel Type (m^2)			Wetlands* (m^2)	Total W_A (m^2)
	XC	SC	BC		
September 2012	3,580	7,215	9,118	24,155	44,068
May 2013	6,249	11,184	24,409	24,155	65,918
December 2013	3,580	7,159	11,520	24,155	46,414

*Wetland area is not dependent on surface discharge and has not been seasonally adjusted.
NOTES:
XC – cross-channel habitat;
SC – side channel habitat
BC – groundwater-fed blind channel habitat

Table 5.7-14: Wetted Area W_A of Estimated Freshwater Off-channel Habitat as a Function of Median Monthly Discharge Q_{March}

Metric	Q_{March} (m^3/s)	W_A (m^2)
25th percentile	0.3156	18,967
Median	0.3810	19,914
75th percentile	0.5165	21,548

Estuarine Habitat

Freshwater streams in the LSA are subject to tidal influences in the lower reaches extending directly into the estuary where transitional habitat for salmonid fry and smolts including chum, chinook, coho, pink, and river-type sockeye salmon is available up to the high tide mark. A portion of the estuary at the south end of the LSA is subject to flooding during the spring tides only. It is an area of entrapment for fish (i.e., a source of fish stranding) as flood waters recede and the salt marsh dries up. This habitat is usable, but unsuitable for fish (Figure 5.7-3).

The presence of juvenile salmonids in tidal channels was most pronounced in the spring (i.e., following fry emergence). Coho fry and parr were also observed in tidal channels during spring and fall, due to freshet events. They appear to retreat to upstream freshwater habitats shortly after flows subside and in response to increasing salinity. Stream habitat in Anderson and Beaver creeks is more readily accessible than the Kitimat River mainstem to fish that must retreat to freshwater habitats from the estuary. The 2 km long dike, which was originally constructed on the floodplain to protect the Alcan (RTA) facility in the 1950s, blocks access to freshwater habitats in the Kitimat River side channel system from the estuary (Figure 5.7-3). As a result, fish that move from the estuary back into freshwater remain confined to habitat on the west side of the dike over winter. Haisla Nation believes that coho salmon from the Kitimat River use these channels west of the dike following seasonal flushing events associated with freshet flows (Bolton 2013, pers. comm.); the baseline assessment cannot determine conclusively if this is the case, although the observations support this view.

5.7.4 Project Interactions

Table 4.4–1 (Section 4) identifies potential interactions of concern between Project activities and each of the selected VCs. The extent to which the interactions are considered is ranked in Table 5.7-15. The rankings (i.e., 0, 1, or 2) are defined in a footnote to the table.

A conservative approach is taken in assigning a rank of 1, whereby interactions with a meaningful degree of uncertainty are assigned Rank 2 so that a detailed effects assessment is conducted.

Table 5.7-15: Potential Effects on Freshwater and Estuarine Fish and Fish Habitat

Project Activities and Physical Works	Potential Effect		
	Change in Fish Habitat	Change in Risk of Physical Injury or Mortality to Fish	Change in Fish Health
Facility Activities and Works			
Construction			
Site preparation (clearing, grubbing, grading, levelling, and set-up of temporary facilities)	2	2	1
Onshore construction (installation of LNG facility, utilities, ancillary support facilities, access roads, and includes hydrotesting)	1	2	1
Vehicle and rail traffic (haul road upgrades, road use, vehicle traffic)	1	1	1
Operation			
LNG production (including natural gas treatment, condensate extraction, storage in tanks, and transfer onto rail cars,) storage and loading	1	2	1
Vehicle and rail traffic (road use, vehicle traffic)	0	1	0
Decommissioning			
Dismantling of land-based and marine infrastructure	1	1	1
Remediation and reclamation of the site	1	1	1

KEY:

0 = No interaction.

1 = Potential adverse effect requiring mitigation, but further consideration determines that any residual adverse effects will be eliminated or reduced to negligible levels by existing codified practices, proven effective mitigation measures, or BMPs.

2 = Interaction may occur and the resulting effect may exceed negligible or acceptable levels without implementation of Project-specific mitigation. Further assessment is warranted.

NOTE: Only activities with an interaction of 1 or 2 for at least one effect are shown. Change in fish health has been further discussed in this assessment based on direct linkages to other VCs: Marine Resources (Section 5.8) and Water Quality (Section 5.9).

5.7.4.1 Justification of Interaction Rankings

Interactions ranked 0 indicate Project activities that do not have potential effects on freshwater and estuarine fish and fish habitat. These interactions are not further discussed in this assessment. Interactions ranked 1 and 2 are discussed in detail in this section or in Section 5.7.5 and summarized in Section 5.7.6. They are further discussed in the context of the cumulative effects assessment in Section 5.7.7.

Site Preparation

Site preparation will include clearing, grubbing, grading, leveling, and set-up of temporary facilities. Use of industrial machinery will involve the use of hazardous materials (e.g., fuels and hydraulic fluids). Effective mitigation will include the use of appropriate systems for safe handling, such as the Workplace Hazardous Materials Information System (WHMIS) and BMPs for spill prevention. A spill response plan will be included as part of the environmental management plans (EMPs) for the Project.

The effects from loss of vegetation will increase risk of effects on water quality due to erosion, which could potentially harm fish or impair fish health. It will be necessary to implement environmental monitoring, which will include an erosion and sediment control (ESC) plan. Any temporary stream crossings must conform to provincial standards. Potential effects on nearby freshwater and estuarine habitat can be managed or avoided with adherence to:

- Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993)
- Measures to Avoid Causing Harm (DFO 2013d)
- Standards and Best Practices for Instream Works (MWLAP 2004), and
- Fish-stream Crossing Guidebook (MFLNRO et al. 2012).

Onshore Construction

Onshore construction, including the installation of LNG facility components, utilities, ancillary support facilities, and access roads could have potential effects on fish habitat and fish health. Effects on fish habitat and fish health can be managed or avoided with mandatory employment of safe work practices (i.e., WHMIS) including any transportation of dangerous goods (TDG) near watercourses, adherence to guidelines (DFO 1993, 2013d; MWLAP 2004; MFLNRO et al. 2012), and industry-specific standard BMPs under the Environmental Protection and Management Guidelines (EPMG; e.g., CAPP et al. 2005). Effects that result as unexpected occurrences due to an accident or malfunction are assessed in Section 10, Accidents or Malfunctions.

Hydrostatic testing of pipelines and cooling infrastructures involves the withdrawal, test use, potential treatment of the water used in the process, and discharge. The *Hydrostatic Test Water Management*

Guidelines (CAPP 1993) state the requirements necessary to manage effects on freshwater and estuarine fish and fish habitat. The *Freshwater Intake End-of-Pipe Fish Screen Guideline* (DFO 1995) will be followed to avoid or manage risk of entrainment and impingement of fish through the placement of fish screens on water intakes. Water use from Kitimat River could potentially lead to interactions with downstream fish.

Standard mitigation measures and best practices include:

- Design and installation of stream crossings to a 1:100 year flow event at a minimum (Mitigation 5.7-1).
- Restoration of fish access with the removal of migration barriers (where applicable).
- To minimize potential sedimentation of watercourses, disturbed riparian areas will be reclaimed with appropriate vegetation cover, as soon as practicable after construction (Mitigation 5.7-2).
- If isolating freshwater habitats during instream works occurs, fish will be salvaged and relocated to unaffected habitats (Mitigation 5.7-3).
- An onsite environmental monitor will be present during all instream (freshwater) works to confirm adherence with measures detailed in the Fish Habitat Offsetting Plan (Mitigation 5.7-4).
- To minimize impact to fish and fish habitat, instream works will occur within the relevant reduced risk work windows, where practicable. Where Project activities need to occur outside the reduced risk work windows, measures to protect fish and fish habitat will be developed in consultation with appropriate regulatory bodies including DFO. These measures will be detailed in the Fish Habitat Offsetting Plan (Mitigation 5.7-5).
- Establish and implement a Spill Response Plan as part of a broader Emergency Response Plan with input from relevant agencies (Mitigation 7.2-7).
- Measures to protect fish and fish habitat will be provided in various EMPs including a Fish Habitat Offsetting Plan, an Erosion and Sediment Control Plan, a Surface Water Management Plan, and a Wastewater Management Plan (Mitigation 5.7-6).

As outlined in Section 12.1.12 of the EMPs for LNG Canada, a Surface Water Management Plan will include:

- stormwater will be collected, treated, tested and discharged as well as any follow-up monitoring requirements
- best management practices, such as diverting external surface water runoff around the facility to avoid potential contamination.

A Wastewater Management Plan will include:

- a framework describing how wastewater (including effluent such as hydrostatic test water) and sanitary sewage, will be collected, treated, tested and discharged as well as any follow-up monitoring requirements.

Vehicle and Rail Traffic (haul road upgrades)

Measures to mitigate adverse effects resulting from the haul road upgrades or vehicle use are identified in specific guidebooks and BMPs such as the *Standards and Best Practices for Instream Works* (MWLAP 2004) and the *Fish-stream Crossing Guidebook* (MFLNRO et al. 2012), as well as the OGC *Environmental Protection and Management Guidelines* (OGC 2013). These measures are either based on regulatory standards for various activities (e.g., road building standards) or are generally accepted procedures for mitigating adverse effects (e.g., measures to avoid or manage the introduction of suspended sediments). Where appropriate, these standard BMPs will mitigate the potential for water quality changes that could lead to changes in fish habitat, injury or mortality to fish, or change in fish health throughout the construction and operation phases of the Project.

Improvements to roads will not affect the current level of access to fish habitat in the LSA by fishers because the Project will remain restricted from general public use, for safety considerations. This will prevent any increase in fishing pressure that might lead to change in risk of injury or mortality of fish.

LNG Production

Production of LNG during the operation phase will involve a maximum water use of approximately 70,000 m^3/day at full build-out (approximately 3,000 m^3/hour for all facility processes), which includes an estimated 15,000 m^3/day for each of four LNG trains plus water for use in other facility processes. Water withdrawal of this volume could potentially exceed seasonal instream flow needs (IFN) from Kitimat River, with a potential for interaction to occur through the impairment of fish access to potential habitat. The OWMP will be necessary for monitoring water use, especially during the winter period when water availability is lowest.

The Surface Water Management Plan (Mitigation 5.5-9) and Wastewater Management Plan (Mitigation 5.7-7) includes a framework describing how respective stormwater and wastewater (including cooling water effluent) will be collected, treated, tested and discharged, as well as any follow-up monitoring requirements.

Access to fish habitat in the LSA will remain restricted from general public use for safety considerations. This will prevent any increase in fishing pressure that might lead to change in risk of injury or mortality of fish.

Conclusions from Other Assessment Sections Regarding LNG Production

The following sections contain assessment results that suggest that no further detailed assessment for change in fish health from LNG production (ranked as 1) is warranted:

- Section 5.9, Surface Water Quality, which is based on the Surface Water Quality TDR (Stantec 2014b)
- effects modelling based on Section 5.2, Air Quality, and
- Section 5.8, Marine Resources.

Summary

LNG production and associated industrial activities will contribute emissions to the airshed, including sulphur dioxide (SO_2) and nitrogen oxides (NO_x). The potential for effects to cause a change in fish health depends on the nature of emissions; sulphur-based and nitrogen-based emissions, as well as other chemical species can affect pH and nutrient levels in nearby watercourses. Estimated tonnages of SO_X and NO_X are determined from effects modelling in the Section 5.2, Air Quality. Potential for acidification (i.e., pH) and eutrophication (i.e., nutrient concentration) in surface waterbodies within a defined LSA of 79,830 ha around the Project is discussed in Section 5.9, Water Quality.

In the surface water quality assessment, the determination of acidification and eutrophication effects is based on a conservative approach to protect all aquatic life. With respect to acidification potential (Section 5.9.5.2), a single waterbody (End Lake; LAK 06), which is approximately 1% of all sites sampled, has a low magnitude of critical load exceedance in the application case (2.2 meq/m^2/year), which is not evident in the base case (-0.012 meq/m^2/year). With respect to change in trophic status causing eutrophication (Section 5.9.5.3), no freshwater systems will have a change in trophic status compared to base case and two lakes that are currently eutrophic will have negligible changes in nitrogen loading (0.2% to 0.4% increase). Residual and cumulative effects on surface water quality from Project emissions are assessed to be not significant (refer to Section 5.9.5.4). Effects on fish health due to Project emissions are not expected to occur since the conservative approach used to evaluate the acidification of freshwater systems is anticipated to protect all biota. In addition, the marine resources assessment (Section 5.8.5.3) concludes that “change in fish health as a result of toxicity related to the LNG facility is assessed as not significant.”

Waste Management

Operational water use for cooling during the liquefaction process will withdraw water from Kitimat River. Cooling water will be pre-treated and contained within a closed loop system. Water lost due to evaporation will be actively replenished by withdrawal from Kitimat River. There will also be a recurring discharge of about 10% to 15% of the volume to flush minerals out of the system. This discharge will be directed to the wastewater treatment ponds for testing prior to discharge. Stormwater that accumulates in the facility site due to precipitation and runoff will be gathered in stormwater ponds, tested for compliance, and then reused for process water where possible or discharged into marine environment by a buried pipeline. The buried pipeline will be adjacent to the loading line.

Discharge of waste is prohibited for all industrial operations under the *Environmental Management Act,* except in accordance with the conditions of a permit (MOE 2014). All wastewater from site will be appropriately monitored and treated, as necessary, to protect the aquatic receiving environment. Mitigation to manage or prevent a change in fish health as a result of toxicity from the LNG facility is discussed in Section 5.8, Marine Resources. Wastewater discharged from the LNG facility during all phases must meet regulatory standards designed to protect aquatic life; therefore, no residual effect on fish health is expected for marine fisheries (Section 5.8.4.1), and by extension, estuarine fisheries.

Decommissioning of Land-based and Marine Infrastructure

The Project's environmental management system and specific EMPs will incorporate and carry strategic level requirements for later integration of required elements into the decommissioning process. Therefore, residual effects from the dismantling of land-based infrastructure will not occur. Appropriate standards and BMPs used will reflect modifications to guidelines, should they change over the lifespan of the Project. A Decommissioning Environmental Management Program will be necessary component of the framework and will appropriately address waste management, dismantling, and removal of instream works. Develop and implement a Decommissioning Plan before decommissioning to allow habitat recovery and wildlife movement to proceed as soon as possible (Mitigation 5.6-4).

5.7.5 Assessment of Residual Effects

5.7.5.1 Analytical Methods

5.7.5.1.1 Analytical Assessment Techniques

The analytical approach to the assessment of residual effects relies on the *Practitioners Guide to the Risk Management Framework for DFO Habitat Management Staff* (DFO 2010). It presents the type of activities for each phase of the Project, known stressors associated with each activity, and the potential effects on freshwater and estuarine fish and fish habitat. A pathway of effects diagram illustrates potential causal relationships between Project mechanisms and receptors in the receiving environment and is contained in the Freshwater and Estuarine Fish and Fish Habitat TDR (Triton 2014a Appendix F). The associated mitigation measures listed in Section 5.7.4.1 effectively manage the potential for residual effects for each pathway.

Quantification of permanent alteration to or destruction (i.e., PAD) of fish habitat is contained in the Freshwater and Estuarine Fish and Fish Habitat TDR (Triton 2014a Appendix F). It includes a detailed description of the method developed to evaluate PAD of fish habitat using a series of quantitative analyses and qualitative descriptions as measurable parameters.

5.7.5.1.2 Assumptions and the Conservative Approach

Uncertainty arises both as a result of natural variation in the empirical approach to evaluate effects and the likelihood that some degree of modification to the engineering and design of the Project will occur and may change expected effects. Consequently, the assessment takes a conservative approach. Assumptions in the evaluation of productivity are discussed in detail in the Freshwater and Estuarine Fish and Fish Habitat TDR for this assessment (Triton 2014a). A brief summary includes the following assumptions:

- The seasons surveyed for the baseline assessment are representative of current conditions, on average, for fish use within an acceptable margin of error.
- Fish sampling effort assumed constant capture probability among cohorts within a single age class, but acknowledged that capture probability will differ among ages and is dependent on the capture method.
- Catch data are representative of the relative abundance and distribution of fish in the LSA during individual seasons.
- Stream mesohabitats units mapped and measured as part of the baseline examination of mainstem streams are representative of general fish habitat conditions found within mainstem stream channels of the LSA.
- Channel and cover characteristics described at individual sample sites within stream reaches are representative of general conditions found within mainstem stream reaches of the LSA.
- Availability of off-channel stream habitat is positively correlated with stream discharge as an independent variable continuously measured in the mainstem channel of Anderson Creek above the area of surface flow interaction with Beaver Creek.
- Availability of ponded habitat in wetlands is not dependent on stream discharge; rather, it is a function of groundwater availability.
- Beaver Creek discharge relative to Anderson Creek discharge is directly proportionate to the component spatial area of each sub-drainage in the total catchment area of the drainage basin.

The Freshwater and Estuarine Fish and Fish Habitat TDR provides a detailed description of the estimation procedures used to evaluate changes in fish habitat as an empirical habitat-based approach that included all affected streams directly displaced by the Project footprint (Triton 2014a, Appendix F). Based on information provided at the time of the Application, engineering constraints have resulted in adjustments to the total amount of affected freshwater fish habitat due to the need for realignment of Beaver Creek in order to overcome geotechnical constraints. This additional fish habitat has not been evaluated using the procedure developed in the Freshwater and Estuarine Fish and Fish Habitat TDR (Triton 2014a, Appendix F). Consequently, conservative estimates are used that assume optimal suitability of aquatic habitat for fish in these habitats. Results have been reported in this assessment with the intent of refining the precision of any Project effects, as required under the federal *Fisheries Act,* prior to the issuance of an Authorization under paragraph 35(2)(b).

5.7.5.2 Assessment of Changes in Fish Habitat

5.7.5.2.1 Description of Project Effect Mechanisms for Changes in Fish Habitat

Site preparation during the construction phase of the Project involves the removal of riparian habitat and the clearing and grading of the site resulting in areas of exposed mineral soils that have the potential to create sediment-laden water during rainfall events. Site preparation also involves the removal of aquatic habitat with infilling of mainstem and off-channel streams and fish-bearing wetlands, as well as grading, construction, and expansion of roads and linear ROWs. The removal of aquatic ecosystems in the LSA could directly affect salmonid species through reduced access to spawning, rearing, and overwintering habitats if mitigation and offsetting are not developed and implemented. Temporary instream works might also reduce the abundance of benthic invertebrates and adversely affect food availability for resident salmonids.

5.7.5.2.2 Mitigation for Changes in Fish Habitat

The following mitigation measures will manage potential adverse changes in fish habitat and offset PAD:

- Footprint for LNG facility and temporary construction facilities will be sized to allow safe and efficient construction. Existing cleared areas will be utilized, where practicable, to limit area of new disturbance (Mitigation 5.3-4).
- Design of the LNG loading line corridor will consider and incorporate, where practicable, ways to maintain tidal flow and wildlife passage (Mitigation 5.5-8).
- Design stream crossings to a 1:100 year flow event at a minimum (Mitigation 5.7-1).
- To minimize impact to fish and fish habitat, instream works will occur within the relevant reduced risk work windows, where practicable. Where Project activities need to occur outside the reduced risk work windows, measures to protect fish and fish habitat will be developed in consultation with appropriate regulatory bodies including DFO. These measures will be detailed in the Fish Habitat Offsetting Plan (Mitigation 5.7-5).
- If isolating freshwater habitats during instream works occurs, fish will be salvaged and relocated to unaffected habitats (Mitigation 5.7-3).

- To minimize potential sedimentation of watercourses, disturbed riparian areas will be reclaimed with appropriate vegetation cover, as soon as practicable after construction (Mitigation 5.7-2).
- An onsite environmental monitor will be present during all instream (freshwater) works to confirm adherence with measures detailed in the Fish Habitat Offsetting Plan (Mitigation 5.7-4).
- Measures to protect fish and fish habitat will be provided in various EMPs including a Fish Habitat Offsetting Plan, an Erosion and Sediment Control Plan and Surface Water Management Plan and Wastewater Management Plan (Mitigation 5.7-6).
- The Fish Habitat Offsetting Plan will be developed and implemented to offset unavoidable permanent alteration or destruction of fish habitat from Project activities and works, in consultation with DFO, Haisla Nation, and key stakeholders (Mitigation 5.7-8).
- An Erosion and Sediment Control Plan will be developed and implemented to manage surface water and avoid sedimentation in adjacent vegetation communities (Mitigation 5.5-5).
- A Surface Water Management Plan will be developed to address stormwater collection, treatment, and disposal during construction and operation (Mitigation 5.5-9).
- A Wastewater Management Plan will be developed to address wastewater collection, treatment, and disposal during construction and operation (Mitigation 5.7-7).

Avoidance

Design considerations take into account a reduction in the amount of freshwater and estuarine fish habitat subjected to PAD, including the avoidance of mainstem channels of Anderson and Moore creeks. Delineation of the Project footprint allows Anderson and Moore creeks to flow unobstructed across the Project footprint downstream to the estuary, with habitat effects restricted to linear corridors, including the haul road at the crossings. The LNG loading line corridor, which will traverse estuarine habitat to the marine terminal, will be over and above the creeks, allowing for continued fish passage and habitat use. Fish passage will also remain unobstructed for smaller estuarine flood channels extending off the mainstem channel of Moore Creek. The smaller estuarine channels flood periodically due to tidal flows and will effectively remain accessible to fish in the estuary.

Channel Realignment

Where effects on fish and fish habitat cannot be avoided, sections of mainstem Beaver Creek and the Kitimat River side channel will be realigned to mitigate effects on freshwater fish habitat near the Project footprint. This mitigation measure will maintain fish migration routes from the estuary to upstream spawning habitats. Before site preparation or channel realignment activity occurs, a baseline assessment of benthic production will determine productivity in the affected areas and inform the development of effective offsetting measures. Channel realignments will allow continual flow of Beaver Creek and the

Kitimat River side channel during the construction phase. Effectiveness of channel realignments as a mitigation measure will require a monitoring program.

The Beaver Creek channel realignment will be outside the LNG facility site, but within the Project footprint, roughly parallel to Haisla Boulevard around the west boundary up to the existing RTA footprint, then east towards the haul road (see Figure 5.7-4). The realigned channel of Beaver Creek will be a sufficient distance from the LNG facility to allow for channel design that can support enhanced habitat structures and maintain productivity while providing fish access to upstream spawning habitat and downstream estuary channels. The channel will contain complex woody debris structures favourable to coho salmon and primarily serve as rearing habitat; this will offset the productivity that will be lost in the current channel. Any net loss of productivity in the realigned channel will require habitat offsetting elsewhere, as part of the offsetting plan.

The Kitimat River side channel on the east side of the Project footprint will also require realignment outside the Project footprint, but within the LSA, to maintain flow to the oxbow portion connected to the Kitimat River mainstem. The realigned Kitimat River side channel will be designed to provide sufficient flow and DO levels to support CRA fisheries. This will improve the potential for eulachon recovery, given historic observations in this location (Figure 5.7-8). Pacific salmon spawners were not directly observed in the affected side channel, although recently emerged chum salmon fry were evident in pools during March 2013 and 2014, during late winter base-flow conditions. At least a portion of the affected side channel contains habitat that is suitable for chum salmon spawning. Juvenile coho salmon have also been observed over winter in low numbers. Design of the realigned side channel will continue to support spawning and rearing of Pacific salmon while also potentially contributing to eulachon recovery efforts. The realigned channel will have improved productivity compared to the affected channel. A detailed offsetting plan will be developed to evaluate habitat gains relative to losses.

Offsetting Strategy

Residual effects on fish habitat that cannot be avoided or fully mitigated will require an Application for Authorization under paragraph 35(2)(b) of the *Fisheries Act* (DFO 2013b). The terms of the authorization will involve mandatory habitat offsetting measures that must uphold the guiding principle of no net loss of productivity. Such measures will also effectively address spatial and temporal losses associated with the Project's development timeline. The offsetting strategy is described in the *Conceptual Fish Habitat Offsetting Plan* (Stantec and Triton 2014), which outlines the approach to develop a conceptual plan that will evolve into the final plan to be submitted with the authorization application to DFO.

Quantification of PAD of freshwater and estuarine fish habitat is based on current engineering and design plans. Final PAD will be confirmed prior to submission of the application for a *Fisheries Act* authorization to DFO. An appropriate habitat gain to loss ratio (to achieve no net loss of productivity) will be proposed in that application. Implementing the offsetting measures will result in both the creation and enhancement of freshwater fish habitat, including the provision of functional riparian habitat. Offsetting opportunities will be explored as the offsetting plan designs are further developed, recognizing existing initiatives of local industries, DFO, and Haisla Nation. Initial reconnaissance of all candidate options for offsetting measures will lead to a more detailed examination of site feasibility, which may include topographic, hydrological, and geotechnical surveys as required, followed by detailed design.

Members of the Working Groups requested that benthic productivity (i.e., invertebrates and periphyton) and sediment quality be assessed in potentially affected streams as a measure of ecosystem health. Sediment quality is examined in the Freshwater and Estuarine Fish and Fish Habitat TDR in terms of the assessment of substrate as a habitat parameter for the quantification of PAD (Triton 2014a, Appendix F). Benthic invertebrate and periphyton production will be examined prior to the finalization of offsetting measures, pursuant to requirements of a *Fisheries Act* authorization for the Project.

The offsetting plan will acknowledge instream work windows for the protection of fish. It will also take into account the Project's construction schedule in order to limit the period between PAD of fish habitat and implementation of offsetting measures.

Post-Closure Reclamation and Follow-up Monitoring

Following the operational life of the Project, rehabilitation efforts must comply with all statutory requirements at the time. Rehabilitation will include the remediation of contaminated sites and reclamation of habitat for use by fish, including the replanting of riparian vegetation. Given the current statutory requirements for habitat offsetting, reclamation efforts will provide a net benefit to fish. Reclamation will require a period of effectiveness monitoring to ensure that riparian vegetation is re-established.

5.7.5.2.3 Characterization of Change in Fish Habitat

Construction

In the freshwater part of the Project footprint, development activities during the construction phase are estimated to result in a one-time, direct loss of fish habitat of approximately:

- 891,300 m^2 of riparian habitat consisting of:
  - 837,300 m^2 of stream riparian habitat
  - 54,000 m^2 of pond and wetland riparian habitats of value to fish
- 75,500 m^2 of aquatic habitat consisting of:
  - 25,200 m^2 of mainstem channel habitat (expressed as HU)

  - 19,700 m^2 of off-channel habitat, and
  - 30,600 m^2 of wetland habitat.

Modification to additional freshwater habitat in the LSA, due to the need for realignment of Upper Beaver Creek around the Project footprint, are estimated to result in a one-time, direct loss of fish habitat of approximately:

- 168,700 m^2 of riparian habitat consisting of:
  - 51,700 m^2 of riparian habitat along Upper Beaver Creek mainstem
  - 117,000 m^2 of off-channel wetland riparian habitats of value to fish
- 49,500 m^2 of aquatic habitat consisting of:
  - 5,200 m^2 of mainstem channel habitat (i.e., Upper Beaver Creek)
  - 27,600 m^2 of off-channel habitat, and
  - 16,700 m^2 of wetland habitat.

Construction will therefore result in the PAD of up to 125,000 m^2 of freshwater aquatic habitat (see Table 5.7-16).

Wetted mainstem freshwater fish habitat is presented in Table 5.7-11 in terms of hydraulic channel units (i.e., pool, riffle, and run) expressed as both total area (m^2) and as HU. A portion of the total aquatic freshwater habitat includes off-channel areas that could not be evaluated using the HSI approach because the survey of off-channel habitat did not include discharge or FHAP data. The area estimate of off-channel aquatic habitat is presented in Table 5.7-14 as a function of the median monthly discharge for March 2013 with a lower and upper quartile range. In the Freshwater and Estuarine Fish and Fish Habitat TDR, this estimate is associated with habitat availability at the end of the winter season as the limiting determinant of annual productivity (Triton 2014a, Appendix F).

In the estuarine part of the Project footprint, development activities during the construction phase are estimated to result in a one-time, direct loss of approximately 52,500 m^2 of fish habitat including:

- 29,000 m^2 of riparian habitat consisting of:
  - 20,500 m^2 of riparian habitat associated with streams and tidal channels
  - 8,500 m^2 of riparian habitat associated with wetlands
- 23,500 m^2 of aquatic habitat consisting of:
  - 7,700 m^2 of moderate-value aquatic habitat, and
  - 15,800 m^2 of low-value aquatic habitat associated with a seasonally flooded area of entrapment.

Construction will therefore result in the PAD of up to 23,500 m^2 of estuarine aquatic habitat (see Table 5.7-16).

Table 5.7-16: Type, Productive Capacity, and Area of Serious Harm to Freshwater Fish

Habitat Type	Component	Productive Capacity	Project Mechanism	Area (HU/m²)
Mainstem Aquatic Habitat	Anderson Creek	Moderate	Haul road enhancements	1,280
			Creek realignment at bridge	2,673
	Beaver Creek	High	LNG facility site	17,234
			Upstream diversion of Beaver Creek	5,160[a]
	Moore Creek	Low	Haul road enhancements	417
	Kitimat River Side Channel	Low	LNG facility site	3,577
			Total:	**30,341 HU**
Off-channel Aquatic Habitat (includes wetlands)	Anderson Creek	Moderate	LNG facility site	3,564
			Creek realignment at bridge	1,275
			Haul road enhancements	351
	Beaver Creek	Moderate	Upstream diversion of Beaver Creek	44,264[b]
			LNG facility site	14,358
			Workforce accommodation centre (s)	12,760
	Kitimat River Side Channel	Low	LNG facility site	17,988
			Total:	**94,791**
			Total Aquatic Freshwater Habitat Affected:	**124,901**

NOTES:
[a] Represents gross wetted area of the mainstem channel upstream of the Project footprint due to modifications that allow for channel realignment. It is assumed have an optimum habitat suitability (i.e., HSI = 1) and is based on a conservative estimate.
[b] Represents a conservative estimate of aquatic off-channel habitat upstream of the Project and accessible to fish; area will require more detailed examination as part of the offsetting strategy.

Table 5.7-17: Type, Productive Capacity, and Area of Serious Harm to Estuarine Fish

Habitat Type	Productive Capacity	Project Mechanism	Area (m^2)
Estuarine aquatic habitat	Moderate	▪ LNG facility site ▪ LNG loading line ROW	7,714
Estuarine entrapment habitat	Low	▪ Haul road enhancements ▪ LNG loading line ROW	15,788
		Total Aquatic Estuarine Habitat Affected:	**23,502**

Water withdrawal will be required during all phases of the Project. Water withdrawal rates will comply with conditions of the water licence. Therefore, water drawdown will not affect upstream accessibility by anadromous fish in Kitimat River. According to the Water Availability Report (Stantec 2014a), additional water withdrawal during construction and operation will not lead to adverse effects to IFN under average monthly hydrologic conditions.

Summary

Freshwater and estuarine fish habitat will be permanently lost or altered during site preparation to accommodate the facility components. Habitat will be cleared in the Project footprint and outside of existing disturbed industrial areas for facility buildings, infrastructure, roads, and ROWs for the LNG loading line corridor and water pipeline RoW. The changes in fish habitat are contained in the LSA and occurs as a single event. The magnitude of effects will be negligible due to mitigation through offsetting and will be short-term in duration. With the application of recommended mitigation and environmental protection measures, offsetting, and Project decommissioning and reclamation, changes in fish habitat, including changes in habitat quality and quantity, will be reversible and will not affect the sustainability of fish populations. Because a large proportion of the LSA was previously disturbed by timber extraction and industrial development, fisheries resources in the LSA have a moderate degree of resilience.

5.7.5.2.4 Determination of Significance for Changes in Fish Habitat

PAD will be mitigated through offsetting, in accordance with a *Fisheries Act* authorization for the Project. Therefore, the potential effects on changes in fish habitat quality have a low likelihood of leading to residual effects. Given the legislative requirements of the *Fisheries Act*, changes in fish habitat are assessed as not significant.

5.7.5.3 Assessment of Change in Risk of Physical Injury or Mortality to Fish

5.7.5.3.1 Description of Project Effect Mechanisms for Change in Risk of Physical Injury or Mortality to Fish

Development activities during construction involve infilling of fish-bearing streams, off-channel wetted habitats, and fish-bearing wetted estuarine habitat. Fish in permanently altered or destroyed habitats face potential injury and mortality due to dewatering and infilling activities. Water withdrawal from Kitimat River during construction, as well as during operation of the Project, might lead to entrainment and impingement of juvenile fish, especially planktonic eulachon larvae and juvenile Pacific salmon from the incurrent force of water being drawn in at the intake, thereby causing physical injury or mortality. No physical injury or mortality to fish is expected to occur in the decommissioning phase, with the appropriate mitigation measures identified in Section 5.7.4.1 having been implemented.

5.7.5.3.2 Mitigation for Change in Risk of Physical Injury or Mortality to Fish

The following mitigation measures will manage risk of physical injury or mortality to fish:

- Footprint for LNG facility and temporary construction facilities will be sized to allow safe and efficient construction. Existing cleared areas will be utilized, where practicable, to limit area of new disturbance (Mitigation 5.3-4).
- Design of the LNG loading line corridor will consider and incorporate, where practicable, ways to maintain tidal flow and wildlife passage (Mitigation 5.5-8).
- Design stream crossings to a 1:100 year flow event at a minimum (Mitigation 5.7-1).
- To minimize impact to fish and fish habitat, instream works will occur within the relevant reduced risk work windows, where practicable. Where Project activities need to occur outside the reduced risk work windows, measures to protect fish and fish habitat will be developed in consultation with appropriate regulatory bodies including DFO. These measures will be detailed in the Fish Habitat Offsetting Plan (Mitigation 5.7-5).
- If isolating freshwater habitats during instream works occurs, fish will be salvaged and relocated to unaffected habitats (Mitigation 5.7-3).
- To protect fish from injury and mortality, freshwater habitats to be affected by construction activities will be isolated from adjacent fish-bearing aquatic habitats (Mitigation 5.7-9).
- An onsite environmental monitor will be present during all instream (freshwater) works to confirm adherence with measures detailed in the Fish Habitat Offsetting Plan (Mitigation 5.7-4).
- Measures to protect fish and fish habitat will be provided in various EMPs including a Fish Habitat Offsetting Plan, an Erosion and Sediment Control Plan and Surface Water Management Plan and Wastewater Management Plan (Mitigation 5.7-6):
    - The Fish Habitat Offsetting Plan will be developed and implemented to offset unavoidable permanent alteration or destruction of fish habitat from Project activities and works, in consultation with DFO, Haisla Nation, and key stakeholders (Mitigation 5.7-8).
    - An Erosion and Sediment Control Plan will be developed and implemented to manage surface water and avoid sedimentation in adjacent vegetation communities (Mitigation 5.5-5).
    - A Surface Water Management Plan will be developed to address stormwater collection, treatment, and disposal during construction and operation (Mitigation 5.5-9).
    - A Wastewater Management Plan will be developed to address wastewater collection, treatment, and disposal during construction and operation (Mitigation 5.7-7).

- Water use will be managed under an operational water management plan and licence issued by the respective provincial agency (Mitigation 5.7-10).
- Water intake design will minimize the risk of injury and mortality to fish, and will take into consideration the risk of entrainment of planktonic eulachon larvae during seaward migrations (Mitigation 5.7-11).

The Project will meet the requirements of an authorization to commit serious harm to fish under paragraph 35(2)(b) of the federal *Fisheries Act* and associated guidelines and policies. These include the *Measures to Avoid Causing Harm to Fish and Fish Habitat* (DFO 2013d).

Timing Windows

During the construction phase, instream and estuarine work activities have the potential to result in physical injury or mortality to fish due to disturbance of fish during critical life stage processes, such as adult spawning or incubation of developing embryos. Instream work activities will be planned in order to manage disturbance to fish and disruption of behaviour during sensitive life stages.

Fish Salvage and Relocation

To reduce the likelihood of injury or death to fish due to activities leading to PAD of fish habitat, fish-bearing waterbodies will be isolated from the rest of the aquatic system. This will prevent additional fish migration into affected habitats. After isolation, fish will be salvaged and resident and anadromous fish will be relocated prior to infilling or dewatering of aquatic habitat. Fish salvages in the seasonally wetted salt marsh estuary habitat can be avoided, provided that site preparation activities take place before the onset of spring tides. This habitat is an area of entrapment with low fish value given its limited capacity to drain after it becomes seasonally flooded (Figure 5.7-3). Salvage will require immediate relocation to available aquatic habitats of similar productive value (i.e., possess comparable quality of physical habitat characteristics, including substrate, cover, and food availability) to be most effective. Immediate relocation into comparable habitats will increase the likelihood of successful mitigation of injury or mortality to fish.

Restriction from Entrainment and Impingement

Water use is required for hydrostatic testing of water lines, cooling towers, and pressurized lines that contain substances other than water, such as incoming natural gas and outgoing LNG. Water intake structures will address the risk of entrainment and impingement of fish in any watercourses used as a water source. *Hydrostatic Test Water Management Guidelines* (CAPP 1993) for water withdrawal during the construction phase will be followed and the *Freshwater Intake End-of-Pipe Fish Screen Guideline* (DFO 1995) will be consulted during the construction and operation phases to manage risk of entrainment and impingement of fish through the placement of fish screens on water intakes. In addition, federal requirements under the *Fisheries Act* state that fish guards are mandatory on intakes in order to prevent the undue passage of fish (DFO 1995).

LNG Canada conservatively estimates water withdrawal at 1.1 m^3/s for operational water use. In the case of Kitimat River eulachon, larval fish are small (i.e., less than 1 cm in body length; McPhail 2007), so specific mitigation measures may be required to manage the risk of planktonic larvae injury or mortality due to entrainment at the intake. Based on the eulachon life history, the incubation period following spawning is temperature-dependent (Hay and McCarter 2000), which indicates that the range of timing from spawning to larval out-migration will vary from year to year. Historic information also indicates that the majority of eulachon spawning has taken place in the section of Kitimat River adjacent to *Kitamaat IR No.1,* (Beak 1994; Pederson et al. 1995), which is downstream of the water intake location. Through consultation with the appropriate regulatory agencies, Aboriginal Groups, and other key stakeholders the Project may consider the use of special intake filters.

Operational Water Management Plan

Authority to divert and use surface water for construction and operation is obtained in accordance with the statutory requirements of the *Water Act*. The approval of water use will be contingent on LNG Canada meeting these criteria through the development of an OWMP. The OWMP will require the LNG Canada to record the rate of water use and describe compliance with the terms of the water licence. The OWMP will also include a procedure for safely adjusting flow rates in consideration of downstream fish. A key criterion, in terms of the risk to injury or mortality of fish, is the maintenance of IFN.

The Water Availability Report (Stantec 2014a) used the Alberta Desktop Method (Locke and Paul 2011), with some modifications by the OGC, to determine ecosystem flow thresholds for Kitimat River. The study determined whether:

- sufficient water exists—under average, non-drought conditions in Kitimat River, and
- thresholds exist at which water withdrawal could potentially be restricted because of low flow conditions.

The analysis incorporated low-flow frequency discharge (i.e., 7Q10 and 7Q20) over a 46-year synthetic data set based on flow data taken from the Water Survey of Canada gauge station (i.e., Station #08FF001, Kitimat River below Hirsch Creek), which is located 2 km upstream of the intake. It conservatively assumes a Project water demand of 70 000 m^3/day or 0.81 m^3/s and incorporated existing Kitimat River water licences, which yields a cumulative withdrawal rate of 5.70 m^3/s and is approximately 4.3% of mean annual flow in Kitimat River based on the Water Availability Report (Stantec 2014a).

The IFN identify ecosystem base flows (EBF) to protect aquatic resources (Locke and Paul 2011). Recommended EBF based the Alberta Desktop Method is the greater of the following two conditions:

- EBF Condition 1 – 85% of the natural flow at the intake location must be maintained, such that 15% or less of instantaneous flow reduction is permitted from natural flows under average weekly flow conditions
- EBF Condition 2 – the lesser of the natural flow or the 93.3% exceedance natural flow, which is modified by the OGC from an 80% exceedance set by Locke and Paul (2011), and based on a weekly time step

These two conditions jointly determine when water withdrawal will not be permitted during the lowest flows, which occur 6.7% of the time (i.e., flows with a 93.3% exceedance threshold). For the remaining 80% of time, flows that are higher and up to 15% of the natural flow can be considered for withdrawal under a water licence.

Maximum percent reduction in Kitimat River, given the increase in water use from the Project, will be 11.6% during late February according to the Water Availability Report (Stantec 2014a), which meets EBF Condition 1, that cumulative water withdrawal not exceed a 15% reduction of natural flow under average conditions at the intake.

The Water Availability Report (Stantec 2014a) concludes that the Project water withdrawals will not exceed the allowable reduction of natural flow conditions based on a cumulative assessment of IFN. Approval for water use will require an OWMP, which may impose water restrictions to mitigate risk to IFN for fish in lower Kitimat River during infrequent low-flow periods, including droughts. Such a plan may also require an empirical means of setting IFN, based on site-specific continuous streamflow data in Kitimat River (Hatfield et al. 2003).

5.7.5.3.3 Characterization of Change in Risk to Physical Injury or Mortality to Fish

The risk of injury and mortality effects on freshwater and estuarine fish will be substantially reduced with adherence to applicable federal and provincial legislation and with implementation of the mitigation measures and standard BMPs identified in Section 5.7.4.1 as part of the Project's environmental management system.

Construction

Injury or mortality to fish will be restricted to the Project footprint. Construction activities will occur over a short-term duration, but residual effects have a shorter duration (i.e., during fish salvages). The potential for risk will be highest during site preparation activities associated with infilling of aquatic habitats. Isolation of affected habitat (Mitigation 5.7-9) and fish salvage efforts will be necessary to relocate fish from affected habitats (Mitigation 5.7-3). Once fish have been salvaged, risk of physical injury or mortality due to construction activities can effectively be avoided. Measures will also be factored into the design of the intake structure during hydrostatic testing to manage the risk of physical injury or mortality to freshwater fish (Mitigation 5.7-11).

Fish salvage efforts (Mitigation 5.7.-3) over the construction period will be short-term. Harm by way of physical injury or mortality to freshwater or estuarine fish species will be negligible in magnitude (i.e., limited to a small number of individuals during fish salvage efforts) and reversible in that it will not cause a measurable change in the population. Reduced fitness or mortality of a small number of fish within a population will be reversible due to the inherent compensatory response in recruitment of fish populations, which tend to be density-dependent (Walters and Martell 2004). The residual effect will occur in the Project footprint only and freshwater and estuarine fish and fish habitat have a high degree of resilience in this regard, given the current state of the coho salmon population in the freshwater system and despite a considerable amount of previous disturbance from adjacent industrial developments. The residual effect will occur during multiple irregular fish salvage events, but the number of individual fish potentially affected will be low and will not affect the sustainability of fish populations.

Operation

Additional effects of potential risk of injury or mortality to freshwater or estuarine fish species will not occur, based on mitigation measures to be implemented during instream activities, such as adherence to the Project's EMPs and employment of standard BMPs under the terms of all permits and authorizations. An appropriate intake design (Mitigation 5.7-11) will manage the risk of larval eulachon and juvenile salmonids located outside the Project footprint being affected by entrainment and impingement during the operation phase, leading to a negligible effect that is confined to the LSA. Water withdrawal during LNG production in the operation phase is continuous over the long-term (i.e., minimum 25-year operational lifespan), but is reversible following the operation phase when water withdrawal ceases. Although injury or death of individual fish is a permanent loss, reduced fitness or loss of a small number of fish within a larger population is a reversible effect at the population level. Experience has shown that diligent mitigation can effectively manage fish injuries and mortalities. Replacement of the individual fish will occur within one or two generations (i.e., residual effects will have short-term duration).

The existing level of water use in Kitimat River has continued to sustain CRA fisheries, with the possible exception of eulachon. It is unclear whether historic or existing water withdrawal from Kitimat River has contributed to the eulachon decline. In the context of all CRA fisheries within the LSA, the system demonstrates moderate resilience.

5.7.5.3.4 Determination of Significance for Change in Risk of Physical Injury or Mortality to Fish

With the application of mitigation measures, the potential change in risk of physical injury or mortality to freshwater or estuarine fish species in the LSA will not affect the sustainability of fish populations during the construction or operation phases. Any such residual effect has a low likelihood of occurrence and is assessed to be not significant.

5.7.6 Summary of Project Residual Effects

With the application of mitigation measures and implementation of the offsetting plan combined residual effects will not affect the sustainability of fish populations in freshwater and estuarine fish and fish habitat in the LSA. As such, combined residual adverse effects on freshwater and estuarine fish and fish habitat are assessed as not significant.

Table 5.7-18 summarizes residual effects and mitigation measures.

Table 5.7-18: Summary of Project Residual Effects: Freshwater and Estuarine Fish and Fish Habitat

Project Phase	Mitigation Measures	Residual Effects Rating Criteria: Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood of Residual Effects	Significance	Prediction Confidence	Follow-up and Monitoring
LNG Facility Works and Activities											
Changes in Fish Habitat											
Construction	Mitigation 5.3-4 Mitigation 5.5-8 Mitigation 5.7-6 Mitigation 5.7-5 Mitigation 5.7-3 Mitigation 5.7-2 Mitigation 5.7-4 Mitigation 5.7-4 Mitigation 5.7-8 Mitigation 5.5-9 Mitigation 5.7-7	N	LSA	ST	S	R	M	L	N	H	No follow-up programs are proposed for freshwater and estuarine fish and fish habitat.

Project Phase	Mitigation Measures	Residual Effects Rating Criteria						Likelihood of Residual Effects	Significance	Prediction Confidence	Follow-up and Monitoring
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context				
Change in Risk of Physical Injury or Mortality to Fish											
Construction	Mitigation 5.3-4 Mitigation 5.5-5 Mitigation 5.5-8 Mitigation 5.7-3 Mitigation 5.7-4 Mitigation 5.7-5 Mitigation 5.7-6 Mitigation 5.7-7 Mitigation 5.7-8 Mitigation 5.7-9 Mitigation 5.7-11	N	PF	ST	MI	R	H	L	N	H	No follow-up programs are proposed for freshwater and estuarine fish and fish habitat.
Operation	Mitigation 5.7-1 Mitigation 5.7-7 Mitigation 5.7-10 Mitigation 5.7-11	N	LSA	LT	C	R	M	L	N	H	No follow-up programs are proposed for freshwater and estuarine fish and fish habitat.

KEY

MAGNITUDE:

N = Negligible—no measurable change

L = Low—a measurable change from existing baseline conditions that is below environmental or regulatory thresholds and does not affect the sustainability of fish populations

M = Moderate—a measurable change from existing baseline conditions that is above environmental and/or regulatory thresholds but does not affect the sustainability of fish populations

H = High—a measurable change from existing baseline conditions that is above environmental and/or regulatory thresholds and might adversely affect the sustainability of fish populations

GEOGRAPHIC EXTENT:

PF = Project footprint—effects are restricted to the Project footprint

LSA —effects extend into the LSA

RSA—effects extend into the RSA

DURATION:

ST = Short-term—no measurable residual effect exists beyond construction or decommissioning phases (i.e., < 6 years)

MT = Medium-term—measurable residual effect persists beyond construction or decommissioning phases for 6 to 25 years

LT = Long term—measurable residual effect persists beyond operational phase (>25 years), but is not permanent.

P = Permanent—measurable residual effect is a permanent condition

FREQUENCY:

S = Single event—residual effect occurs once, typically during construction phase

MI = Multiple irregular event— residual effect occurs more than once, but infrequently

MR = Multiple regular events—residual effect occurs more than once and frequently

C = Continuous—residual effect occurs continuously

REVERSIBILITY:

R = Reversible—residual effect is expected to cease and conditions are expected to recover to baseline during or after the Project is completed

I = Irreversible—residual effect is expected to persist and conditions are not expected to recover to baseline after the life of the Project, even after reclamation and the implementation of offsetting measures

CONTEXT:

L = Low resilience—residual effect occurs in a fragile ecosystem or the level of baseline disturbance can be a contributing factor to reduced sustainability of a local or regional fish population

M = Moderate resilience—residual effect occurs in a moderately stable ecosystem or level of baseline disturbance that does not contribute to reduced sustainability of a local or regional fish population

H = High resilience—residual effect occurs in a highly stable ecosystem or the level of baseline disturbance does not contribute to reduced sustainability of a local or regional fish population

SIGNIFICANCE:

S = Significant

N = Not Significant

PREDICTION CONFIDENC:

Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation, and assumptions made.

L = Low level of confidence

M = Moderate level of confidence

H = High level of confidence

LIKELIHOOD OF RESIDUAL EFFECT OCCURRING :

Based on professional judgment

L = Low likelihood that there will be a residual effect

M = Moderate likelihood that there will be a residual effect

H = High likelihood that there will be a residual effect

NOTES:

Change in fish health was identified as a potential residual effect, but the sources, pathways, and receptors leading to this effect have been identified and justified in Section 5.7.4, based on the outcome of not significant in the residual effects assessment for Marine Resources (Secion 5.8) and Water Quality (Section 5.9). As such, the effect on freshwater and estuarine fish and fish habitat does not require further assessment.

5.7.6.1 Changes in Fish Habitat

Changes in in fish habitat quality will occur in both freshwater and estuarine fish habitat due to the Project. Beaver Creek and associated off-channel habitat will be most affected and will require channel realignment to maintain fish access to upper Beaver Creek. Realignment of the Kitimat River side channel outside of the Project footprint will also be necessary to maintain downstream flows along the entire length of the side channel. The channel will be re-designed to provide DO levels that are suitable for CRA fish and physical habitat characteristics aimed at supporting eulachon recovery and sustaining Pacific salmon productivity. Benthic production in both affected channels will be taken into consideration in determining the level of offsetting requirements pursuant to a *Fisheries Act* authorization application (Mitigation 5.7-8). With application of the habitat offsetting mitigation strategy, there is a high degree of confidence that changes in fish habitat due to the Project will be negligible and will be a not significant residual effect.

5.7.6.2 Change in Risk of Physical Injury or Mortality to Fish

Risk of physical injury or mortality to freshwater and estuarine fish will be negligible as a result of Project activities. Fish found in habitats to be affected by site preparation due to dewatering and infilling activities will be relocated to appropriate habitats (Mitigation 5.7-3). Preferably, fish will be relocated to offsetting habitat that has been constructed prior to site preparation activities. As a residual effect, a small number of individual fish may be injured, killed, or stranded during salvage events.

Water withdrawal from Kitimat River for cooling purposes and during the hydrostatic testing may lead to entrainment and impingement of fish in their early life history stages. Fish exclusion from the intake can effectively mitigate the risk of injury and mortality.

If the fish salvage (Mitigation 5.7-3) and avoidance measures for entrainment and impingement (i.e., restriction) are followed, the likelihood of a residual effect is predicted to be low and the residual effect is assessed as not significant. The confidence in this prediction is high based on existing baseline information, the effectiveness of mitigation, and professional judgment.

Baseline data and existing scientific information, effectiveness mitigation, and professional judgment, lead to a high level of confidence that the Project will not contribute to a reduced sustainability of CRA fisheries in the LSA.

5.7.6.3 Change in Fish Health

The assessment of acidification and eutrophication effects has been determined from the conclusions from Section 5.9, Water Quality. The determination of acidification effects is based on critical load exceedances identified for the protection of aquatic life and is not significant (Section 5.9.5.2). The determination of eutrophication effects is based on a change in trophic status causing eutrophication and is not significant (Section 5.9.5.3).

5.7.7 Assessment of Cumulative Effects

Cumulative effects are assessed for each Project-specific residual effect. Three stages are involved: (1) establishing context by providing an overview of the cumulative effects of other projects and activities on the freshwater and estuarine fish and fish habitat; (2) determining the potential for Project-specific residual effects to interact with the effects of other projects and activities; and if the Project does interact cumulatively with other actions; and (3) if the Project does interact cumulatively with other projects and activities, assessing the significance of the resulting overall cumulative effect, and characterizing the Project’s contribution to the change in cumulative effects.

5.7.7.1 Stage 1, Cumulative Effects Context

The majority of resource development activity in the RSA occurs within 5 km of the LSA and includes the RTA facility and Modernization Project, the former Eurocan Pulp and Paper mill, which is now owned by the Kitimat LNG Terminal Project, as well as several proposed pipeline projects. LNG Canada owns the former Methanex terminal, which is also wholly contained within the LSA. Additional developments proposed in the RSA will combine with ongoing Project operations throughout the District of Kitimat. There are several other past, existing, and proposed development projects within the RSA including Douglas Channel LNG, Coastal Gas Link Pipeline, Pacific Trail Pipelines, Pacific Northern Gas Loop Pipeline, and Enbridge Northern Gateway. Additional industries incorporated in the cumulative effects context include forestry activities as well as fisheries and aquaculture. Aquaculture in this case pertains to ongoing hatchery enhancement activities in the RSA.

The cumulative effects assessment takes into account the residual effects attributable to the Project, as described in detail in Section 5.7.5, that could interact with other projects. Cumulative effects also consider the regional context (i.e., the RSA) over longer periods of time, including the past, present, and future (i.e., proposed projects). For these reasons, the approach examines whether all effects identified in the assessment, over and above the effects carried forward to the residual effects assessment, might occur beyond the LSA. For freshwater and estuarine fish and fish habitat, this specifically pertains to the change in fish health due to past projects and activities. Cumulative effects on water quality that could lead to acidification and/or eutrophication of freshwater systems are evaluated as not significant (see

Section 5.9.8). Cumulative effects on fish health due to air emissions are therefore not expected to occur. The conservative approach used to evaluate effects of air emissions on freshwater systems is anticipated to protect all biota.

Future projects are described as proposed projects that are in one of multiple stages of development and that have sufficient details to determine any interaction with the Project: projects that have been publicly announced; projects that are currently undergoing an environmental assessment process; or projects that have been reviewed and accepted by the EAO.

Two specific fisheries of CRA importance, eulachon and Pacific salmon, are considered for potential cumulative interactions.

Eulachon

The lower Kitimat River is one of several locations in the Haisla Nation traditional territory where eulachon spawning has been recorded. Activities that have occurred as a result of previous projects include effluent discharge from the former Eurocan pulp and paper mill, armoring of the streambank as an erosion abatement measure for the former Methanex/Cenovus Terminal, and construction of dikes by Alcan (RTA). In particular, eulachon may have been affected by contaminants from the former Eurocan effluent lagoons along Kitimat River (Tirrul-Jones 1985); this reduced the quality of the eulachon fishery due to perceived tainting of fish from effluent, which led Haisla Nation to abandon fishing for eulachon in Kitimat River in 1971 (DFO 1972, 1973).

Pacific Salmon

There is a wider interest held in the Pacific salmon fishery, extending well beyond the RSA to include Haisla Nation in conjunction with all potentially affected Aboriginal Groups and communities of the Regional District of Kitimat–Stikine.

Effects on Pacific salmon could also result from past development activities combined with the numerous projects currently proposed in the RSA. Dikes have affected the surface drainage pattern on Kitimat River and led to a confinement of flows on the west side of the 2 km long dike and upstream of the main confluence of Anderson and Moore creeks (Figure 5.7-3). Relatively high abundance of juvenile coho salmon observed west of the dike (Figure 5.7-5) and TK about fish use of the area (Bolton 2013, pers. comm.) both suggest the confinement effect has enhanced the rearing capacity of juvenile coho salmon in that area. Any juvenile salmonid rearing enhancement due to the dike combined with regular releases of juvenile salmonids produced at the hatchery, might offset past reduction in spawning habitat due to the channelization of Moore, Anderson, and Beaver Creeks (see Figure 5.7-3). Spawning activities are largely restricted to the channelized sections of Anderson and Moore creeks due to the barriers present immediately upstream and to the west of Haisla Boulevard.

Reduced spawning capacity due to previous industrial developments in the RSA, along with ongoing hatchery enhancement activities, is a potential cumulative interaction with the Project. Coho salmon rearing capacity in off-channel habitats of Lower Anderson and Beaver creeks and in the mainstem channel of Beaver Creek will be lost during site preparation activities (see Section 5.7.5.2 for the area estimates). Project activities will not lead to population-level effects on the coho salmon fishery due to targeted habitat offsetting measures that will be necessary under a *Fisheries Act* authorization for the Project.

5.7.7.2 Stage 2, Determination of Potential Cumulative Interactions

There are past, existing, and proposed industrial projects and associated activities in the RSA (Table 5.7-19). Project residual effects having the potential to interact with the effects of past projects, existing developments, or proposed projects could lead to a risk for one or more CRA fisheries.

Table 5.7-19: Potential for Cumulative Effects on Freshwater and Estuarine Fish and Fish Habitat

Other Projects and Activities with Potential for Cumulative Effects	Potential Cumulative Effects		
	Changes in Fish Habitat	Change in Risk of Physical Injury or Mortality to Fish	Change in Fish Health
Kitimat Area Project/Facility			
Coastal GasLink Pipeline Project		✓	
Douglas Channel LNG Project (also known as BC LNG)	✓	✓	✓
Enbridge Northern Gateway Project	✓	✓	
Former Eurocan Pulp and Paper Co. Site	✓		✓
Former Methanex/Cenovus Terminal	✓		
Kitimat LNG Terminal Project	✓	✓	✓
Pacific Northern Gas Pipeline (includes proposed looping)		✓	
Pacific Trail Pipelines Project		✓	
Rio Tinto Alcan Facility and Modernization Project	✓		✓
Activity			
Forestry Activities	✓		
Fishing and Aquaculture Activities		✓	

NOTE:
✓ = those ‘other projects or activities’ whose effects have potential to interact cumulatively with the Project’s residual effects.

5.7.7.2.1 Changes in Fish Habitat

Clearing and construction activities of the Project over approximately five years will lead to changes in freshwater and estuarine fish and fish habitat. These changes will be negligible when the Project-affected fish habitat is effectively offset under the federal *Fisheries Act*. There are eight projects or activities, including LNG Canada, which have a potential to affect fish habitat in the RSA. Of these eight, the construction at the RTA facility of the Kitimat Modernization Project (ongoing) and the Kitimat LNG Terminal Project (2012 to 2016) will overlap temporally and spatially with the Project and, therefore, have the greatest potential for cumulative interactions that could affect the populations of eulachon and coho salmon.

Eulachon

Industrial development has occurred in the RSA and has affected an area of the LSA that is known to be Kitimat River eulachon spawning habitat (Figure 5.7-8; Beak 1994; Pederson et al. 1995). This includes the former Eurocan lands, which have been acquired for the Kitimat LNG Terminal Project. Extensive armour along the west side of Kitimat River, near the northeast corner of the former Methanex/Cenovus terminal, protects the bank from erosion. The location of armouring along the cutbank of this meander in the river is important because it is in direct vicinity of the most suitable spawning habitat for Kitimat River eulachon. Eulachon also prefers areas with finer substrates, such as silts, sand, and gravels for spawning (McPhail 2007). There are additional Kitimat River side channels that were also previously connected with the eulachon spawning area directly downstream of this armoured section of river bank and directly upstream of the estuary. These channels were blocked by the dike constructed by Alcan (RTA) in the 1950s and are no longer available to Kitimat River eulachon. They historically represented potential eulachon habitat, since the channels are tidally-influenced and are located immediately downstream of known spawning habitat, which is just upstream of the salt wedge. Spawning habitat could, therefore, have previously been accessible during high tide through these channels.

Historical information indicates that the majority of the eulachon fishery spawns in the section of Kitimat River adjacent to *Kitamaat IR No.1,* (Beak 1994; Pederson et al. 1995), which is in the area of potential interaction. The Project will displace 3,578 m^2 in the Kitimat River side channel habitat according to the Freshwater and Estuarine Fish and Fish Habitat TDR (Triton 2014a Appendix F) directly downstream of the armoured bank. Channel realignment will be required as part of offsetting under the *Fisheries Act* authorization. Observations of the existing side channel indicate that it does not support suitable habitat for eulachon spawning in its present state; however, more suitable eulachon spawning habitat will be provided in the realigned channel as part of offsetting.

Coho Salmon

Forestry activities occur in the RSA, and timber licences for the lower Kitimat River were previously held by Eurocan (MacDonald and Shepherd 1983). Changes in fish habitat in Kitimat River could not be directly linked to the overall rate of timber harvest according to Karanka (1993), which attributed upsteam rain-on-snow events and subsequent bedload wedge formation to the destabilization of Kitimat River's downstream channel located in the RSA. MacDonald and Shepherd (1983) attributed the observed bank instability and increased sediment loads to unsustainable logging practices.

Kitimat River has had previous declines in coho and chinook salmon escapement (MacDonald and Shepherd 1983), which may be due to a combination of factors including forestry activities, industrial development by Eurocan and RTA in the RSA, harvest mortality from the commercial fishery (outside of the RSA), recreational harvest mortality within the RSA, or some other factor. In any case, the declines led to the construction of the Kitimat River hatchery in 1983 and salmonid enhancement activities have been successful for numerous species including coho salmon, chinook salmon, chum salmon, steelhead trout, and cutthroat trout (DFO 2014). Of these species, only coho salmon has the potential for cumulative interaction by the Project with other projects and activities.

Potential exists for cumulative effects to coho salmon, given both the degree of PAD of juvenile rearing habitat that must be offset and previously affected upstream spawning capacity resulting from stream channelization of Moore, Anderson, and Beaver creeks associated with industrial activities. Beaver Creek channel realignment is necessary to mitigate PAD of fish habitat and maintain upstream fish access to spawning habitat in upper Beaver Creek. The channel is proposed to be realigned around the Project footprint and south to the estuary.

Presence of a dike upstream of the Kitimat River estuary hinders movement of fish from the estuary to Kitimat River, but it has stabilized the area against effects from forestry activities. There is also a marked increase in aquatic off-channel habitat on the west side of the dike compared to the east side (Figure 5.7-3); however, without examination of groundwater dispersion, it cannot be determined whether the dike is responsible. A high degree of off-channel rearing habitat observed west of the dike may enhance productivity beyond what is expected from a diminished spawning capacity in these upstream channelized reaches, which pass through the RTA facility and along the former Eurocan Pulp and Paper mill site. There are two possible reasons for this:

- off-channel habitat conditions improve survival rates for overwintering coho salmon fry produced by spawners within the area, or
- surplus inputs of fry come from spawners outside the system from the estuary channels and are confined to the area due to the dike and by unsuitable estuarine conditions in winter (i.e., high salinity).

The cumulative interaction of PAD of coho rearing habitat in the LSA and previous reduction in spawning due to stream channelization through the RTA facility could reduce coho salmon production within the LSA. However, after the habitat offsetting strategy is successfully implemented, combined with ongoing hatchery enhancement efforts, the Project is assessed to not contribute to cumulative effects from other projects or activities listed in Table 5.7-19.

5.7.7.2.2 Change in Risk of Physical Injury or Mortality to Fish

Past project and activities in the RSA have caused injury or mortality effects to freshwater and estuarine fish. Direct fishing mortality to Pacific salmon must be acknowledged in the assessment because it is an important CRA fishery. Eulachon are traditionally harvested by Haisla Nation. Active management of these fisheries has continued through traditional harvest, stock assessment, and ongoing hatchery enhancement efforts in order to sustain them as valuable resources.

Construction of several pipeline projects is planned in the RSA, including Coastal Gas Link Pipeline Project, Enbridge Northern Gateway Project, Pacific Northern Gas Pipeline (includes proposed looping), and Pacific Trail Pipeline. In relation to the LNG Canada Project, pipelines will include crossings of Kitimat River to the east (i.e., Coastal Gas Link Pipeline and Pacific Northern Gas Pipeline projects), as well as Beaver, Anderson, and Moore creeks to the west (i.e., Enbridge Northern Gateway and Pacific Trails Pipeline projects) and directly upstream of the LNG Canada Project, the existing RTA facility, and former Eurocan Pulp and Paper mill. The potential for risk of injury or mortality of fish pertains to instream work activities and associated effects for these proposed crossings. Successful permitting will require the pipeline projects undertake appropriate standard BMPs recognized by provincial and federal regulatory authorities to mitigate the risk of injury or mortality to fish. Accordingly, the adoption these standard mitigation measures will manage the potential for cumulative interactions leading to physical injury or mortality to fish.

As for the risk of injury or mortality to eulachon larvae due to entrainment at the intake, the majority of eulachon spawning occurs within the reserve lands (Beak 1994; Pederson et al. 1995), so most larvae will emerge downstream of the water intake location and risk is minimal.

With the adoption of the EMPs, fish salvage (Mitigation 5.7-3), and a properly designed fish exclusion device at the intake (Mitigation 5.7-11), no direct residual effects from the Project on physical injury or mortality of fish will occur. Therefore, the Project contribution to cumulative effects on physical injury or mortality of fish is assessed as not significant.

5.7.7.2.3 Change in Fish Health

Effluent from the former Eurocan Pulp and Paper mill previously caused adverse effects to surface water quality in the RSA (Warrington 1987), which may have contributed to an historic collapse in the Kitimat River eulachon Aboriginal fishery. The decision by Haisla Nation to desist with Kitimat River eulachon harvest, due to perceived tainting effects (Tirrul-Jones 1985; DFO 1972, 1973), can also be reasonably interpreted as a change in fish health. Potential for cumulative effects of air emissions on freshwater systems is assessed in the water quality cumulative assessment, Section 5.9.8. The operation phase could potentially overlap with three other major industrial projects in the airshed (i.e., Douglas Channel LNG Project, the RTA facility and Modernization Project, and the Kitimat LNG Terminal Project), among other projects in the RSA. Section 5.9.8 concluded no significant cumulative effects of freshwater systems due to air emissions, using conservative assumptions for the protection of all aquatic life.

The Project will comply with applicable federal and provincial legislation to prevent change in fish health. Compliance with and enforcement of the terms set by mandatory legal permits and authorizations, including the Project's Water Licence and Waste Discharge Authorization (if required), will manage the risk of Project contribution to cumulative effects leading to change in fish health that could adversely affect the sustainability of CRA fisheries in the region. Successful permitting of all proposed projects likewise requires appropriate compliance with provincial and federal regulatory authorities. Accordingly, the potential for cumulative change in fish health will be managed.

5.7.7.3 Stage 3, Determining Significance of Cumulative Effects

5.7.7.3.1 Changes in Fish Habitat

LNG Canada will undertake offsetting measures that must be acceptable to DFO to avoid any net loss in productivity of fish habitat. Freshwater offsets will be designed to support salmon and eulachon rearing and spawning activities. Estuarine habitat offsets is considered in the conceptual plan for the marine offsetting strategy, which is discussed in Section 5.8, Marine Resources. Therefore, the Project contribution to cumulative effects on fish habitat is assessed as not significant and will not adversely affect the sustainability of fisheries in the region. As a result, the Project contribution to cumulative effects on PAD of fish habitat is assessed to be not significant.

5.7.7.3.2 Change in Risk of Physical Injury or Mortality to Fish

The Project contribution to cumulative effects on harm to fish, by way of physical injury or mortality, will not adversely affect the sustainability of salmonid populations in the RSA or in the Kitimat River watershed. Cumulative effects will be negligible and, therefore, not significant.

5.7.7.3.3 Change in Fish Health

In the surface water quality assessment, the determination of acidification and eutrophication effects is based on a conservative approach to protect all aquatic life. Residual and cumulative effects of air emission on freshwater systems located near the LNG facility are assessed as not significant (Section 5.9.7 and Section 5.9.8, respectively). As such, the Project contribution to change in fish health due to air emissions is negligible, and it will not change the overall cumulative effects significance determination.

5.7.7.4 Summary of Cumulative Effects

Cumulative effects from the Project will be local and will not lead to population effects on eulachon or Pacific salmon. As a result, the Project will not affect the long-term sustainability of regional fish populations and cumulative effects are assessed to be not significant. Table 5.7-20 summarizes cumulative effects and mitigation measures.

5.7.8 Prediction Confidence and Risk

There is scientific certainty around quantifying the baseline data and qualifying the effects and mechanisms of each respective effect. The mitigation measures and standard BMPs are an effective strategy to manage the risk of adverse effects to fish and fish habitat. The potential pathway of effects is well understood and has demonstrated capacity to mitigate the risks identified in this effects assessment.

The abundance of available scientific literature, field studies, and comprehensive data analysis from existing data sources and scientifically conducted field surveys provide a high degree of confidence in the results of the assessment. Given the legislative requirements of the *Fisheries Act*, changes in fish habitat are predicted to be negligible and not significant with a high degree of confidence. Change in risk to injury or mortality of fish has a low likelihood of occurrence and is assessed to be not significant with a high degree of confidence. The potential risk of change in fish health for freshwater and estuarine fisheries is assessed as not significant, with a high degree of confidence.

Preliminary information on the development stage for a number of proposed future projects results in a confidence determination of moderate.

Table 5.7-20: Summary of Cumulative Effects on Freshwater and Estuarine Fish and Fish Habitat

Effect	Other Projects, Activities and Actions	Cumulative Effects Characterization					
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context
Facility Activities and Works							
Cumulative Changes in Fish Habitat							
Cumulative effect with the Project and other projects, activities and actions ▪ Effects from past activities including bank armour along the Kitimat River, stream channelization through upstream industrial sites, and construction of dikes along the estuary floodplain. ▪ Future projects will be required to effectively offset potential effects to fish habitat	▪ Douglas Channel LNG Project (also known as BC LNG) ▪ Enbridge Northern Gateway project ▪ Forestry Activities ▪ Former Eurocan Pulp and Paper Co. Site ▪ Former Methanex/Cenovus Terminal ▪ Kitimat LNG Terminal Project ▪ Rio Tinto Alcan Facility and Modernization Project	H	RSA	LT	C	R	M
Contribution from the Project to the overall cumulative effect ▪ Residual effects will be negligible if the affected fish habitat is effectively offset. • Construction of the Project will result in approximately 125,000 m^2 of PAD of freshwater aquatic habitat requiring offsetting and 23,500 m^2 of PAD of estuarine aquatic habitat requiring offsetting.		N	LSA	ST	S	R	M

Effect	Other Projects, Activities and Actions	Cumulative Effects Characterization					
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context
Cumulative Change in Risk of Physical Injury or Mortality to Fish							
Cumulative effect with the Project and other projects, activities and actions ▪ Past and current projects have not affected the sustainability of fish populations, with the possible exception of Kitimat River eulachon. ▪ Future projects will not affect the sustainability of fish populations by following standard BMPs recognized by regulatory authorities.	▪ Coastal Gas Link Pipeline ▪ Douglas Channel LNG Project (also known as BC LNG) ▪ Enbridge Northern Gateway Project ▪ Fishing and Aquaculture Activities ▪ Kitimat LNG Terminal Project ▪ Pacific Northern Gas Pipeline (includes proposed looping) Pacific Trail Pipelines Project	M	RSA	ST	MI	R	M
Contribution from the Project to the overall cumulative effect: ▪ Water intake design, isolation of affected habitats, and implementation of fish salvage will manage the risk of injury and mortality to fish.		N	PF	ST	MI	R	H

KEY

MAGNITUDE:

N = Negligible—no measurable change

L = Low—a measurable change from existing baseline conditions that is below environmental or regulatory thresholds and does not affect the sustainability of fish populations

M = Moderate—a measurable change from existing baseline conditions that is above environmental and/or regulatory thresholds but does not affect the sustainability of fish populations

H = High—a measurable change from existing baseline conditions that is above environmental and/or regulatory thresholds and might adversely affect the sustainability of fish populations

GEOGRAPHIC EXTENT:

PF = Project footprint—effects are restricted to the Project footprint

LSA —effects extend into the LSA

RSA—effects extend into the RSA

DURATION:

ST = Short-term—no measurable residual effect exists beyond construction or decommissioning phases (i.e., < 6 years)

MT = Medium-term—measurable residual effect persists beyond construction or decommissioning phases for 6 to 25 years

LT = Long term—measurable residual effect persists beyond operational phase (>25 years), but is not permanent.

P = Permanent—measurable residual effect is a permanent condition

FREQUENCY:

S = Single event—residual effect occurs once, typically during construction phase

MI = Multiple irregular event— residual effect occurs more than once, but infrequently

MR = Multiple regular events—residual effect occurs more than once and frequently

C = Continuous—residual effect occurs continuously

REVERSIBILITY:

R = Reversible—residual effect is expected to cease and conditions are expected to recover to baseline during or after the Project is completed

I = Irreversible—residual effect is expected to persist and conditions are not expected to recover to baseline after the life of the Project, even after reclamation and the implementation of offsetting measures

CONTEXT:

L = Low resilience—residual effect occurs in a fragile ecosystem or the level of baseline disturbance can be a contributing factor to reduced sustainability of a local or regional fish population

M = Moderate resilience—residual effect occurs in a moderately stable ecosystem or level of baseline disturbance that does not contribute to reduced sustainability of a local or regional fish population

H = High resilience—residual effect occurs in a highly stable ecosystem or the level of baseline disturbance does not contribute to reduced sustainability of a local or regional fish population

SIGNIFICANCE:

S = Significant

N = Not Significant

PREDICTION CONFIDENC:

Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation, and assumptions made.

L = Low level of confidence

M = Moderate level of confidence

H = High level of confidence

LIKELIHOOD OF RESIDUAL EFFECT OCCURRING :

Based on professional judgment

L = Low likelihood that there will be a residual effect

M = Moderate likelihood that there will be a residual effect

H = High likelihood that there will be a residual effect

5.7.9 Follow-up Program and Compliance Monitoring

No follow-up programs are proposed for freshwater and estuarine fish and fish habitat. Compliance monitoring to be implemented through Environmental Management Plans is described in Section 12 and Section 21 (Table 21.3–1).

The Project will require an authorization from DFO to commit *serious harm to fish* under paragraph 35(2)(b) of the *Fisheries Act* due to PAD of fish habitat. This will involve an offsetting plan that can achieve the guiding principle of no net loss of productivity (Mitigation 5.7-8). To be accepted, an appropriate monitoring program will be required and must comply with DFO's fish protection policy and guidelines. A qualified professional will monitor compliance with requirements outlined in the paragraph 35(2)(B) *Fisheries Act* authorization. Monitoring requirements may include the following measures:

- channel realignment effectiveness
- improvements in benthic productivity
- effectiveness of habitat enhancement structures
- changes in substrate and water quality
- eulachon and Pacific salmon migration and spawning success
- stream productivity at offsetting sites (e.g., created or enhanced channels), and
- fish population abundance and distribution at offsetting sites (e.g., created or enhanced channels).

5.7.10 Summary of Mitigation Measures

These mitigation measures are intended to prevent *serious harm to fish* from occurring as a result of Project activities. The activities have initially been identified as part of the pathway of effects diagram in the Freshwater and Estuarine Fish and Fish Habitat TDR (Triton 2014a Appendix F) developed under the *Practitioners Guide to the Risk Management Framework for DFO Habitat Management Staff* (DFO 2010). Standard BMPs, measures to avoid causing harm, codified practices, and additional mitigation measures contained in the construction and operational EMPs of the Project's environmental management system will be applied to manage the effects identified as Rank 1 interactions (refer to Section 5.7.4.1).

Mitigation of PAD of fish habitat will include commitments associated with Project activities:

- The footprint for LNG facility and temporary construction facilities will be sized to allow safe and efficient construction. Existing cleared areas will be utilized, where practicable, to limit area of new disturbance (Mitigation 5.3-4).
- Design of the LNG loading line corridor will consider and incorporate, where practicable, ways to maintain tidal flow and wildlife passage (Mitigation 5.5-8).

- Design stream crossings to a 1:100 year flow event at a minimum (Mitigation 5.7-1).
- To minimize impact to fish and fish habitat, instream works will occur within the relevant reduced risk work windows, where practicable. Where Project activities need to occur outside the reduced risk work windows, measures to protect fish and fish habitat will be developed in consultation with appropriate regulatory bodies including DFO. These measures will be detailed in the Fish Habitat Offsetting Plan (Mitigation 5.7-5).
- If isolating freshwater habitats during instream works occurs, fish will be salvaged and relocated to unaffected habitats (Mitigation 5.7-3).
- To minimize potential sedimentation of watercourses, disturbed riparian areas will be reclaimed with appropriate vegetation cover, as soon as practicable after construction (Mitigation 5.7-2).
- An onsite environmental monitor will be present during all instream (freshwater) works to confirm adherence with measures detailed in the Fish Habitat Offsetting Plan (Mitigation 5.7-4).
- Measures to protect fish and fish habitat will be provided in various EMPs including a Fish Habitat Offsetting Plan, an Erosion and Sediment Control Plan and Surface Water Management Plan and Wastewater Management Plan (Mitigation 5.7-6):
    - The Fish Habitat Offsetting Plan will be developed and implemented to offset unavoidable permanent alteration or destruction of fish habitat from Project activities and works, in consultation with DFO, Haisla Nation, and key stakeholders (Mitigation 5.7-8).
    - An Erosion and Sediment Control Plan will be developed and implemented to manage surface water and avoid sedimentation in adjacent vegetation communities (Mitigation 5.5-5).
    - A Surface Water Management Plan will be developed to address stormwater collection, treatment, and disposal during construction and operation (Mitigation 5.5-9).
    - A Wastewater Management Plan will be developed to address wastewater collection, treatment, and disposal during construction and operation (Mitigation 5.7-7).
- Water use will be managed under an operational water management plan and licence issued by the respective provincial agency (Mitigation 5.7-10).
- A Decommissioning Environmental Management Program will be necessary component of the framework and will appropriately address waste management, dismantling, and removal of instream works. The Decommissioning Plan will be developed and implemented before decommissioning to allow habitat recovery to proceed as soon as possible (Mitigation 5.6-4).

Overall, PAD of fish habitat can be effectively mitigated through offsetting measures developed under meaningful consultation with DFO and Haisla Nation and in consideration of neighbouring resource development interests.

Mitigation of injury and mortality of fish will include commitments associated with Project activities:

- Footprint for LNG facility and temporary construction facilities will be sized to allow safe and efficient construction. Existing cleared areas will be utilized, where practicable, to limit area of new disturbance (Mitigation 5.3-4).
- Design of the LNG loading line corridor will consider and incorporate, where practicable, ways to maintain tidal flow and wildlife passage (Mitigation 5.5-8).
- Design stream crossings to a 1:100 year flow event at a minimum (Mitigation 5.7-1).
- To minimize impact to fish and fish habitat, instream works will occur within the relevant reduced risk work windows, where practicable. Where Project activities need to occur outside the reduced risk work windows, measures to protect fish and fish habitat will be developed in consultation with appropriate regulatory bodies including DFO. These measures will be detailed in the Fish Habitat Offsetting Plan (Mitigation 5.7-5).
- If isolating freshwater habitats during instream works fish will be salvaged and relocated to unaffected habitats (Mitigation 5.7-3). Suitable relocation habitats will either include nearby unaffected habitat or aquatic habitats developed as acceptable offsets under the *Fisheries Act* authorization.
- To protect fish from injury and mortality, freshwater habitats to be affected by construction activities will be isolated from adjacent fish-bearing aquatic habitats (Mitigation 5.7-9).
- An onsite environmental monitor will be present during all instream (freshwater) works to confirm adherence with measures detailed in the Fish Habitat Offsetting Plan (Mitigation 5.7-4).
- Measures to protect fish and fish habitat will be provided in various EMPs including a Fish Habitat Offsetting Plan, an Erosion and Sediment Control Plan and Surface Water Management Plan and Wastewater Management Plan (Mitigation 5.7-6):
    - The Fish Habitat Offsetting Plan will be developed and implemented to offset unavoidable permanent alteration or destruction of fish habitat from Project activities and works, in consultation with DFO, Haisla Nation, and key stakeholders (Mitigation 5.7-8).
    - An Erosion and Sediment Control Plan will be developed and implemented to manage surface water and avoid sedimentation in adjacent vegetation communities (Mitigation 5.5-5).
    - A Surface Water Management Plan will be developed to address stormwater collection, treatment, and disposal during construction and operation (Mitigation 5.5-9).

- A Wastewater Management Plan will be developed to address wastewater collection, treatment, and disposal during construction and operation (Mitigation 5.7-7).

- Water use will be managed under an operational water management plan and licence issued by the respective provincial agency (Mitigation 5.7-10).
- Water intake design will minimize the risk of injury and mortality to fish, and will take into consideration the risk of entrainment of planktonic eulachon larvae during seaward migrations (Mitigation 5.7-11).
- A Decommissioning Environmental Management Program will be necessary component of the framework and will appropriately address waste management, dismantling, and removal of instream works. The Decommissioning Plan will be developed and implemented before decommissioning to allow habitat recovery to proceed as soon as possible (Mitigation 5.6-4).

Overall, risk of injury and mortality to fish can be effectively mitigated through relocation and restriction measures. There is a high degree of confidence that these efforts will manage the risk posed by the Project. Five years of effectiveness monitoring of the offsetting measures will ensure that they provide suitable fish habitat and uphold the productivity of the affected habitats previously occupied by relocated fish.

Mitigation measures to address potential for change in fish health will include commitments associated with Project activities:

- Stormwater will be managed through the Surface Water Management Plan (Mitigation 5.5-9). The Surface Water Management Plan will include a framework describing how stormwater will be collected, treated, tested and discharged as well as any follow-up monitoring requirements. The plan will include BMPs, such as diverting external surface water runoff around the facility to avoid potential contamination.
- Water use will be managed under an operational water management plan and licence issued by the respective provincial agency (Mitigation 5.7-10).
- Wastewater will be managed through the Wastewater Management Plan (Mitigation 5.7-7). The Wastewater Management Plan will include a framework describing how wastewater (including effluent such as cooling water) and sanitary sewage will be collected, treated, tested and discharged as well as any follow-up monitoring requirements
- A Decommissioning Environmental Management Program will be necessary component of the framework and will appropriately address waste management, dismantling, and removal of instream works. Develop and implement a Decommissioning Plan before decommissioning to allow habitat recovery to proceed as soon as possible (Mitigation 5.6-4)

Overall, risk to change in fish health can be effectively mitigated through measures developed through meaningful consultation with provincial and federal regulatory authorities.

5.7.11 Conclusion

Pacific salmon has become one of Canada's most valuable fisheries and is a jointly managed resource that is shared between Canada and the US under the Pacific Salmon Treaty through the Pacific Salmon Commission. Both wild and hatchery reared salmon stocks hold high fisheries value for FSC purposes for Aboriginal communities. Grease rendered from eulachon has historically been among the most valuable trade commodities to both Coastal and Interior Aboriginal Groups of the Province. The Kitimat River eulachon fishery has been depressed compared to historic abundances due to pre-existing unknown factors, but its recovery is the single most important resource objective of Haisla Nation from a fisheries perspective (Jacobs 2013, pers. comm.).

Scientific evidence and local knowledge suggest that freshwater and estuary ecosystems in the LSA are a potential surplus habitat for Pacific salmon in Kitimat River, which predominantly supports the rearing and overwintering of juvenile coho salmon. The assessments of Project-level residual effects and cumulative effects conclude that effects on CRA fisheries will not pose a risk at the population-level.

Effective mitigation and offsetting measures that meet the guiding principle of no net loss of productivity are the key actions by LNG Canada to manage or eliminate residual effects. Appropriate mitigation, offsetting, and ongoing environmental management will be required under the auspices of an Authorization by DFO under paragraph 35(2)(b) *Fisheries Act*. LNG Canada compliance with the authorization will ensure that the Project results in not significant adverse effects on freshwater and estuarine fish and fish habitat.